CanSat 2020
Preliminary Design Review (PDR)
Version 1.0

Team #7840
grizu-263

Presentation Outline (1 of 8)

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6. Communication and Data Handling (CDH) Subsystem Design - 101

7. Electrical Power Subsystem (EPS) Design - 117

8. Flight Software (FSW) Design - 135

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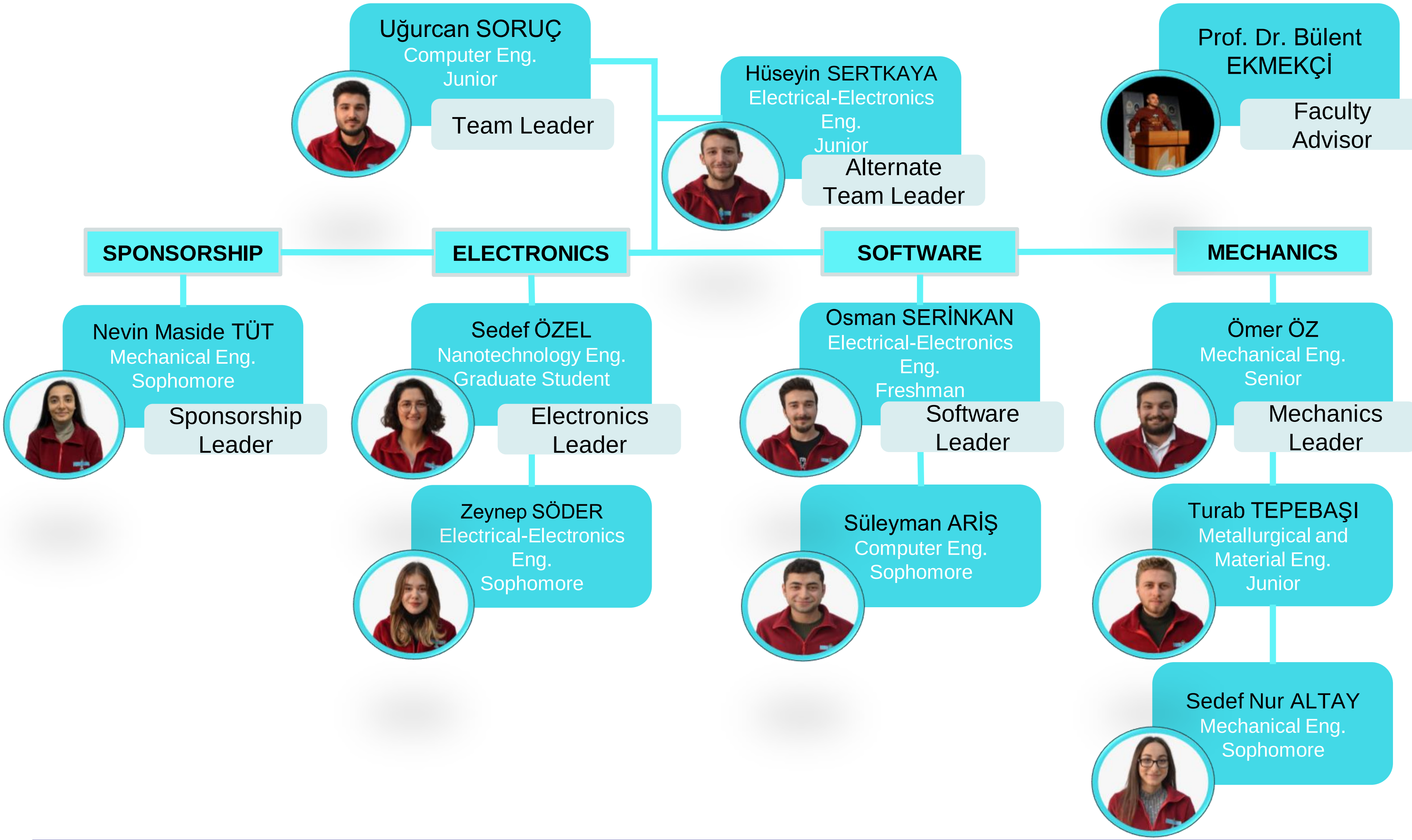
Presentation Outline (7 of 8)

- **Systems Overview –** Sedef Nur ALTAY
- **Sensor Subsystem Design –**Zeynep SÖDER
- **Descent Control Design –** Turab TEPEBAŞI
- **Mechanical Subsystem Design –** Ömer ÖZ
- **CDH Subsystem Design –** Sedef ÖZEL
- **Electrical Power Subsystem Design –** Hüseyin SERTKAYA
- **Flight Software Design –** Osman SERİNKAN
- **Ground Control System Design –** Süleyman ARİŞ
- **CanSat Integration and Test –** Uğurcan SORUÇ
- **Mission Operations and Analysis –** Uğurcan SORUÇ
- **Requirements Compliance –** Uğurcan SORUÇ
- **Management –** Nevin Maside TÜT

Team Organization



Acronyms (1 of 2)

- **A** – Analysis
- **ABS** – Acrylonitrile Butadiene Styrene
- **AC** – Alternate Current
- **ANT** – Antenna
- **Aoa** – Angle of Attack
- **AR** – Aspect Ratio
- **CC** – CanSat Crew
- **CDH** – Communication and Data Handling
- **CDR** – Critical Design Review
- **CRC** – Container Recovery Crew
- **cm** – Centimeter
- **D** – Demonstration
- **dB** – Decibel
- **dBi** – Decibel Isotropic
- **dBm** – Decibel Milliwatt
- **DC** – Direct Current
- **DS** – Datasheet
- **E** – Estimate
- **EEPROM** – Electrically Erasable Programmable Read Only Memory
- **Eng -** Engineering
- **EPS** – Electrical Power Subsystem
- **FSW** – Flight Software
- **g** – Gram
- **GB** – Giga Byte
- **GCS** – Ground Control System
- **GSC** – Ground Station Crew
- **GHz** – Giga Hertz
- **GND** – Ground
- **GPS** – Global Positioning System
- **GR** – Glide Ratio
- **Gs** – Gigashock
- **h** – Hours
- **hPa** – Hecto Pascal
- **Hz** – Hertz
- **I** – Inspection
- **I2C** – Inter-Integrated Circuit
- **ID** – Identification Number
- **IDE** – Integrated Development Environment
- **IMU** – Inertial Measurement Unit
- **kB** – Kilo Byte
- **kg** – Kilogram
- **km** – Kilometer
- **kPa** – Kilo Pascal
- **m** – Meter
- **mA** – Milli Ampere
- **mAh** – Milli Ampere Hour
- **Mb** – Megabit
- **MCO** – Mission Control Officer
- **MCU** – Microcontroller Unit
- **mg** – Milligram
- **MHz** – Mega Hertz
- **min** – Minute
- **mm** – Millimeter
- **MPa** – Mega Pascal
- **ms** – Millisecond
- **MS** – Measurement
- **mW** – Milli Watt

Acronyms (2 of 2)

- **N** – Newton
- **Pa** – Pascal
- **PCB** – Printed Circuit Board
- **PDR** – Preliminary Design Review
- **PFR** – Post Flight Review
- **PM** – Particulate Matter
- **PRC** – Payload Recovery Crew
- **Prev** – Previous
- **PWM** – Pulse Width Modulation
- **r** – Radius
- **RAM** – Random Access Memory
- **RC** – Recovery Crew
- **RF** – Radio Frequency
- **RN** – Requirement Number
- **RP- SMA** – Reverse Polarity SubMiniature Version A
- **RTC** – Real Time Clock
- **s** – Second
- **SD** – Secure Digital
- **SMA** – SubMiniature Version A
- **SPI** – Serial Peripheral Interface
- **Ssh** – Spill Hole Area
- **T** – Test
- **TEMP** – Temperature
- **UART** – Universal Asynchronous Receiver/ Transmitter
- **USB** – Universal Serial Bus
- **UTC** – Coordinated Universal Time
- **V** – Voltage
- **VM** – Verification Method
- **Wh** – Watt hours
- **WS** – Wingspan
- **XCTU** – Next Generation Configuration Platform for XBee/RF Solutions
- C_D – Drag Coefficient
- C_L – Lift Coefficient
- g – Gravitational Force
- Sp – Area of the Parachute with a Spill Hole
- ρ – Air density at +15°C from sea level
- V – Descent Speed
- **%** – Percent
- **.csv** – Comma-Separated Value
- **°C** – Centigrade Degree
- **°** – Degree
- **µA** – Micro Ampere
- **µm** – Micrometer

Systems Overview

Sedef Nur ALTAY

Mission

- The CanSat will consist of a container and a payload.
- The payload shall be a delta wing glider that will glide in a circular pattern, once released.

Mission Objectives

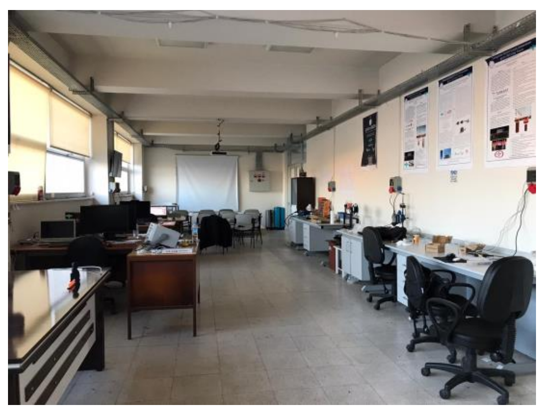
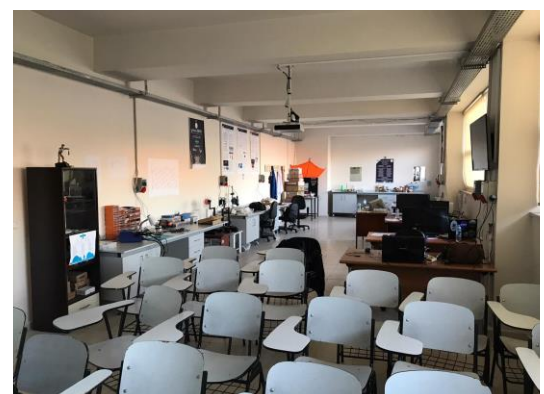
- The CanSat shall be launched to an altitude ranging 670 meters to 725 meters above the launch site and deployed near apogee (peak altitude). Orientation of deployment is not controlled and is most definitely violent.
- The CanSat container must protect the payload from damage during the launch and deployment.
- Once the CanSat is deployed from the rocket, the CanSat shall descent using a parachute at a descent rate of 20 m/s (±5 m/s). At 450 meters (±10 m), the container shall release the payload.
- The payload shall glide in a circular pattern with a radius of 250 meters collecting sensor data for one minute and remain above 100 meters after being released.
- The payload shall monitor altitude, air speed and the payload shall be a particulate/dust sensor to detect particulates in the air while gliding.
- Afterwards, the payload shall deploy a parachute to cause the payload to stop gliding and drop to the ground at a rate of 10 m/s (±5 m/s).

Bonus Objective

- A video camera shall be integrated into the payload and point toward the coordinates provided for the duration of the glide time.
- Video shall be in color with a minimum resolution of 640x480 pixels and 30 frames per second.
- The video shall be recorded and retrieved when the payload is retrieved.

External Objectives

- 3D simulation was added to the software.
- Our goal is to be first in CanSat 2020.
- Through our success in the CanSat competition, we signed a sponsorship agreement with ERDEMİR Company and we expanded our team and moved into our new lab.

External Objectives

- The recognition of the team has increased in Turkey after we came second place for the second time. The awareness of CanSat Competition is also increased nationwide.
- We came first in the model satellite competition held within the scope of TEKNOFEST event held in Turkey.
- We have gained an acceptable experience with CanSat Competition and started a new national project to design and produce Turkey's first PocketQube satellite.
  - PocketQube will have dimensions of the 5x5x5 cm.
  - It will be placed in Low Earth Orbit at an altitude. (500 km)
  - We have completed the ground station installation for PocketQube.
  - PocketQube satellite is under production phase. (prototype 75%)

  At the same time, our satellite ground station is completed, and it is operational now.

- PocketQube and CanSat internet address:

https://x.grizu-263.space/

https://grizu263.beun.edu.tr/

System Requirement Summary (1 of 5)

Requirement Number	Requirement	Rationale	Priority	VM			
				A	I	T	D
RN#1	Total mass of the CanSat (science payload and container) shall be 600 grams +/- 10 grams.	Competition Requirement	HIGH	✓	✓	✓	
RN#2	CanSat shall fit in a cylindrical envelope of 125 mm diameter x 310 mm length. Tolerances are to be included to facilitate container deployment from the rocket fairing.	Competition Requirement	HIGH		✓	✓	✓
RN#3	The container shall not have any sharp edges to cause it to get stuck in the rocket payload section which is made of cardboard.	Competition Requirement	HIGH		✓	✓	
RN#4	The container shall be a fluorescent color; pink, red or orange.	Competition Requirement	HIGH		✓		
RN#5	The container shall be solid and fully enclose the science payload. Small holes to allow access to turn on the science payload is allowed. The end of the container where the payload deploys may be open.	Competition Requirement	HIGH		✓	✓	
RN#6	The rocket airframe shall not be used to restrain any deployable parts of the CanSat.	Competition Requirement	MEDIUM		✓		✓
RN#7	The rocket airframe shall not be used as part of the CanSat operations.	Competition Requirement	HIGH		✓		✓
RN#8	The container parachute shall not be enclosed in the container structure. It shall be external and attached to the container so that it opens immediately when deployed from the rocket.	Competition Requirement	HIGH		✓	✓	✓

System Requirement Summary (2 of 5)

Requirement Number	Requirement	Rationale	Priority	VM			
				A	I	T	D
RN#9	The descent rate of the CanSat (container and science payload) shall be 20 meters/second +/- 5m/s.	Competition Requirement	HIGH		√	√	√
RN#10	The container shall release the payload at 450 meters +/- 10 meters.	Competition Requirement	HIGH		√	√	√
RN#11	The science payload shall glide in a circular pattern with a 250 m radius for one minute and stay above 100 meters after release from the container.	Competition Requirement	HIGH	√	√	√	√
RN#12	The science payload shall be a delta wing glider.	Competition Requirement	HIGH	√	√		√
RN#13	After one minute of gliding, the science payload shall release a parachute to drop the science payload to the ground at 10 meters/second, +/- 5 m/s.	Competition Requirement	HIGH	√	√	√	
RN#18	All electronics shall be hard mounted using proper mounts such as standoffs, screws, or high-performance adhesives.	Competition Requirement	MEDIUM	√	√		
RN#19	All mechanisms shall be capable of maintaining their configuration or states under all forces.	Competition Requirement	HIGH	√		√	
RN#20	Mechanisms shall not use pyrotechnics or chemicals.	Competition Requirement	HIGH	√	√		
RN#21	Mechanisms that use heat (e.g., nichrome wire) shall not be exposed to the outside environment to reduce potential risk of setting vegetation on fire.	Competition Requirement	HIGH	√	√	√	

System Requirement Summary (3 of 5)

Requirement Number	Requirement	Rationale	Priority	VM			
				A	I	T	D
RN#22	The science payload shall measure altitude using an air pressure sensor.	Competition Requirement	HIGH	√		√	√
RN#23	The science payload shall provide position using GPS.	Competition Requirement	HIGH	√		√	√
RN#24	The science payload shall measure its battery voltage.	Competition Requirement	HIGH	√		√	√
RN#25	The science payload shall measure outside temperature.	Competition Requirement	HIGH	√		√	√
RN#26	The science payload shall measure particulates in the air as it glides.	Competition Requirement	HIGH	√		√	√
RN#27	The science payload shall measure air speed.	Competition Requirement	HIGH	√		√	√
RN#28	The science payload shall transmit all sensor data in the telemetry.	Competition Requirement	HIGH	√	√	√	√
RN#29	Telemetry shall be updated once per second.	Competition Requirement	HIGH		√	√	
RN#30	The Parachutes shall be fluorescent Pink or Orange.	Competition Requirement	MEDIUM	√	√		

System Requirement Summary (4 of 5)

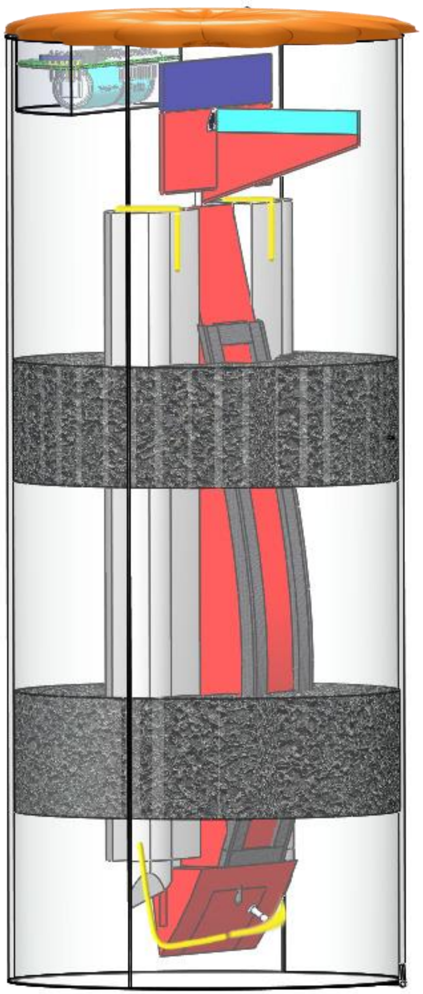
Requirement Number	Requirement	Rationale	Priority	VM A	VM I	VM T	VM D
RN#41	All telemetry shall be displayed in engineering units (meters, meters/sec, Celsius, etc.).	Competition Requirement	HIGH	√			√
RN#46	Both the container and probe shall be labeled with team contact information including email address.	Competition Requirement	MEDIUM	√			√
RN#48	No lasers allowed.	Competition Requirement	MEDIUM	√			
RN#49	The probe must include an easily accessible power switch that can be accessed without disassembling the CanSat and in the stowed configuration.	Competition Requirement	MEDIUM	√	√	√	
RN#50	The probe must include a power indicator such as an LED or sound generating device that can be easily seen without disassembling the CanSat and in the stowed state.	Competition Requirement	MEDIUM	√	√	√	√
RN#51	An audio beacon is required for the probe. It may be powered after landing or operate continuously.	Competition Requirement	HIGH	√		√	
RN#52	The audio beacon must have a minimum sound pressure level of 92 dB, unobstructed.	Competition Requirement	HIGH	√		√	
RN#53	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.	Competition Requirement	HIGH	√	√		

System Requirement Summary (5 of 5)

Requirement Number	Requirement	Rationale	Priority	VM			
				A	I	T	D
RN#54	An easily accessible battery compartment must be included allowing batteries to be installed or removed in less than a minute and not require a total disassembly of the CanSat.	Competition Requirement	HIGH	√	√		
RN#55	Spring contacts shall not be used for making electrical connections to batteries. Shock forces can cause momentary disconnects.	Competition Requirement	MEDIUM	√	√		
RN#56	The CanSat must operate during the environmental tests laid out in Section 3.5.	Competition Requirement	HIGH	√	√	√	√

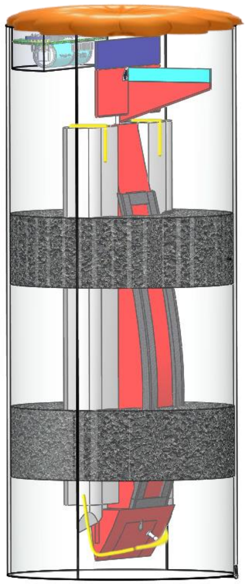
System Level CanSat Configuration Trade & Selection (1 of 5)

Configuration 1



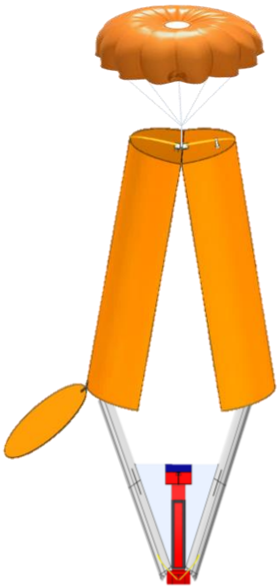
Configuration 1	
General Description	• The system will be provided descent with active control. • The payload has an airfoil form and wings are located in it. • The wings are also in airfoil form. The wings will be opened by the hinge, rotating joint and stretched fabric elastic. • The telescopic system will be integrated in the payload and it will be opened with a small spring. • This way the system length and wing area will be increased to rise the total lifting force.
Pros	• The system can be easily folded and opened. • The airfoil structure of the wing and payload will provide a stable flight and elevated lifting force. • The desired direction will be provided through active control. • The wing area will be increased when the telescopic system is opened. • The diamond type delta wing exhibits a stable flight.
Cons	• The system is difficult to produce.

System Level CanSat Configuration Trade & Selection (2 of 5)



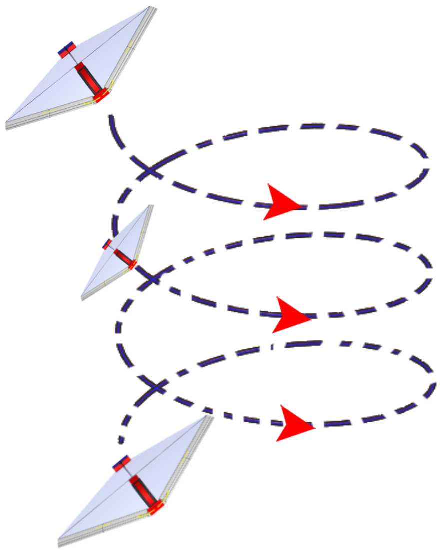
Position 1

The payload will be placed in the container. The payload will be separated from the container with the use of melt of fishline method.



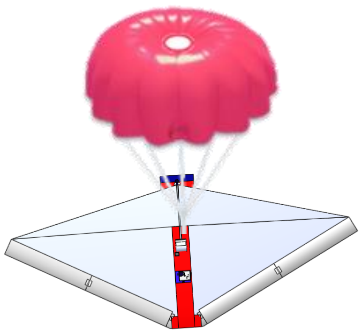
Position 2

The payload will release from the container and the wings will be opened by the use of hinge, rotating joint and stretched fabric elastic. Telescopic system will be opened by a small spring.



Position 3

The payload's wings are shown in the open position. The payload's descent and rotation rate actively controlled with the use of an elevator and a rudder.

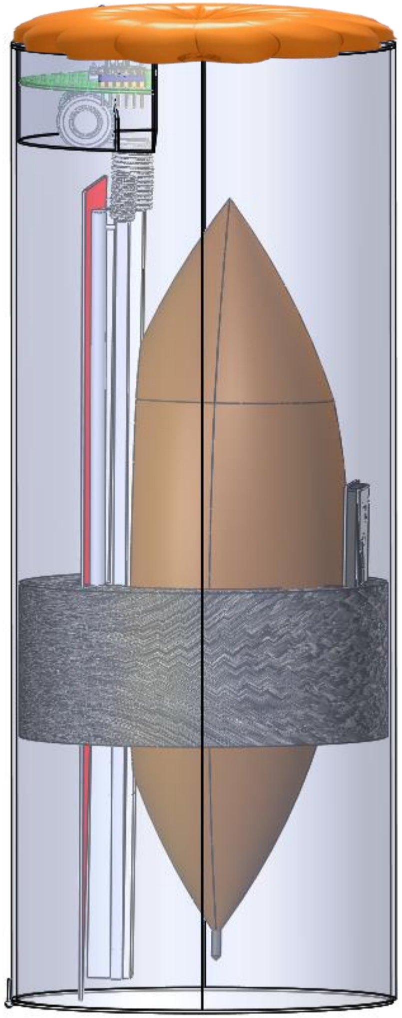


Position 4

The parachute will be opened at the desired altitude.

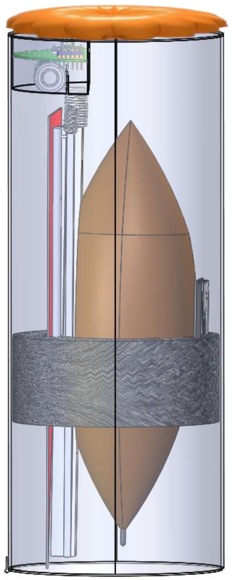
System Level CanSat Configuration Trade & Selection (3 of 5)

Configuration 2



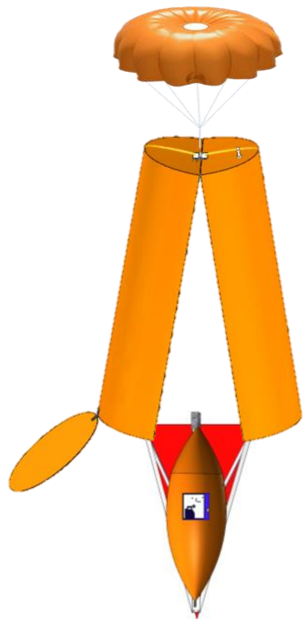
Configuration 2	
General Description	• The system will be descent passively. • Support rods in the middle and side of the payload will be integrated into the telescopic system. • This telescopic system will be opened after exiting the container. The wings will be also opened simultaneously with the system. • The two translational joint guide the opening mechanism. The compressing spring will provide the required force for opening. • Once the payload has exited from the container, the springs force the mechanisms to open the wings. • The flight direction will be adjusted by center of mass shifting.
Pros	• The payload get the required surface area for the wings and will provide a stable flight through the telescopic system. • No elements will be used for routing, so passive decline will be realized.
Cons	• It exhibits an unstable flight at low speed and low altitude. This design can not be controlled in variable weather conditions. • The bonus mission is difficult to perform because passive control is used.

System Level CanSat Configuration Trade & Selection (4 of 5)



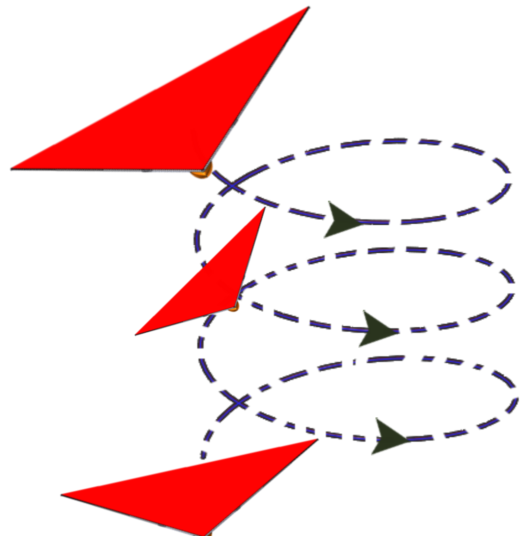
Position 1

The payload will be placed in the container. The payload will be separated from the container with the use of melt of fishline.



Position 2

The payload will be released from the container and the wing will be opened with the use of a telescopic and translational joint system.



Position 3

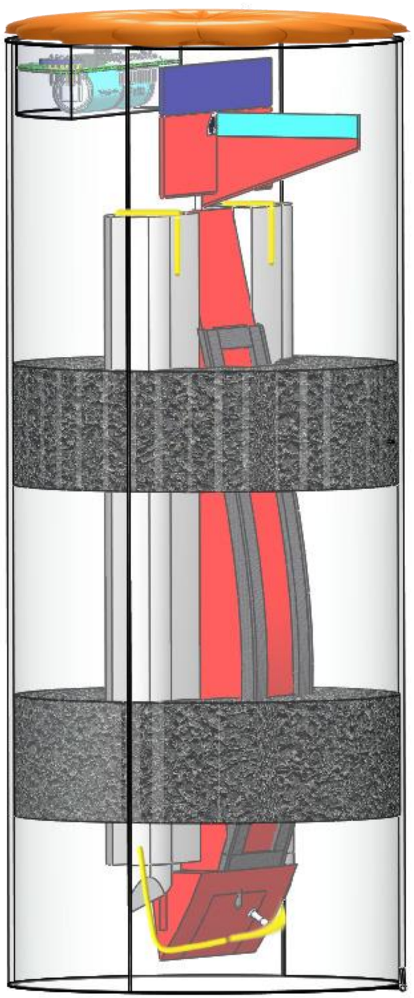
The payload's wings are shown in the open position. The payload descent rate will be passively controlled by center of gravity pre adjustment.

Position 4

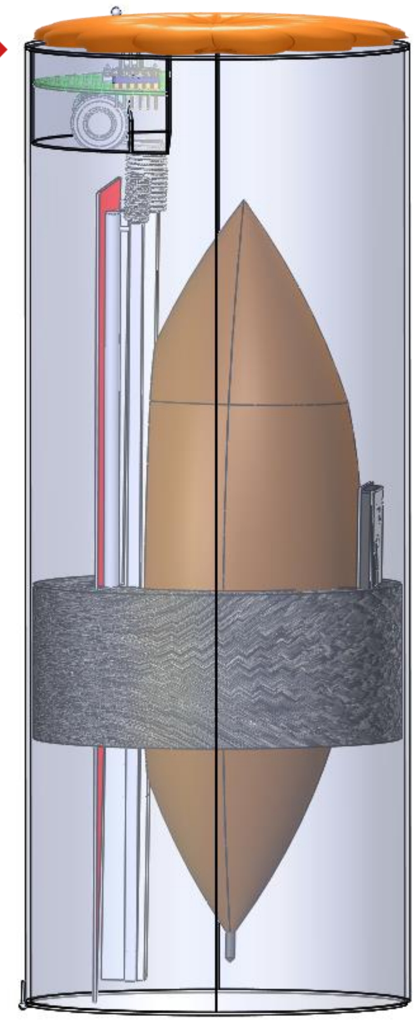
The parachute will be opened at the desired altitude.

System Level CanSat Configuration Trade & Selection (5 of 5)

Configuration 1



Configuration 2



- Both designs comply with the requirements.
- Configuration 2, the bonus mission is difficult to perform because passive control is used.
- Configuration 2's production system is difficult.
- Configuration 1 can be stowed and opened more easily than configuration 2.
- Configuration 1 can easily perform the desired mission with active control.
- Configuration 1 provides more stable descent through the surface area with diamond delta wing.

Therefore, we have selected Configuration 1.

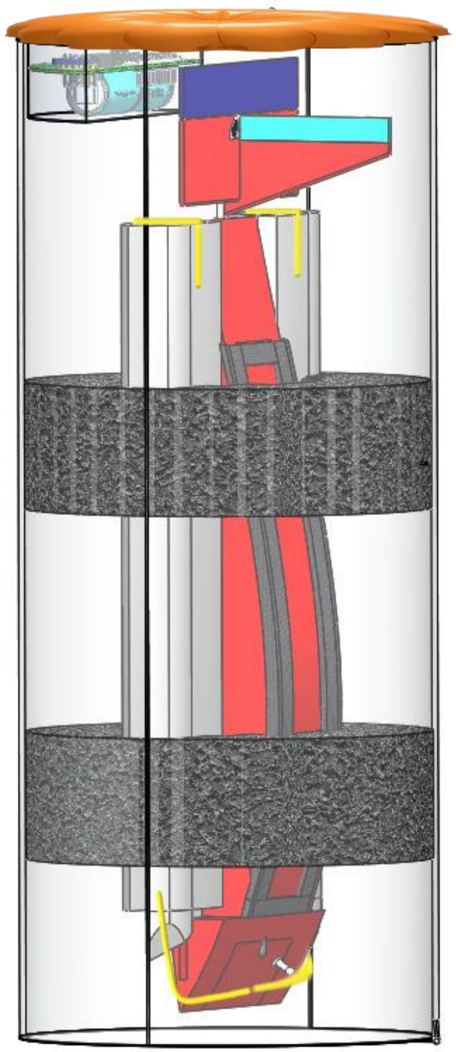
System Level Configuration Selection

Definition of Choose

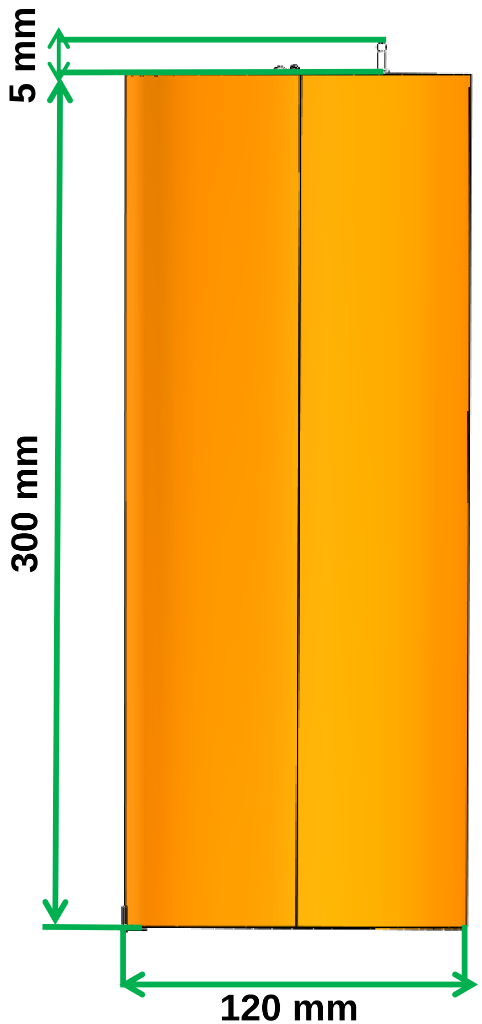
- The payload will be separated from the container with the melt of fishline method.
- The wings will open through the hinge, rotating joint and stretched fabric elastic. Through the telescopic system, the payload length increases.
- The payload has a diamond delta wing.
- To electronic components will be easy to access through touch and close fastener.
- The camera will be fixed to the payload. The payload flight will be controlled according to the given reference point. Thus the camera will be provided to look in the reference point.
- The payload dimensions: 115 mm width and 280 mm length.

Reasons to Choose

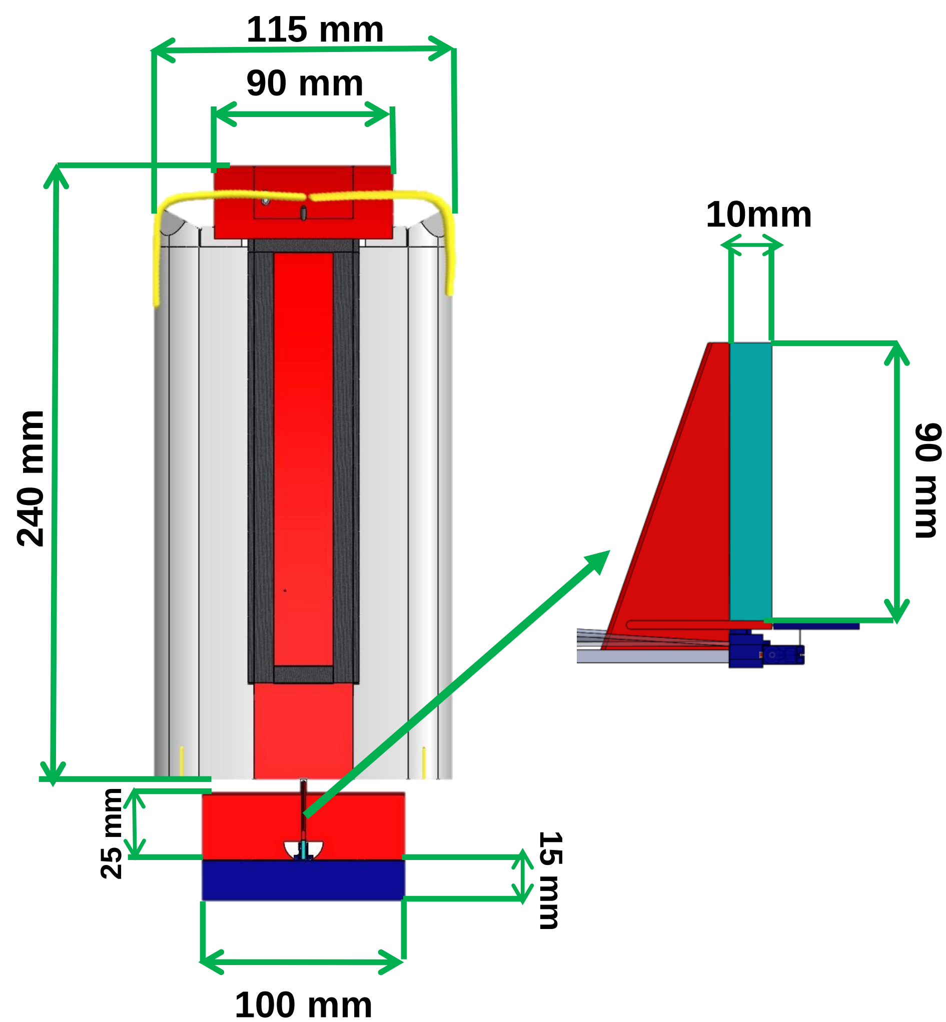
- The system can be easily folded and opened.
- The airfoil structure on the wing and payload provides more stable flight and lifting force.
- The diamond delta wing provides a more stable flight and increases the wing surface area.



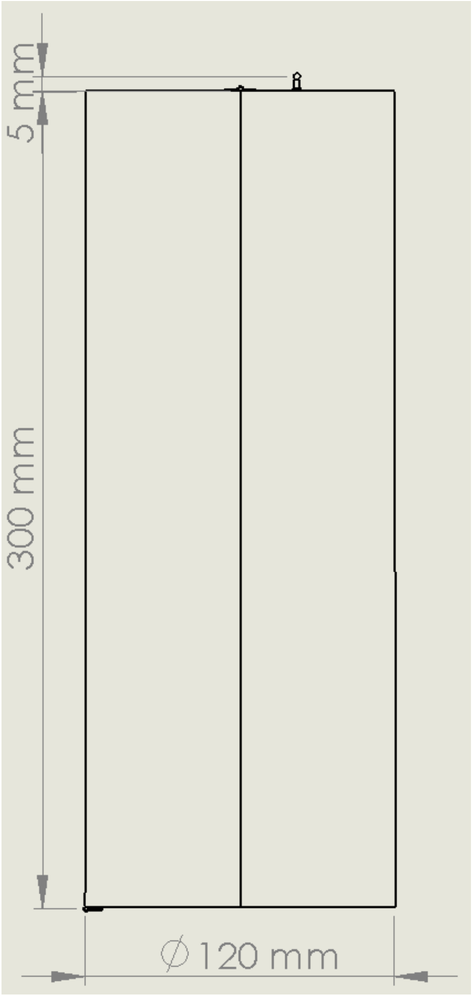
Container Dimensions



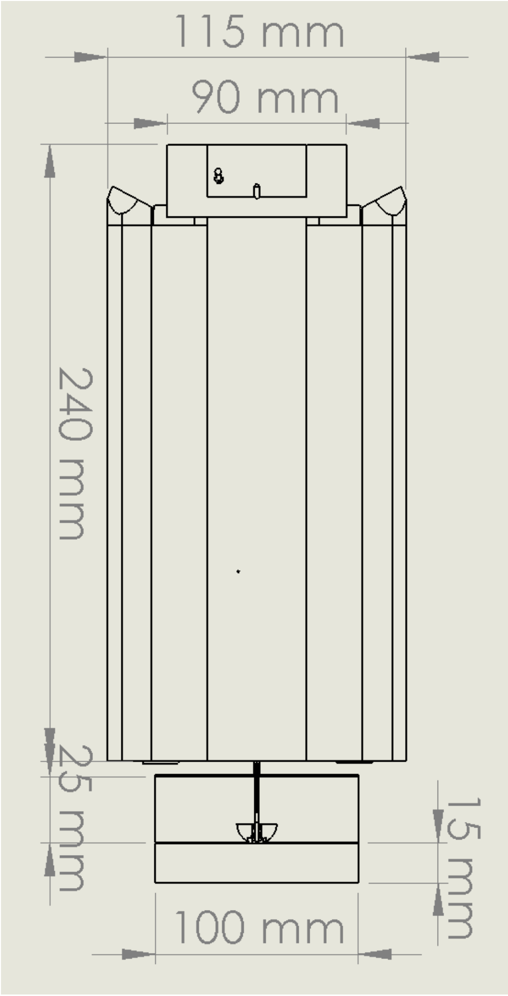
Payload Dimensions



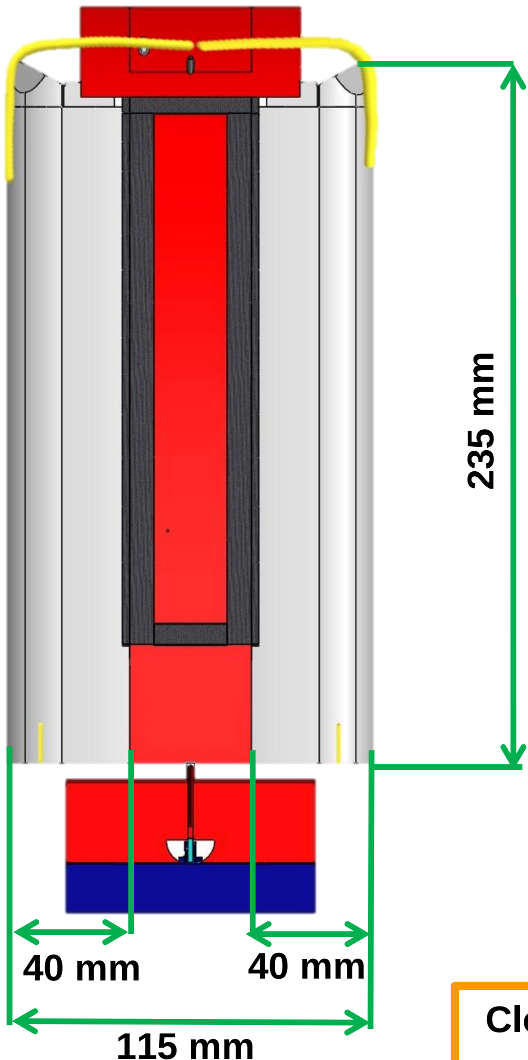
Container Dimensions



Payload Dimensions

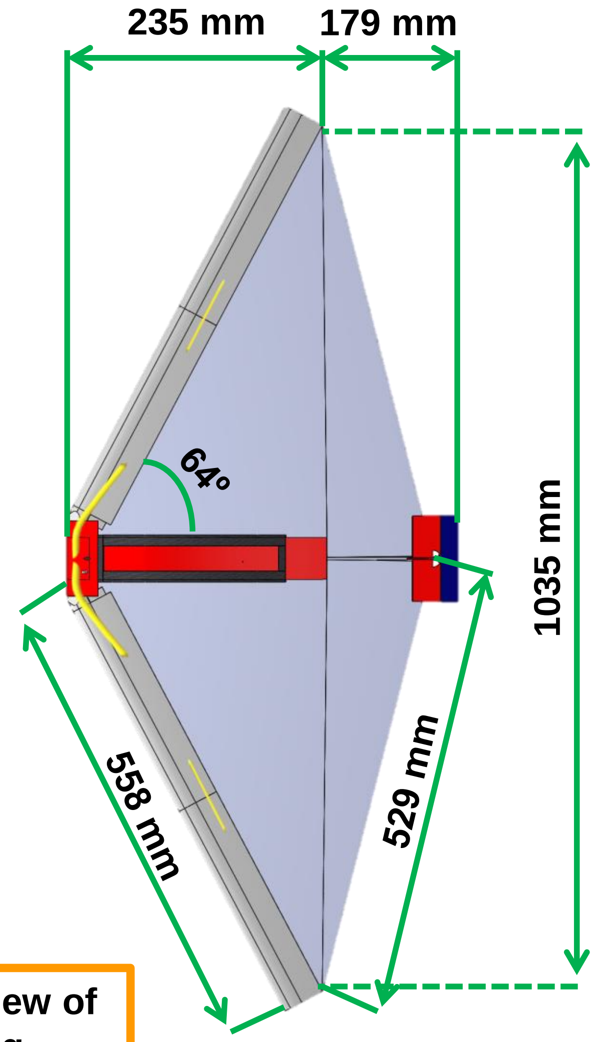


- The container and payload technical drawings.
- Pictures were drawn with CAD program.
- All measurements units are in mm.



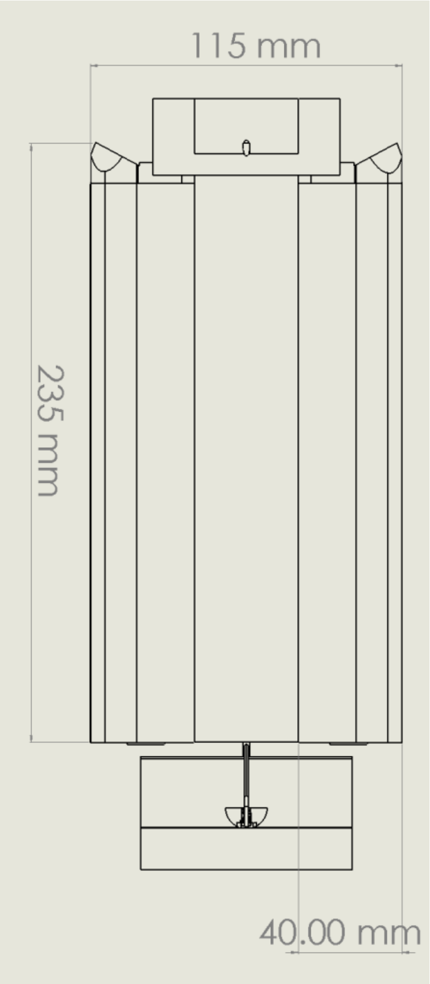
Close view of wing

Wing Dimensions



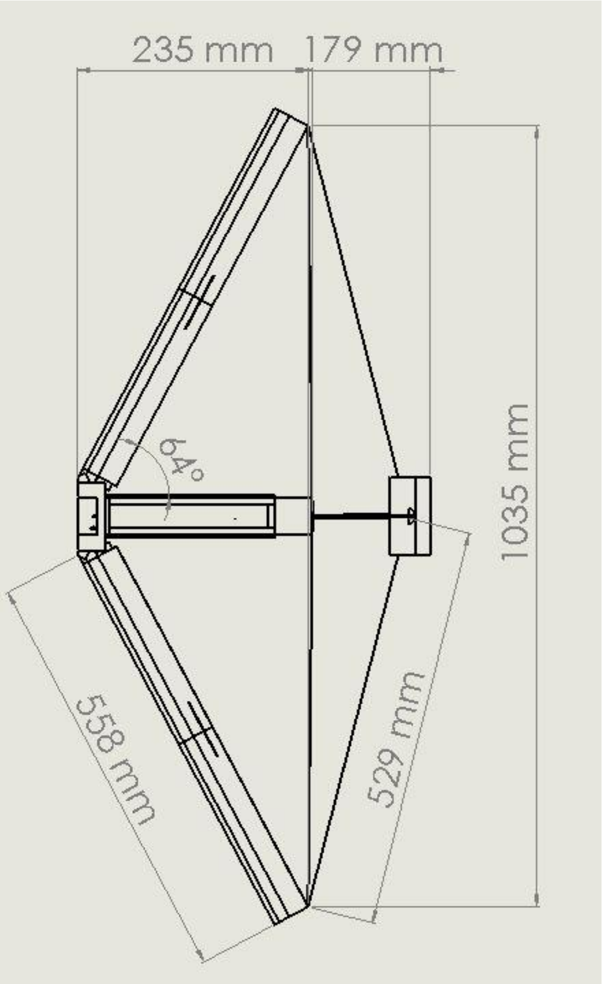
Open view of wing

Wing Dimensions



Close view of wing

Open view of wing



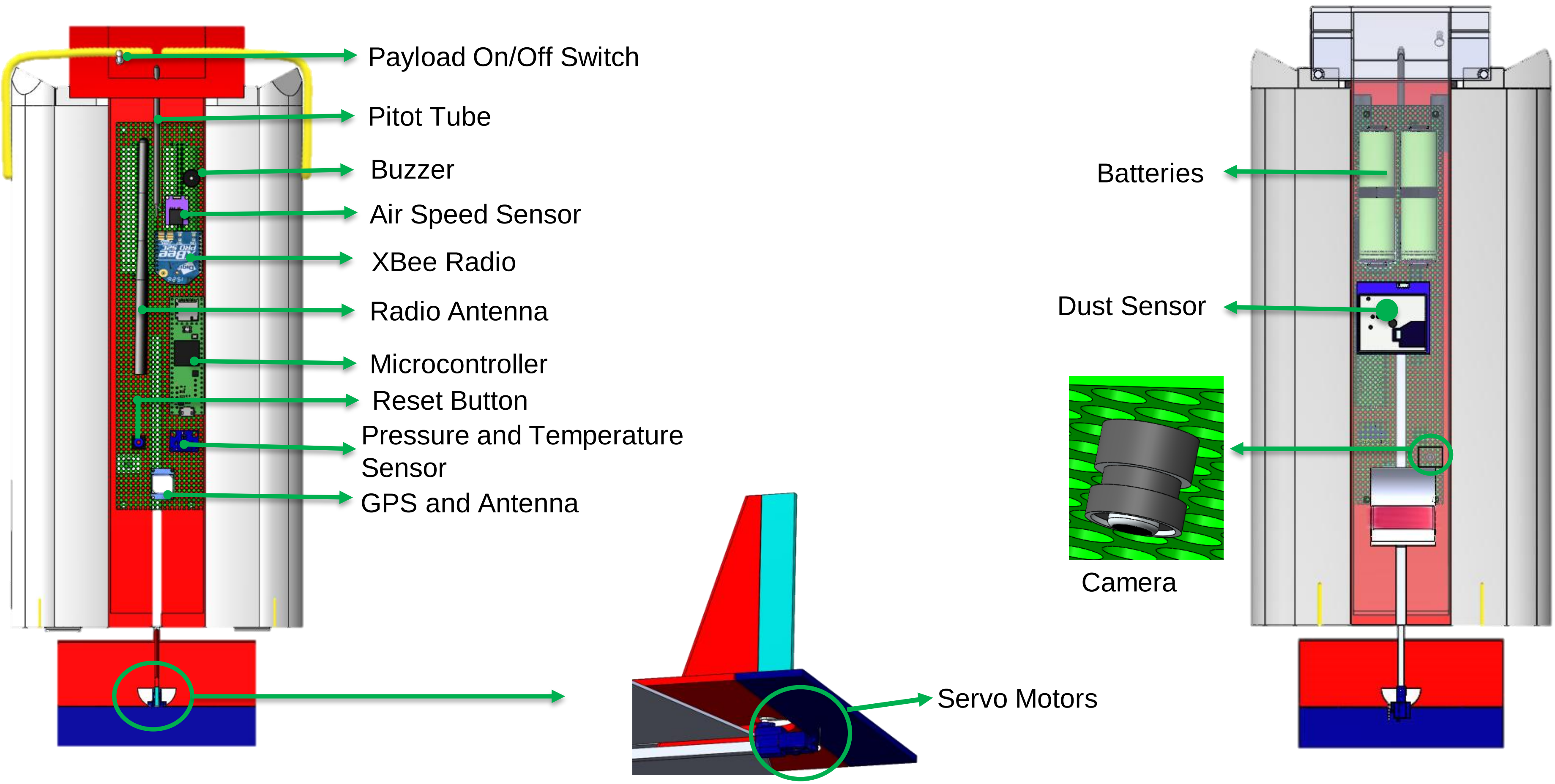
- **Wing technical drawings.**
- **The wing will be opened with the use of hinge, rotating joint and stretched fabric elastic.**

Physical Layout (5 of 7)

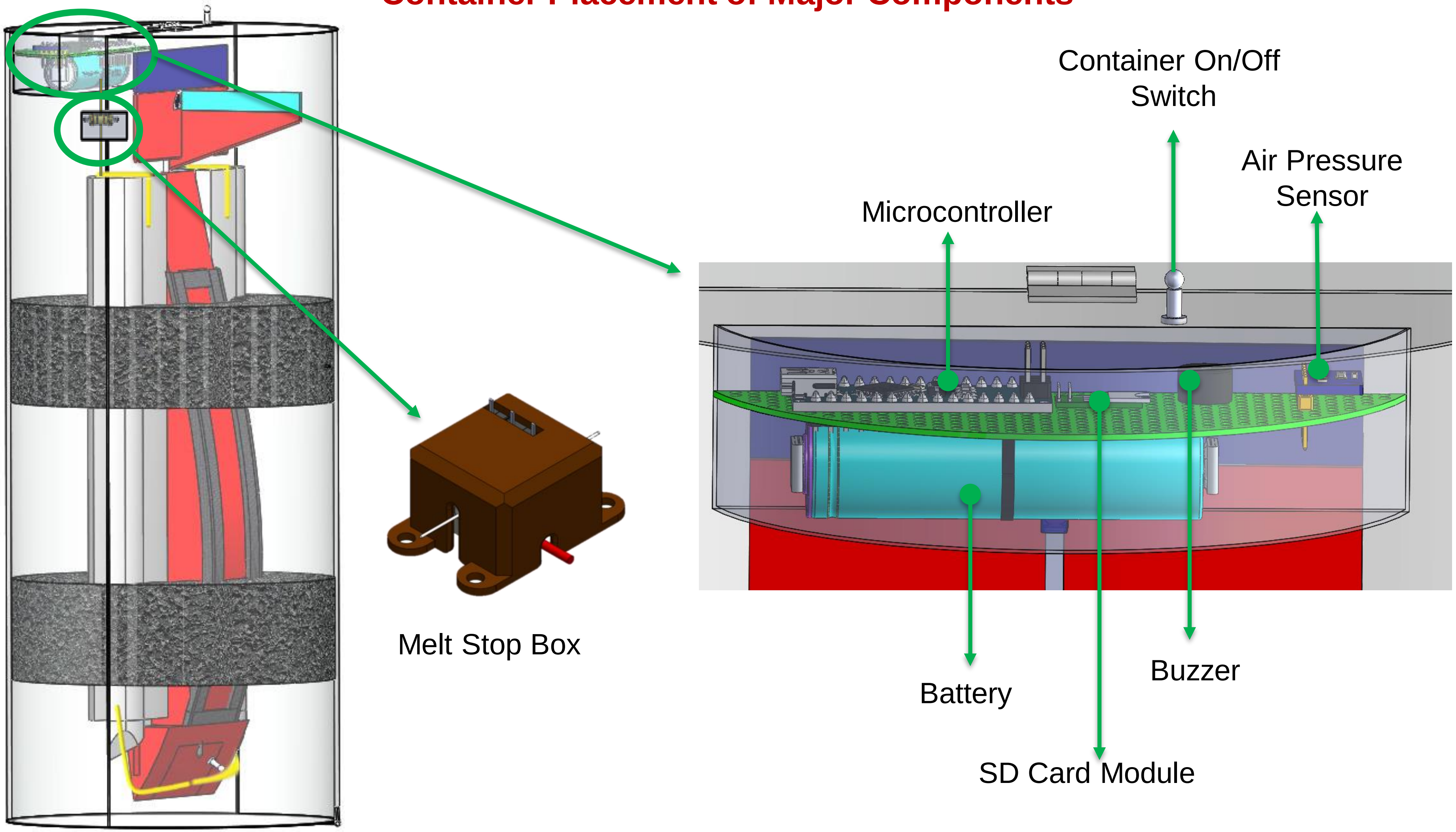
Payload Placement of Major Components

Top view of Electronic Circuit

Bottom view of Electronic Circuit



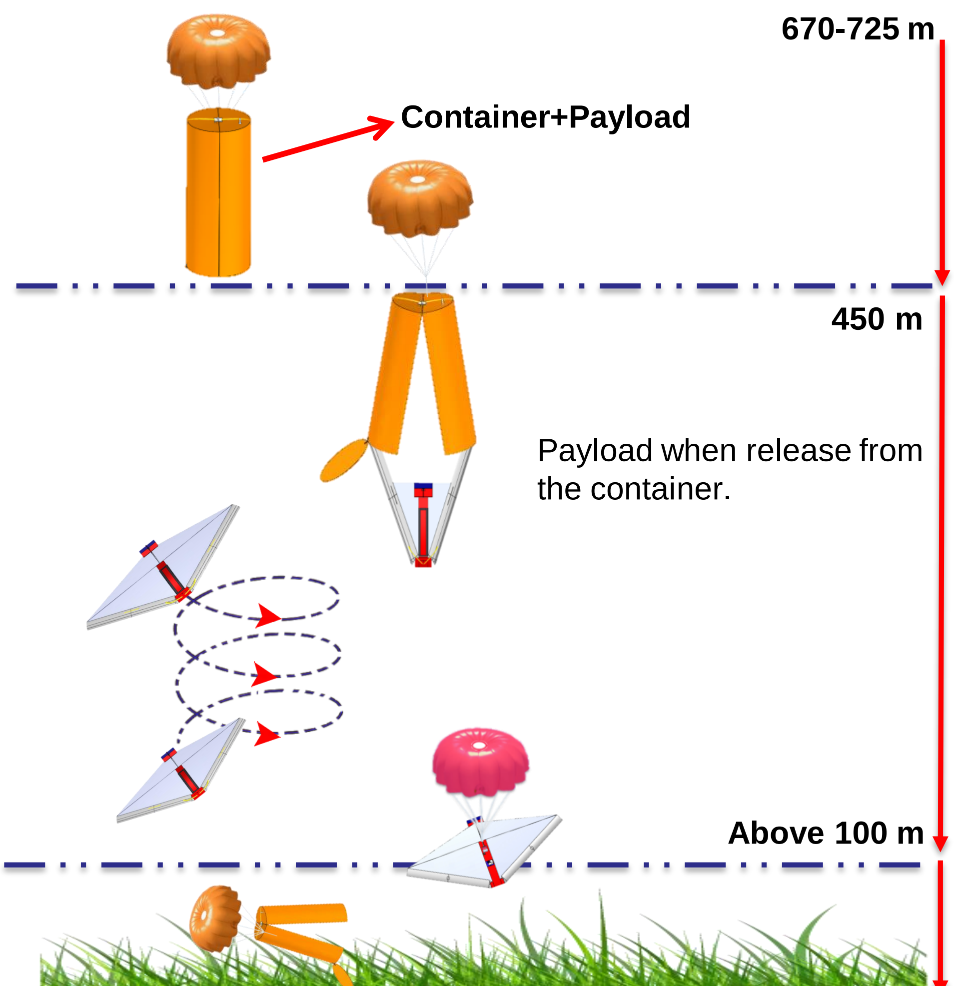
Container Placement of Major Components



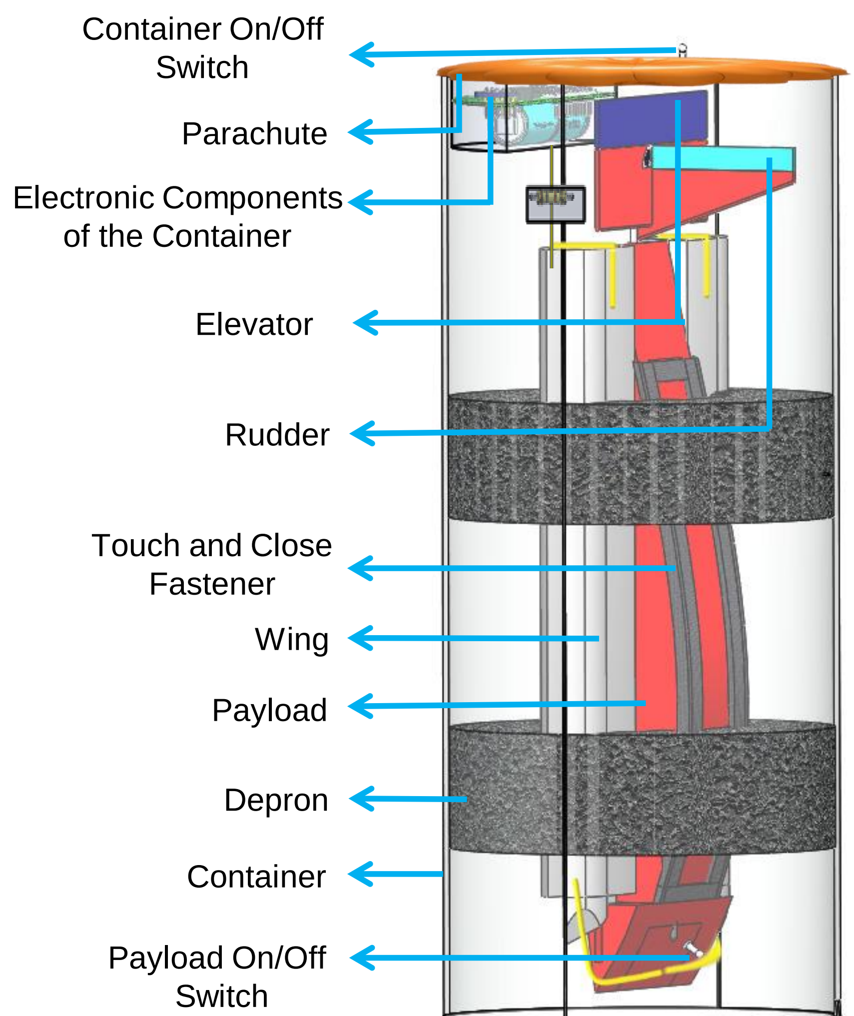
Physical Layout (7 of 7)

Deployed Configuration

Immediately after the CanSat separation from the rocket.



Launch Configuration



System Concept of Operations (1 of 2)

Pre Launch

- Set-up ground station system.
- Check of mechanical systems.
- Communication tests will be conducted.
- The system will be calibrated with the command sent to the ground station and data transfer will be started.
- CanSat will be placed into the rocket.

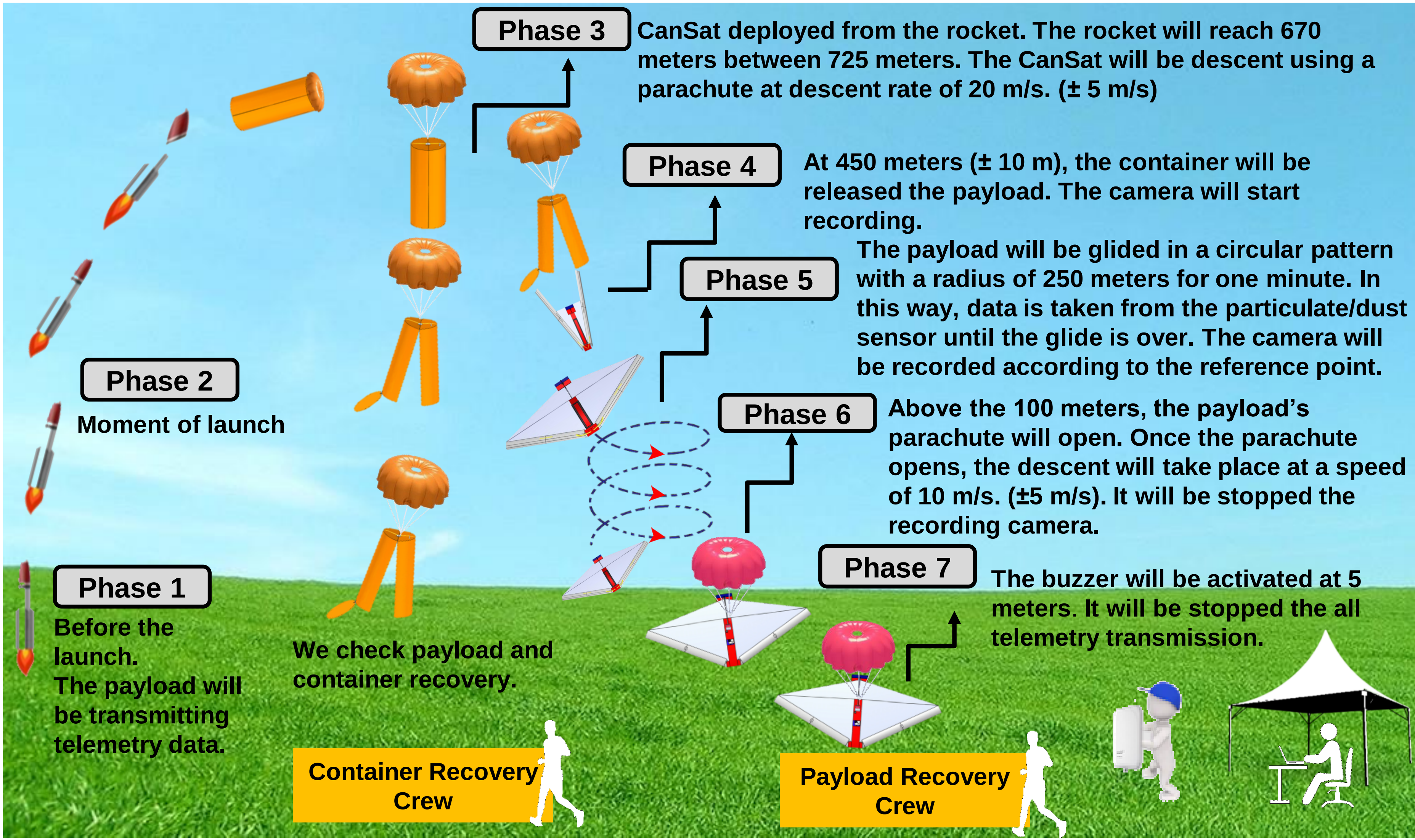
Launch

- Rocket launch.
- CanSat separated from the rocket (between 670-725 meters).
- The parachute will be opened.
- The descent rate of the CanSat shall be 20 m/s (± 5m/s).
- The container will be released the payload at 450 meters (±10 meters).
- The payload shall glide in a circular pattern with a 250 m radius for one minute and stay above 100 meters after release from the container.
- The parachute of payload opens; the descent will take place at a speed of 10 m/s. (±5 m/s)
- Data transmission will be stopped, and buzzer will be activated 5 meters before the end of the flight.

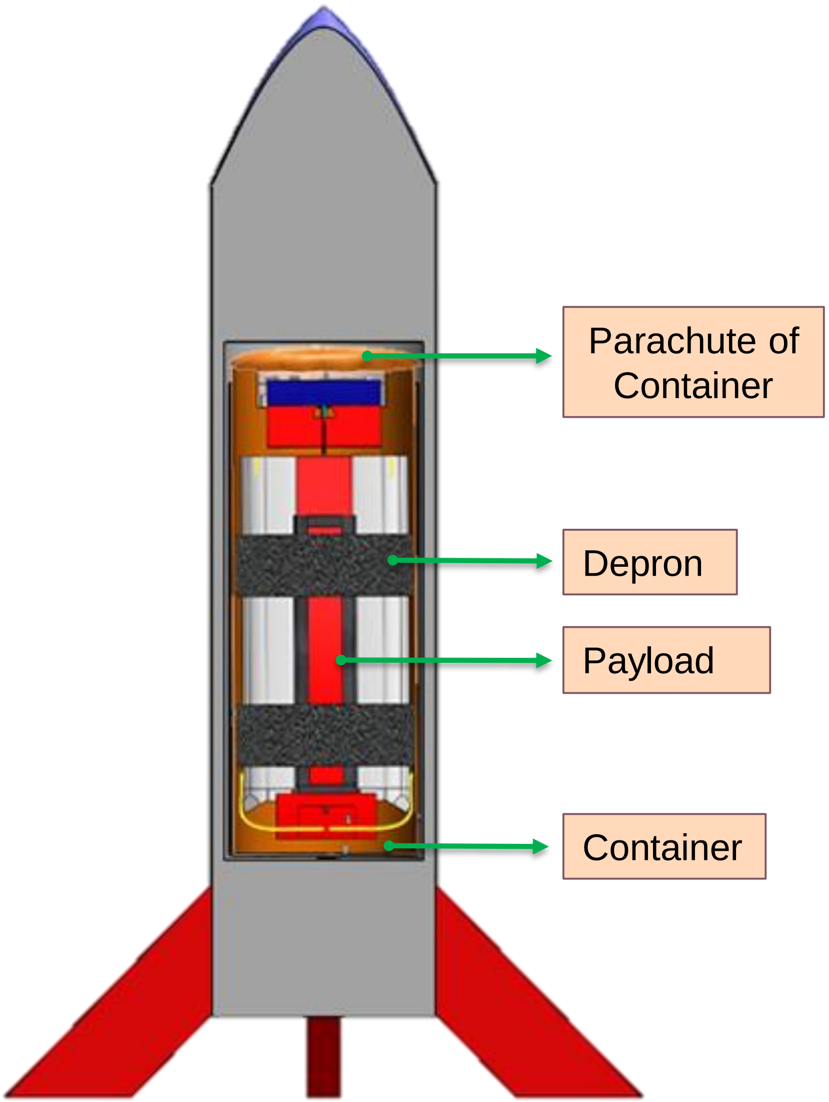
Post Launch

- The location of the payload will be found via GPS and buzzer.
- The location of the container will be found via buzzer.
- We will take the SD card from the CanSat.
- Delivery of received data to the judge.
- Telemetry data from the SD card will be analyzed.
- Preparation for PFR.

System Concept of Operations (2 of 2)



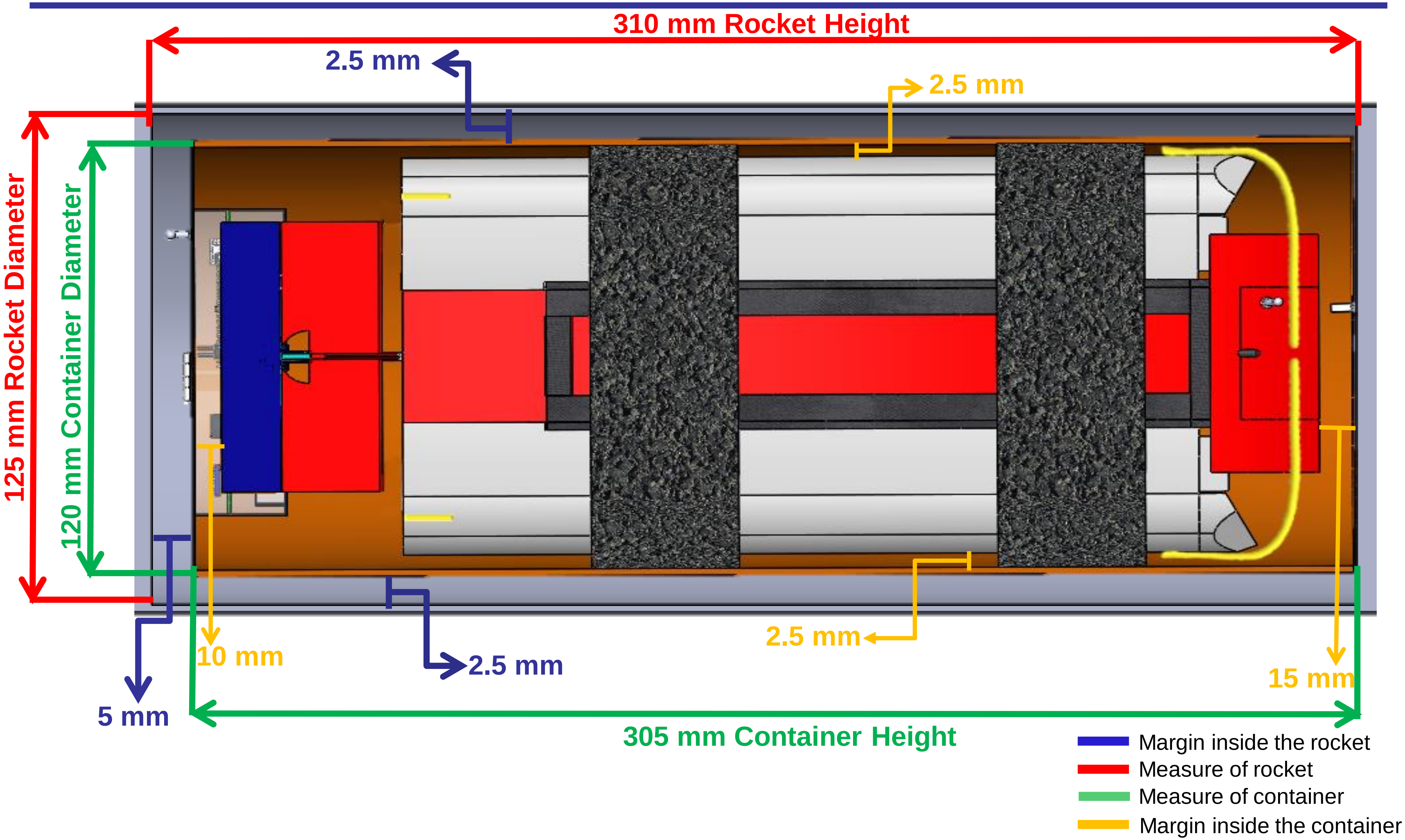
Launch Vehicle Compatibility (1 of 2)



Dimensions / Section	Height (mm)	Length (mm)
Rocket (Requirement Dimensions)	310	125
CanSat	305	120
Payload	280	115

- The CanSat consists of 2 parts: The payload and the container.
- CanSat margins of 5 mm are given for height and 5 mm for length. We give 5 mm margins to make it easy to release from the rocket.
- The CanSat's dimensions have been designed to prevent shaking of the CanSat in the rocket.
- There is no sharp protrusion on the CanSat.

Launch Vehicle Compatibility (2 of 2)



Sensor Subsystem Design

Zeynep SÖDER

Sensor Subsystem Overview

NO	SENSOR TYPE	MODEL	PURPOSE	FUNCTION
1	Inertial Measurement Unit Sensor	10-DOF IMU (BMP280 + MPU-9255)	We will be used 10-DOF IMU sensor since it includes BMP280 and MPU-9255. The BMP280 sensor is used to measure temperature and air pressure. Therefore, we will be used MPU-9255 for active control.	To measure air pressure, air temperature. To measure pitch, roll and yaw.
2	GPS	NEO–7M	We will be used NEO-7M to measure the longitude, latitude and altitude. The NEO-7M has a higher update rate and less power consumption.	To measure location, altitude and satellite count data.
3	Voltage Measurement	Teensy 3.6 Analog Pin	We will be used Teensy 3.6 analog pin to sense the voltage instead of using an additional sensor. Since it is easy to implement and use.	To measure of battery voltage.
4	Air Speed Sensor	APM 2.6 Air Speed Sensor Kit MPXV7002DP	We will be used APM 2.6 sensor kit to measure air speed. The pressure difference occurs between the front and side holes. The air speed is calculated by measuring the pressure difference.	To measure air pressure and air speed.
5	Particulate/Dust Sensor	Sharp GP2Y10	We will be used Sharp GP2Y10 to measure the amount of particulate matter (PM) suspended in air.	To measure particle size and concentration.
6	Camera	SQ11	We will be used the SQ11 camera to record video during the mission process.	To record video.
7	Air Pressure Sensor (Container)	BMP280	We will be used the BMP280 sensor inside the container to measure the air pressure.	To measure of air pressure.

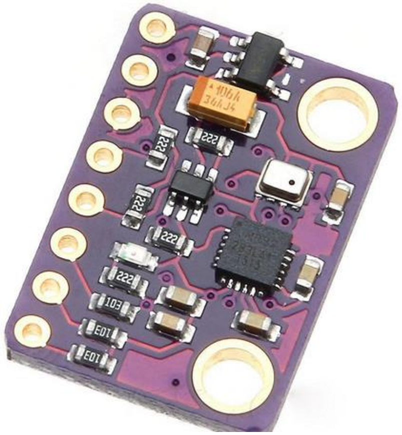
Sensor Subsystem Requirements

Requirement Number	Requirement	Rationale	Priority	VM			
				A	I	T	D
RN#15	All electronic components shall be enclosed and shielded from the environment with the exception of sensors.	Competition Requirement	HIGH		√	√	√
RN#16	All structures shall be built to survive 15 Gs of launch acceleration.	Competition Requirement	HIGH	√	√	√	
RN#17	All structures shall be built to survive 30 Gs of shock.	Competition Requirement	HIGH	√	√	√	
RN#18	All electronics shall be hard mounted using proper mounts such as standoffs, screws, or high-performance adhesives.	Competition Requirement	HIGH	√	√		
RN#22	The science payload shall measure altitude using an air pressure sensor.	Competition Requirement	HIGH	√		√	√
RN#23	The science payload shall provide position using GPS.	Competition Requirement	HIGH	√		√	√
RN#24	The science payload shall measure its battery voltage.	Competition Requirement	HIGH	√		√	√
RN#25	The science payload shall measure outside temperature.	Competition Requirement	HIGH	√		√	√
RN#26	The science payload shall measure particulates in the air as it glides.	Competition Requirement	HIGH	√		√	√
RN#27	The science payload shall measure air speed.	Competition Requirement	HIGH	√		√	√

Payload Air Pressure Sensor Trade & Selection

Payload Air Pressure Sensor	Size (mm)			Weight (g)	Operating Voltage (V)	Operating Current (µA)	Pressure Range (hPa)	Resolution (Pa)	Interface	Price ($)
	Length	Width	Height							
BMP280	20.8	14.3	1.5	2	1.71 – 5.5	325	300 – 1100	0.16	I2C,SPI	10
BMP180	3.8	3.6	0.9	0.4	1.8 – 3.6	650	300 – 1100	1	I2C	3.54
MPL3115A2	5	3	1.1	1.2	1.9 – 3.6	325	500 – 1100	1.5	I2C	20.65

SELECTED	REASONS
BMP280	• We have already gained enough experience with the use of the component. • BMP280 supports the SPI interface. • 10-DOF IMU included on a single board (accelerometer, gyroscope, magnetometer).



Payload Air Temperature Sensor Trade & Selection

Payload Air Temperature Sensor	Size (mm)			Weight (g)	Operating Voltage (V)	Operating Current (µA)	Operating Temperature (°C)	Resolution (°C)	Interface	Price ($)
	Length	Width	Height							
BMP280	20.8	14.3	1.5	2	1.71 – 5.5	325	-40 ~ +85	0.01	I2C,SPI	10
BME280	2.5	2.5	0.9	3	1.71 – 4.25	350	-40 ~ +85	0.01	I2C,SPI	6.55
MPL3115A2	5	3	1.1	1.2	1.9– 3.6	325	-40 ~ +85	1.5	I2C	20.65

SELECTED	REASONS
BMP280	• This sensor measure both temperature and pressure. • 10-DOF IMU included on a single board (accelerometer, gyroscope, magnetometer).

GPS Sensor Trade & Selection

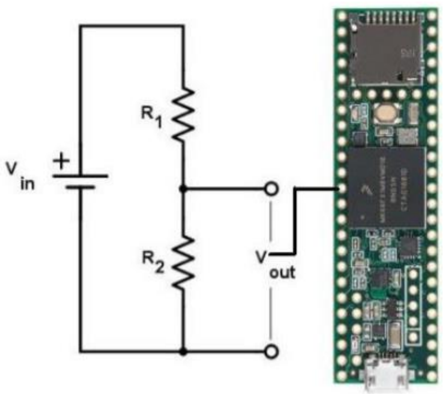
GPS Sensor	Size (mm)			Weight (g)	Operating Voltage (V)	Operating Current (mA)	Max Update Rate (Hz)	Resolution (m)	Interface	Price ($)
	Length	Width	Height							
Quectel L80	16	16	6.4	6	3 – 4.3	20	10	2.5	UART	14.90
NEO-7M	16	12	3	16	2.7 – 5	35	10	2.5	UART	17.4
V.KEL GPS Module	28	28	8.6	18.1	3.3 – 5	30	10	2.5	UART	13.80

SELECTED	REASONS
NEO–7M	• Small in size when compared to the other alternatives. • We have already gained enough experience with the use of the component.

Payload Power Voltage Sensor Trade & Selection

Payload Power Voltage Sensor	Size (mm)		Weight (g)	Measurement Voltage (V)	Resolution (V)	Interface	Price ($)
	Length	Width					
Max471 Voltage Sensor	30.3	19.5	12	0 – 25	0.05	Analog	3.30
Teensy 3.6 Analog Pin	No extra area needed		<1	0 – 3.3	0.05	Analog	Free

SELECTED	REASONS
Teensy 3.6 Analog Pin	• One of the analog pin of the Teensy 3.6 will be used instead of using an additional sensor. The voltage divider is used to supply the reliable potential to the microcontroller. • This method is easy to implement and use. • No additional area is required. Since it is already located on the microcontroller.



The voltage divider circuit will be used because no more voltage can be applied than the Teensy 3.6 Analog Pin 3.3 V.

Air Speed Sensor Trade & Selection

Air Speed Sensor	Size (mm)			Weight (g)	Operating Voltage (V)	Operating Current (mA)	Range (km/h)	Resolution (kPa)	Interface	Price ($)
	Length	Width	Height							
APM 2.6 Air Speed Sensor Kit MPXV7002DP	17	11	12	15	4.75 – 5.25	10	360	1	Analog	45.43
EAGLE TREE Air Speed Microsensor V3	28	16	10	22.7	4 – 16	10	350	1	I2C	42.99

SELECTED	REASONS
APM 2.6 Air Speed Sensor Kit MPXV7002DP	• Small in size and lighter when compared to the other alternative.

Particulate/Dust Sensor Trade & Selection (1 of 2)

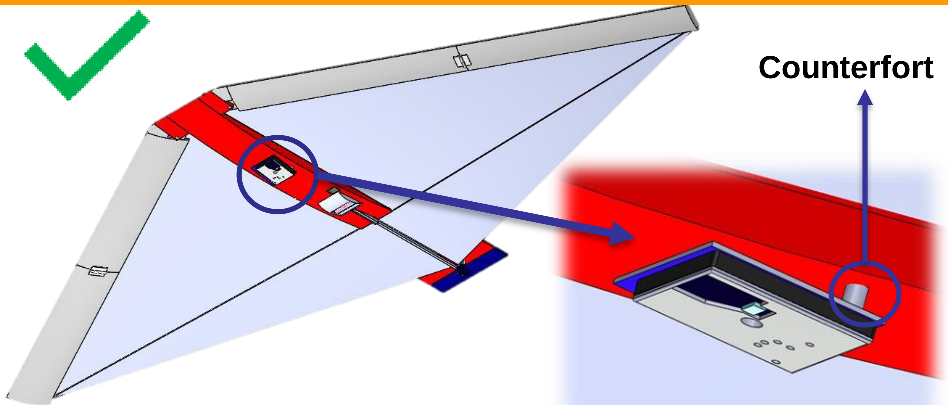
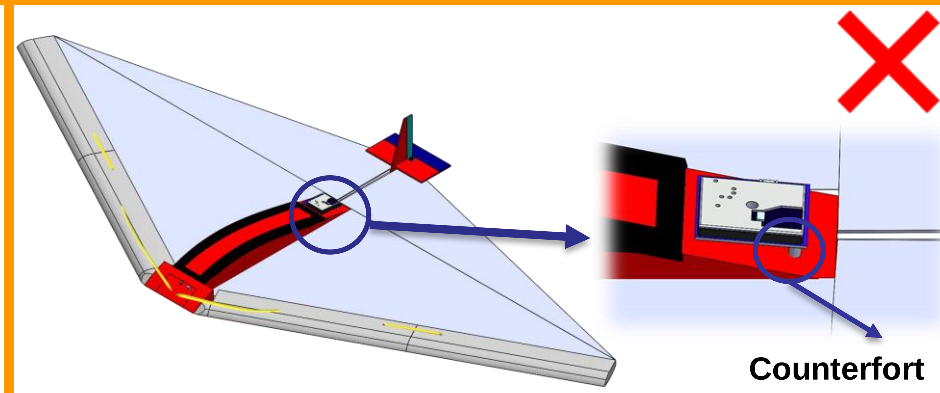
Particulate/ Dust Sensor	Size (mm)			Weight (g)	Operating Voltage (V)	Current Consumption (mA)	Detectable range of concentration (mg/m³)	Resolution/ Particle size (µm)	Interface	Price ($)
	Length	Width	Height							
Sharp GP2Y10 Optical Dust Sensor	46	30	17.6	20	4.5 – 5.5	20	0.1	0.5	Analog	7.01
DSM501	59	45	17	25	5	90	0 ~ 1.4	1	I2C	4.51

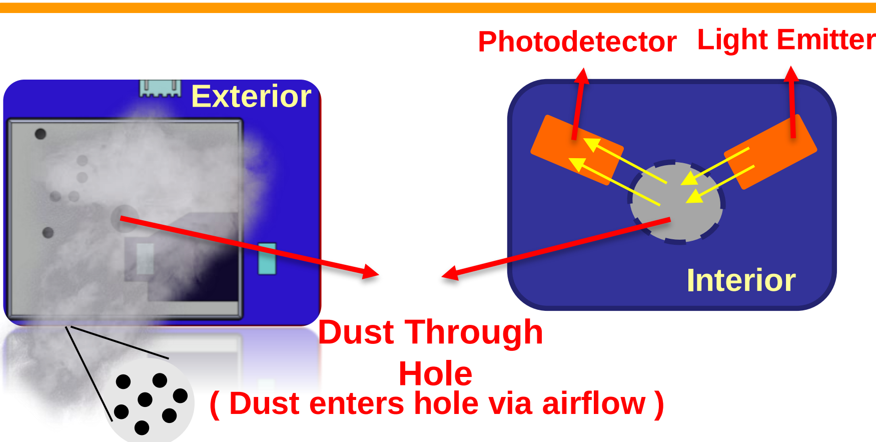
SHARP GP2Y10

SELECTED	REASONS
Sharp GP2Y10 Optical Dust Sensor	• Small in size and lighter when compared to the other alternative. • Low current consumption. • Sharp GP2Y10 has a high sensitivity to dust conditions.

DSM501

Particulate/Dust Sensor Trade & Selection (2 of 2)

DESIGN 1 (SELECTED)	DESIGN 2
	
The dust sensor (Sharp GP2Y10) will be glued **angled on the bottom of the payload.**	The dust sensor (Sharp GP2Y10) will be glued **angled on the top of the payload.**



(Smoke Dust Particules)

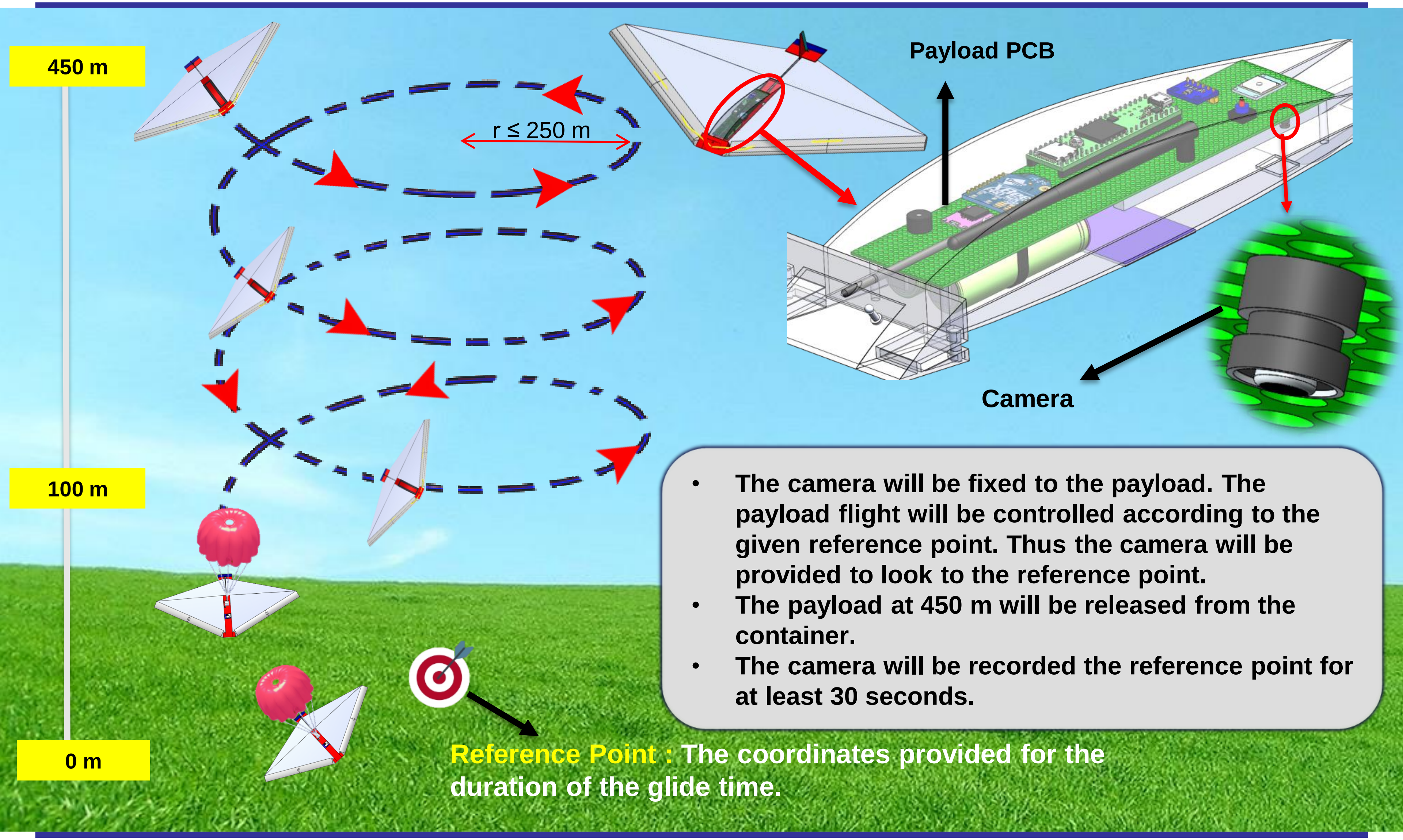
SELECTED	REASONS
DESIGN 1	• In Design 1, the dust sensor will be glued on the bottom of the payload, so it will take more air into the sensor. • In Design 2, the dust sensor will be glued on the top of the payload and the airfoil will be disrupted the structure.

Bonus Camera Trade & Selection (1 of 2)

Camera	Size (mm)			Weight (g)	Operating Voltage (V)	Range of Vision (◦)	Video Resolution (pixel)	Interface	Price ($)
	Length	Width	Height						
TTL Serial JPEG Camera	32	32	32	3	5	60	640x480	SPI	39.95
SQ11	22	22	22	4	5	50	640x480	Digital	12.05
OV7670	35	34	26	12	3	25	640x480	I2C	9.25

SELECTED	REASONS
SQ11	• Small in size when compared to the other alternatives. • SQ11 Camera has an SD card module. • We have already gained enough experience with the use of the component.

Bonus Camera Trade & Selection (2 of 2)

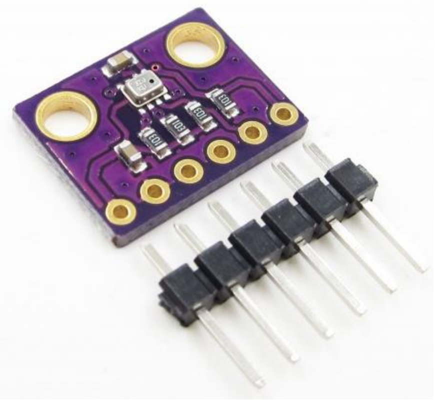


- The camera will be fixed to the payload. The payload flight will be controlled according to the given reference point. Thus the camera will be provided to look to the reference point.
- The payload at 450 m will be released from the container.
- The camera will be recorded the reference point for at least 30 seconds.

Container Air Pressure Sensor Trade & Selection

Container Air Pressure Sensor	Size (mm)			Weight (g)	Operating Voltage (V)	Operating Current (µA)	Pressure Range (hPa)	Resolution (Pa)	Interface	Price ($)
	Length	Width	Height							
BMP280	2.5	2	0.9	1	1.7 – 5.5	325	300 – 1100	0.16	I2C,SPI	3.48
BME280	2.5	2.5	0.9	1	1.7 – 5.5	300	300 – 1100	0.18	I2C,SPI	7.60
MPL3115A2	5	3	1.1	1.2	1.9 – 3.6	325	50 – 1100	1.5	I2C	14.98

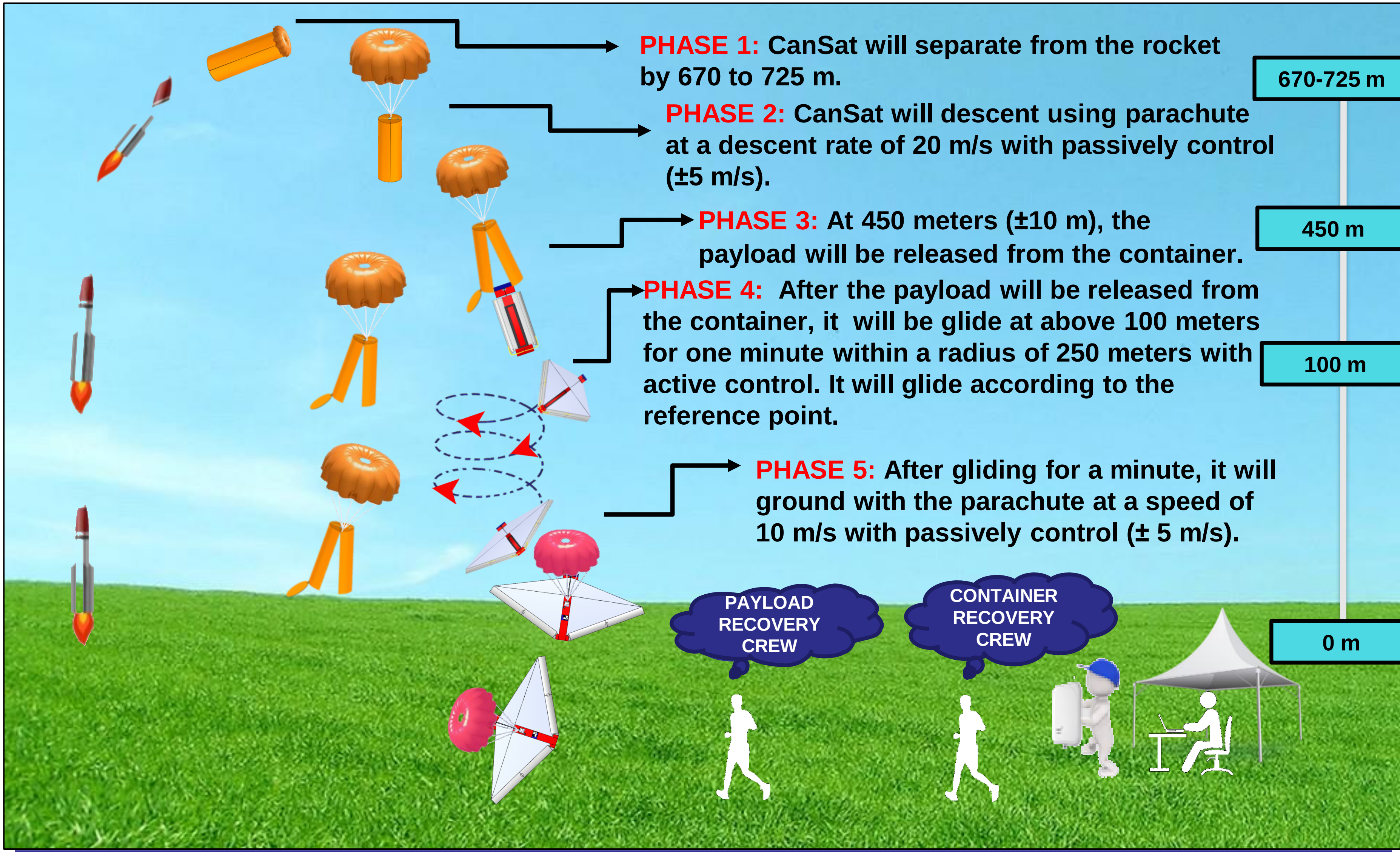
SELECTED	REASONS
BMP280	• Small in size. • Low price. • Experienced with the use of the component.

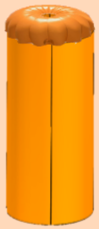


Descent Control Design

Turab TEPEBAŞI

Descent Control Overview (1 of 2)



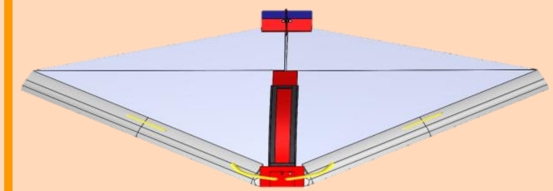


Container

- The container will be 305 mm height and 120 mm in diameter.
- The CanSat will be descent using a parachute at a descent rate of 20 m/s (± 5 m/s). At 450 meters (± 10 m), payload will be separated from the container.
- The container will be made from fiberglass.

Container Parachute

- It will be 143 mm diameter. It includes a spill hole diameter of 32 mm to stabilize parachute container.
- The parachute will be made from Silnylon 30D Nylon 66.



Payload

- The delta wings of the payload will be opened with rotating joints, hinges and stretched fabric elastic. The width of the payload will be reached 1035 mm. The length of the payload will be reached 414 mm with the telescopic system.
- It glides with active descent at above 100 meters in a radius of 250 meters (for one minute). Active control will be provided by the elevator and the rudder (servo motor will be used).
- After gliding for one minute, it will ground with the parachute at a speed of 10 m/s (± 5 m/s).
- The payload wing frame will be constructed by the use of carbon fiber sticks. The top surface of the payload wing will be covered with Silnylon 30D Nylon 66.

Payload Parachute

- It will be 253 mm diameter. It includes a spill hole diameter of 56 mm to stabilize parachute payload.
- The parachute will be made from Silnylon 30D Nylon 66.

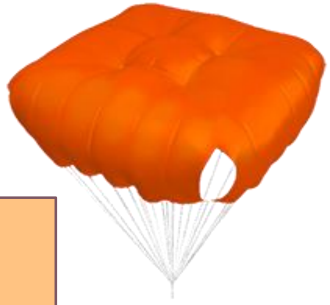
Descent Control Requirements (1 of 2)

Requirement Number	Requirement	Rationale	Priority	VM			
				A	I	T	D
RN#1	Total mass of the CanSat (science payload and container) shall be 600 grams +/- 10 grams.	Competition Requirement	HIGH	√	√	√	
RN#2	CanSat shall fit in a cylindrical envelope of 125 mm diameter x 310 mm length. Tolerances are to be included to facilitate container deployment from the rocket fairing.	Competition Requirement	HIGH		√	√	√
RN#4	The container shall be a fluorescent color; pink, red or orange.	Competition Requirement	HIGH		√		
RN#5	The container shall be solid and fully enclose the science payload. Small holes to allow access to turn on the science payload is allowed. The end of the container where the payload deploys may be open.	Competition Requirement	HIGH		√	√	
RN#6	The rocket airframe shall not be used to restrain any deployable parts of the CanSat.	Competition Requirement	MEDIUM		√		√
RN#7	The rocket airframe shall not be used as part of the CanSat operations.	Competition Requirement	HIGH		√		√
RN#8	The container parachute shall not be enclosed in the container structure. It shall be external and attached to the container so that it opens immediately when deployed from the rocket.	Competition Requirement	HIGH		√	√	√

Descent Control Requirements (2 of 2)

Requirement Number	Requirement	Rationale	Priority	VM			
				A	I	T	D
RN#9	The descent rate of the CanSat (container and science payload) shall be 20 meters/second +/- 5m/s.	Competition Requirement	HIGH		✓	✓	✓
RN#10	The container shall release the payload at 450 meters +/- 10 meters.	Competition Requirement	HIGH		✓	✓	✓
RN#11	The science payload shall glide in a circular pattern with a 250 m radius for one minute and stay above 100 meters after release from the container.	Competition Requirement	HIGH	✓	✓	✓	✓
RN#12	The science payload shall be a delta wing glider.	Competition Requirement	HIGH	✓	✓		✓
RN#13	After one minute of gliding, the science payload shall release a parachute to drop the science payload to the ground at 10 meters/second, +/- 5 m/s.	Competition Requirement	HIGH	✓	✓	✓	
RN#14	All descent control device attachment components shall survive 30 Gs of shock.	Competition Requirement	HIGH	✓	✓	✓	
RN#30	The Parachutes shall be fluorescent Pink or Orange.	Competition Requirement	HIGH	✓	✓		

Payload Descent Control Strategy Selection and Trade (1 of 4)



Container and Payload Parachute Selection

TYPE 1	TYPE 2
Round Parachute	**Square Parachute**
• Easy production. • High durability in opening. • Less horizontal displacement. • High drag coefficient.	• Opening time is long. • High acceleration. • Faster landing.

SELECTED	REASONS
TYPE 1	• Opening time shorter than type 2. • Lighter than type 2. • More controlled descent than type 2.

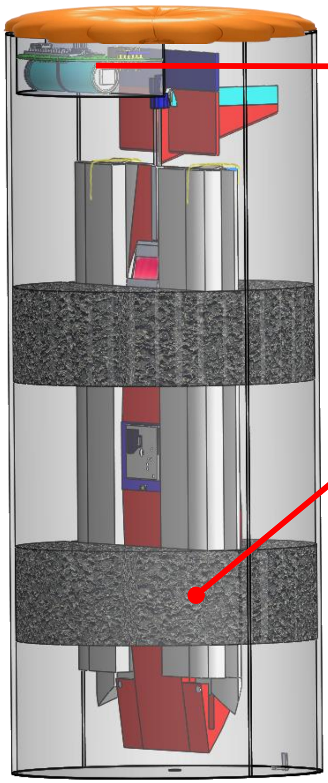
Container Parachute Design
Made of Silnylon 30D Nylon 66.
Parachute diameter is 143 mm.
Spill hole diameter is 32 mm.

Payload Parachute Design
Made of Silnylon 30D Nylon 66.
Parachute diameter is 253 mm.
Spill hole diameter is 56 mm.

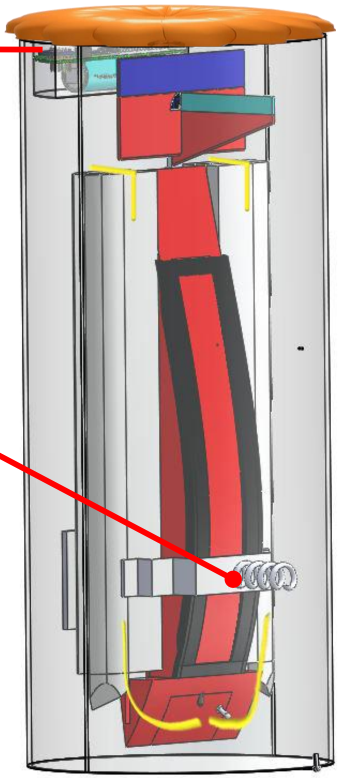
*Fluorescent orange parachute design → Container parachute
*Fluorescent pink parachute design → Payload parachute

Stowed Descent Rate Control (1 of 2)
(Pre-Payload Deployment)

STRATEGY 1



STRATEGY 2



Container Electronic Circuit

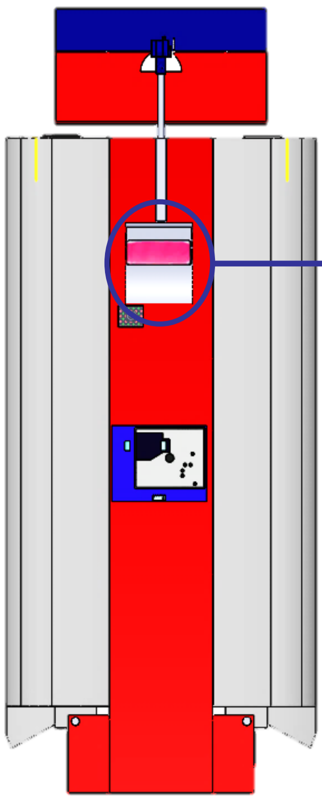
Payload will be placed by depron in the container. Depron prevents vibration of payload.

The payload will be kept in the container with holder springs.

SELECTED	REASONS
STRATEGY 1	• Depron has higher vibration damping capability. • Depron is lighter than the holder springs.

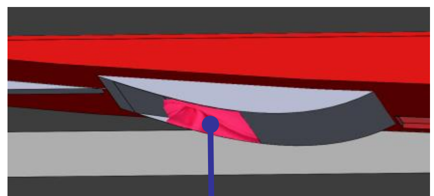
Payload Descent Control Strategy Selection and Trade (3 of 4)

STRATEGY 1



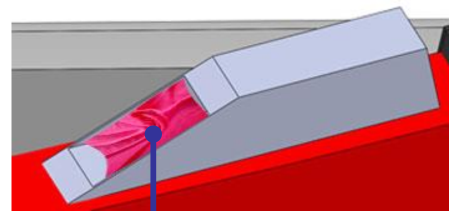
***Bottom view**

Stowed Descent Rate Control (2 of 2)
(After Deployment for Payload Parachute)



PARACHUTE

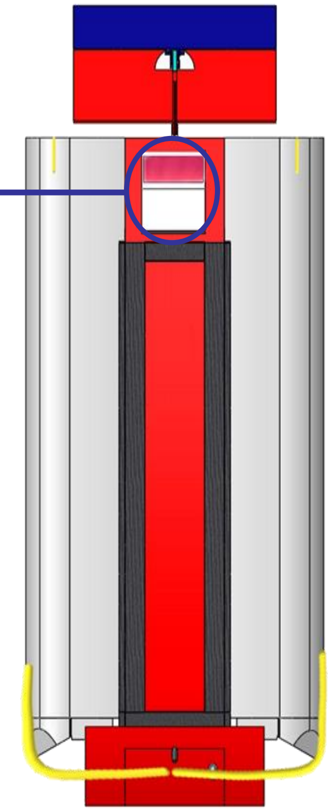
- The payload parachute will be put into a parachute nest. The parachute nest is an airfoil.
- Melt of fishline method will be used.



PARACHUTE

- The payload parachute will be put into a square nest.
- Melt of fishline method will be used.

STRATEGY 2



***Top view**

SELECTED	REASONS
STRATEGY 1	• It doesn't disrupt the aerodynamic structure. • The parachute nest has an airfoil structure.

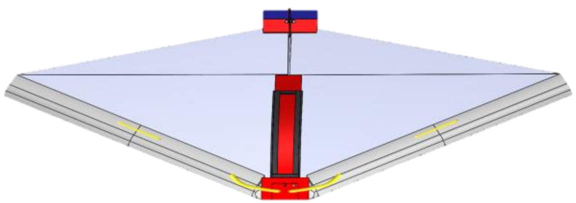
Payload Descent Control Strategy Selection and Trade (4 of 4)

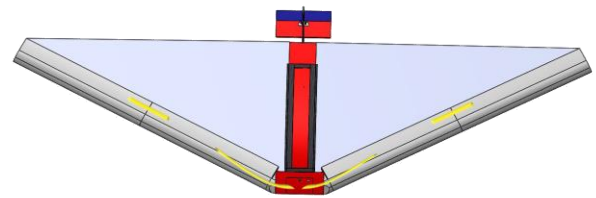
STRATEGY 1
Diamond Delta Wing

Deployed Descent Rate Control
(Post payload deployment)

STRATEGY 2
Simple Delta Wing

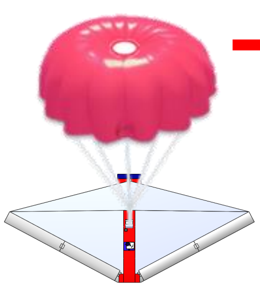
At 450 meters (± 10 m), the payload will release the container. It will be glide at above 100 meters for one minute within a radius of 250 meters with active control.



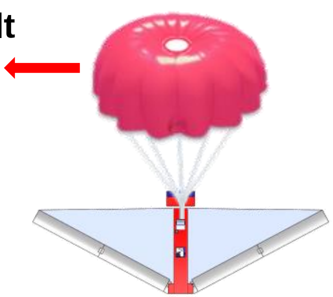


- The payload has a **diamond delta** wing structure.
- It has more area due to the wing structure**.**

- The payload has a **simple delta** wing structure.



The parachute of the payload will be opened at above 100 meters by the melt of fishline method. Passively will descent at a speed of 10 m/s (± 5 m/s).

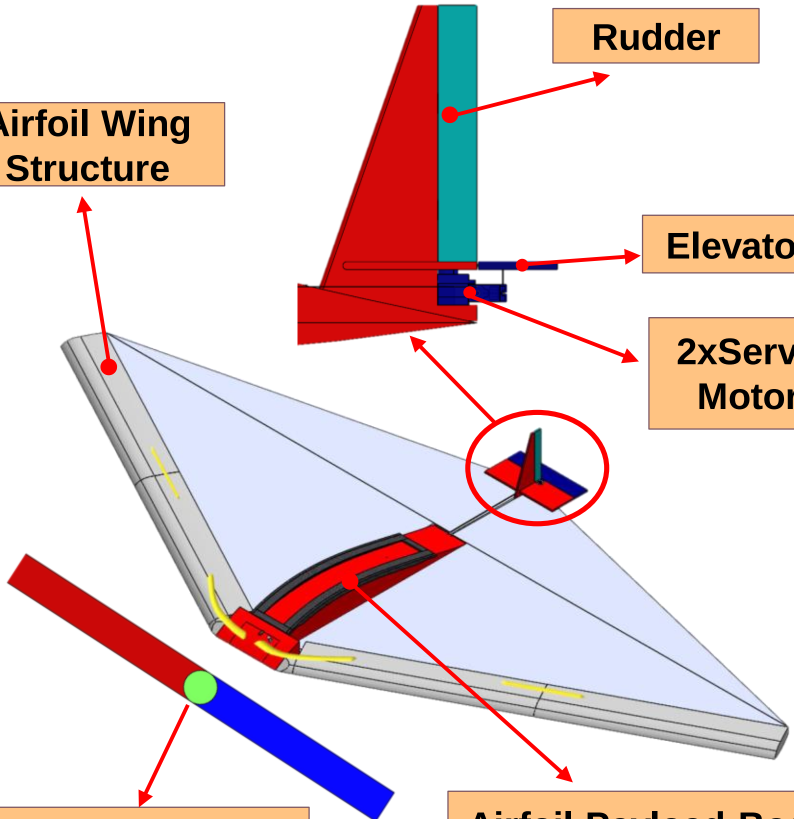


SELECTED	REASONS
STRATEGY 1	• Diamond delta wing provides a more stable flight at low altitude. • Strategy 1 has more wing area, it provides more lifting force.

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

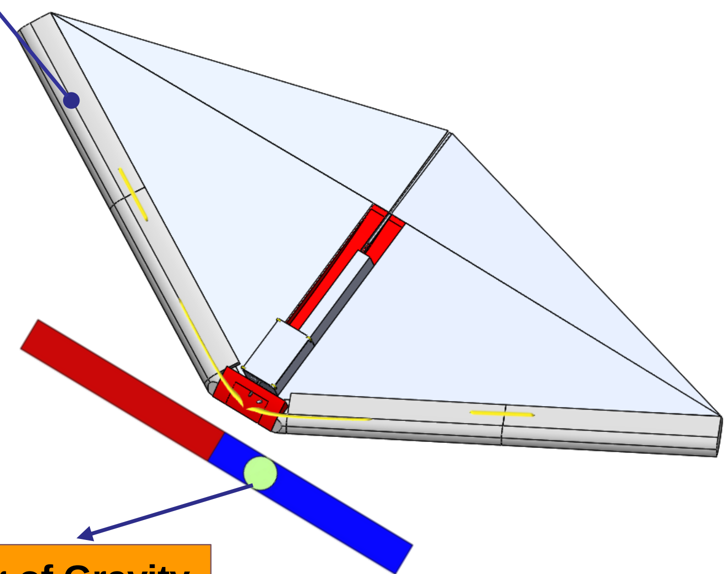
METHOD 1

ACTIVE CONTROL



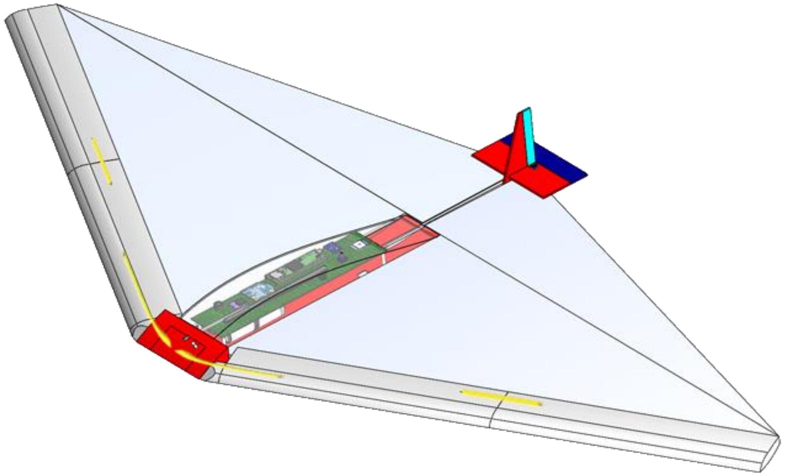
METHOD 2

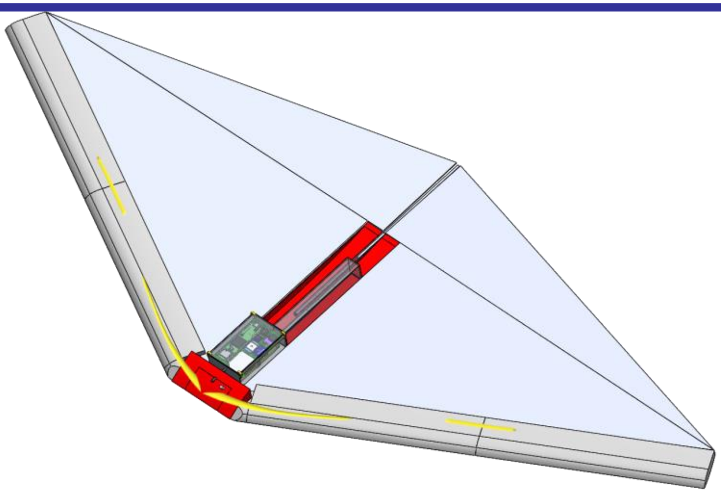
PASSIVE CONTROL



The direction of rotation will be provided by the position of the center of gravity.

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



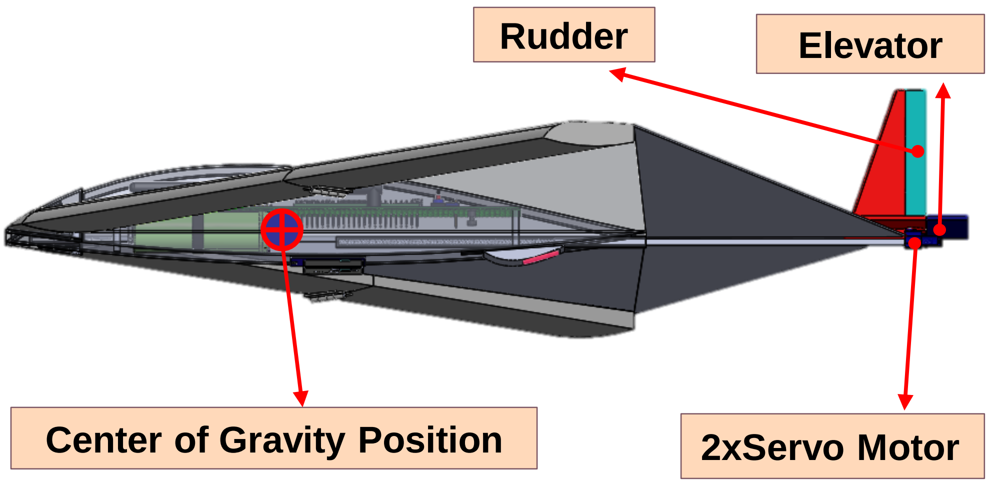


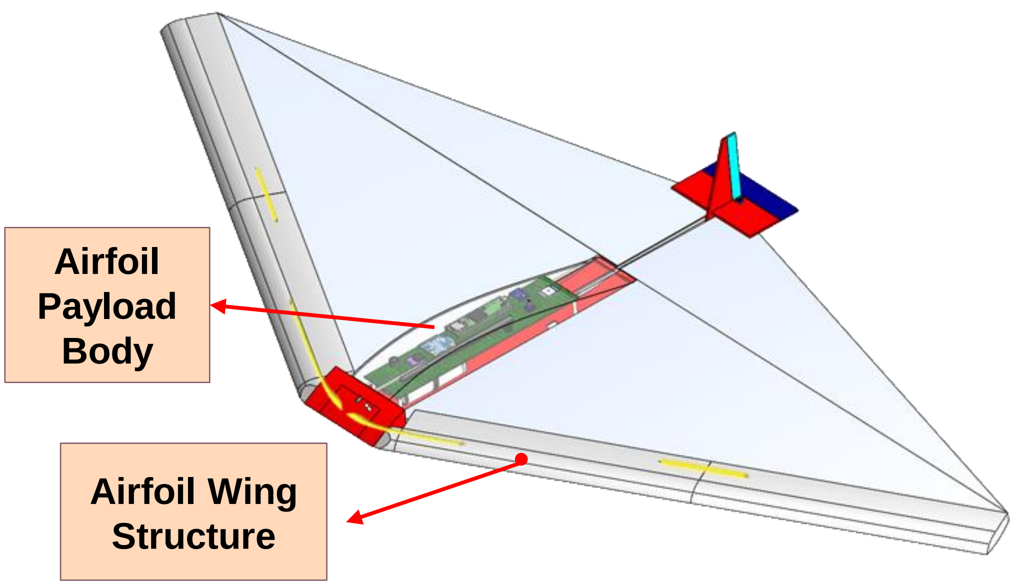
METHOD 1 (Active Control)	METHOD 2 (Passive Control)
• Payload body has an airfoil structure. Elevator and rudder will be used. The descent will be controlled actively.	• The center of gravity will be provided by the position of the electronic components such that the payload can rotate. The descent will be controlled passively.

SELECTED METHOD 1

- It will be used rudder and elevator, the direction and speed of rotation is actively controlled and it is more guaranteed to reach the necessary speed and diameter of rotation.
- The payload body has an airfoil structure, it will perform a more stable flight.

Payload Descent Stability Control Strategy Selection and Trade (3 of 3)





Type of Stability Control of Selected Method

- **<u>It will be controlled actively (servo motor will be used).</u>**
- **<u>Nadir direction will be provided by using elevator with active control.</u>**
- **<u>The payload will be protected from rolling using the elevator and with the position of the center of gravity. Stable descent will take place.</u>**
- The payload wing structure and body have an airfoil structure. The lifting force will obtain by the pressure difference arising from the airfoil structure. Stable descent will take place.
- Necessary descent speed will be adjusted by using an elevator.
- Direction during descent will be provided the rudder.
- The payload will perform an active descent for one minute from 450 meters to 100 meters. Then a passive descent by parachute will take place.

Container + Payload Post Rocket Separation

$$S_p = \frac{2 \times m \times g}{\rho \times V^2 \times C_D}$$

$$S_p = \frac{2 \times (0.6\ kg) \times (9.81\ m/s^2)}{(1.225\ kg/m^3) \times (20\ m/s)^2 \times 1.5}$$

$$S_p = 0.01602\ m^2$$

$$S_p = \frac{1}{4}\pi D^2$$

$$D = \sqrt{\frac{4 \times S_p}{\pi}}$$

S_p = Area of the parachute with a spill hole (m^2)
D = The diameter of the parachute (mm)
V = 20 m/s (Descent Speed)
π = 3.14159
C_D = 1.5 (Drag coefficient of round type parachute)
ρ = 1.225 kg/m^3 (Air density at $+15$°C from sea level)
m = 0.6 kg (Container + Payload Weight)
g = 9.81 m/s^2
S_{S_h} = Spill hole area

- **Area of the spill hole is chosen to be 5% of the total parachute projected area.**
- **Project area of spill hole:**

$$S_{S_h} = S_p \times 5\% \longrightarrow 0.01602\ m^2 \times 0.05 = 0.00080\ m^2$$

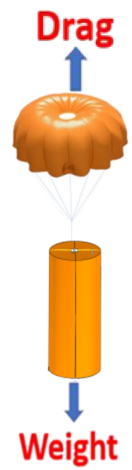
Spill hole Radius $= \sqrt{\frac{S_{sh}}{\pi}} = \sqrt{\frac{0.00080}{\pi}} = 0.01596\ m = 15.96766\ mm \cong 16\ mm$

$$D = \sqrt{\frac{4 \times 0.01602\ m^2}{\pi}} \longrightarrow D = 0.14281\ m \cong 143\ mm$$

Descent Speed Rates

Descent Speed Formula

$$V = \sqrt{\frac{2 \times F_{Drag}}{\rho \times S_p \times C_D}}$$



$$F_{Drag} = F_{Weight}$$

S_p= Area of the parachute with a spill hole (m^2)
V = Descent speed (m/s)
C_D = 1.5 (Drag coefficient of round type parachute)
$\rho = 1.225\ kg/m^3$ (Air density at +15°C from sea level)
$m = 0.1245\ kg$ (Container)
$m = 0.6\ kg$ (Container + Payload)
$g = 9.81 m/s^2$

Descent Speed for Container + Payload

$$V = \sqrt{\frac{2 \times (0.6\ kg) \times (9.81\ m/s^2)}{(1.225\ kg/m^3\ ) \times (0.01602\ m^2) \times 1.5}}$$

$$V = 19.99770\ m/s\ \cong\ \mathbf{20\ m/s}$$

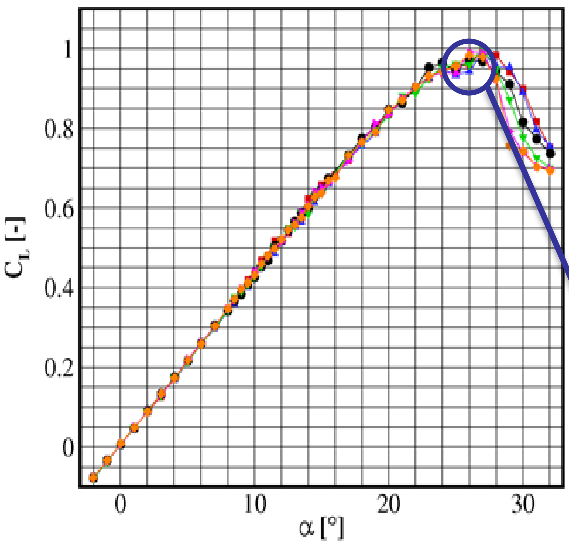
Container Descent Speed for After Released of The Payload

$$V = \sqrt{\frac{2 \times (0.1245\ kg) \times (9.81\ m/s^2)}{(1.225\ kg/m^3) \times (0.01602\ m^2) \times 1.5}}$$

$$V = 9.10938\ m/s\ \cong \mathbf{9\ m/s}$$

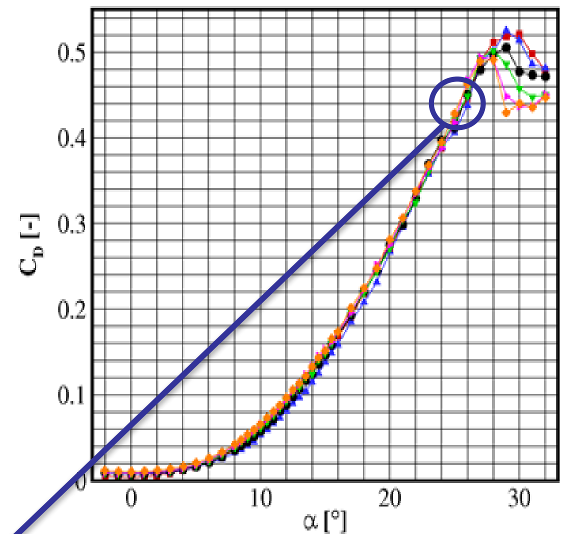
Graphics of Diamond Delta Wing

Lift Coefficient Graphic



$h_d/I_\mu = 0.000\%, Re = 2.7 \times 10^6$
$h_d/I_\mu = 0.019\%, Re = 2.7 \times 10^6$
$h_d/I_\mu = 0.025\%, Re = 2.7 \times 10^6$
$h_d/I_\mu = 0.069\%, Re = 2.4 \times 10^6$
$h_d/I_\mu = 0.125\%, Re = 2.7 \times 10^6$
$h_d/I_\mu = 0.250\%, Re = 2.7 \times 10^6$

Drag Coefficient Graphic



We selected the 26° angle of attack for efficient lift and drag coefficient.

$$C_L = 0.95$$
$$C_D = 0.44$$

- **Source:** https://www.mdpi.com/2226-4310/5/3/98/htm

Delta Wing Payload Calculations

$$V_{Vertical} = \frac{\Delta x}{t} = \frac{450\,m - 100\,m}{60\,s} = \frac{350\,m}{60\,s} = \mathbf{5.83\,m/s}$$

$$\mathrm{F}(\mathrm{m} \times g) = \frac{1}{2} \times C_D \times \rho \times A \times V_{Horizontal}^2$$

$$V_{Horizontal} = \sqrt{\frac{2(m \times g)}{C_D \times \rho \times A}} = \sqrt{\frac{2 \times (0.4711\,kg) \times (9.81\,m/s^2)}{0.44 \times (1.225\,kg/m^3) \times (0.21424\,m^2)}}$$

$$V_{Horizontal} = 8.94669 \cong \mathbf{8.9\,m/s}$$

$\mathrm{AR} = 5$ (Aspect ratio)

$\mathrm{GR} =$ Glide ratio $\left(\frac{V_{\mathrm{Vertical}}}{V_{\mathrm{Horizontal}}}\right)$

$\mathrm{WS} = 1.035\,m$ (Wingspan)

$\mathrm{A} = 0.21424\,m^2$ (Wing area)

$\mathrm{Aoa} = 26°\mathrm{C}$ Angle of attack

$C_D = 0.44$ Drag coefficient

$\mathrm{C_L}/C_D =$ Lift/Drag Ratio

$V =$ Descent speed (m/s)

$g = 9.81\,m/s^2$

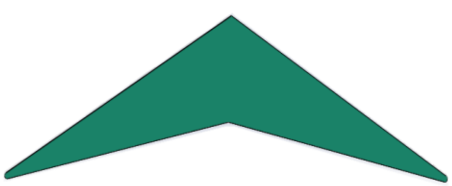
$m = 0.4711\,kg\ (payload)$

$$\mathrm{AR} = \frac{\mathrm{WS}^2}{\mathrm{A}} = \frac{(1.035\,m)^2}{0.21424\,m^2} = 5$$

$$\mathrm{C_L}/\mathrm{C_D} = \frac{0.95}{0.44} = 2.15909 \cong 2.16$$

$$V_{Payload} = \sqrt{5.83^2 + 8.9^2} = 10.63949 \cong \mathbf{10.6\,m/s}$$

$$\mathrm{GR} = \frac{V_{Vertical}}{V_{Horizontal}} = \frac{5.83}{8.9} = 0.65505 \cong 0.66$$



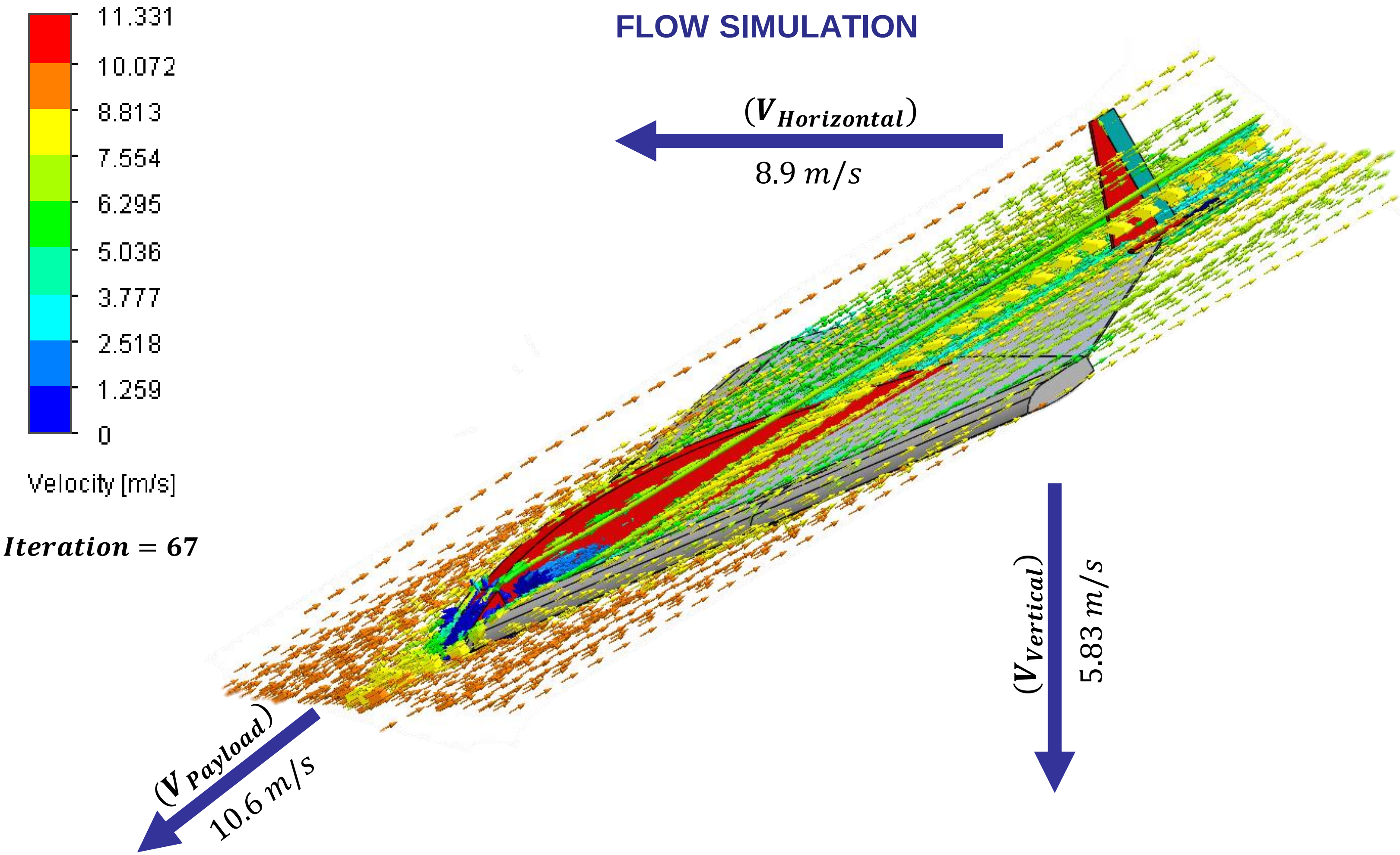
(Aspect ratio 6.8)
High aspect ratio

(Aspect ratio 4.4)
Low aspect ratio

(We observe high and low aspect ratio difference in photos)

- ***At low aspect ratio, the lift coefficient is low, but maneuverability is high, so an optimum value between low and high aspect ratio is chosen for this mission.***

FLOW SIMULATION



- Glider flow simulation in descent time. The wind speed is shown in the simulation according to the colors.
- This simulation proves to us that our payload is of an airfoil form.

Payload Parachute Calculations

$$S_p = \frac{2 \times m \times g}{\rho \times V^2 \times C_D}$$

$$S_p = \frac{2 \times (0.4711\ kg) \times (9.81\ m/s^2)}{(1.225\ kg/m^3) \times (10\ m/s)^2 \times 1.5}$$

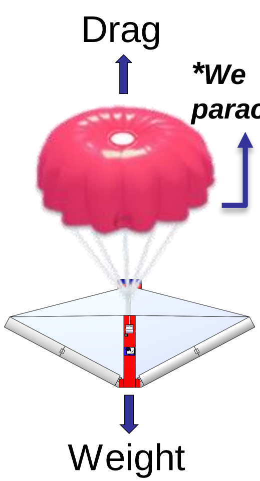
$$S_p = 0.05030\ m^2 \Rightarrow S_p = \frac{1}{4} \times \pi \times D^2$$

$$D = \sqrt{\frac{4 \times S_p}{\pi}}$$

S_p = Area of the parachute with a spill hole (m^2)
D = The diameter of the parachute (mm)
V = 10 m/s Descent speed
π = 3.14159
C_D = 1.5 (Drag coefficient of round type parachute)
ρ = 1.225 kg/m^3 (Air density at +15°C from sea level)
m = 0.4711 kg (Payload)
g = 9.81 m/s^2
S_{S_h} = Spill hole area (m^2)

$$Ss_h = S_P \times 5\% \Rightarrow 0.05030\ m^2 \times 0.05 = 0.00251\ m^2$$

$$\text{Spill Hole Radius} = \sqrt{\frac{Ss_h}{\pi}} = \sqrt{\frac{0.00251}{3.14159}} = 0.02826\ m = 28.26580\ mm \cong 28\ mm$$



We choose the fluorescent pink color parachute for this mission.

$$D = \sqrt{\frac{4 \times 0.05030}{3.14159}} \Rightarrow D = 0.25306\ m \cong 253\ mm$$

$$V = \sqrt{\frac{2 \times m \times g}{\rho \times S_p \times C_D}}$$

$$V = \sqrt{\frac{2 \times (0.4711\ kg) \times (9.81\ m/s^2)}{(1.225\ kg/m^3) \times (0.05030 m^2) \times 1.5}}$$

$$V = 10.00019\ m/s \cong 10\ m/s$$

FINAL RESULTS

CanSat (Container + Payload) Post Rocket Separation

- *Spill hole diameter:* $32\ mm$
- *The diameter of parachute:* $143\ mm$
- *Descent speed:* $20\ m/s$

Container After Being Released

- *Container descent speed after released of the payload:* $9\ m/s$

Payload Following Separation from The Container

- *Angle of attack:* $26°$
- *Area of delta wing:* $0.21424\ m^2$
- *Speed of payload:* $10.6\ m/s$

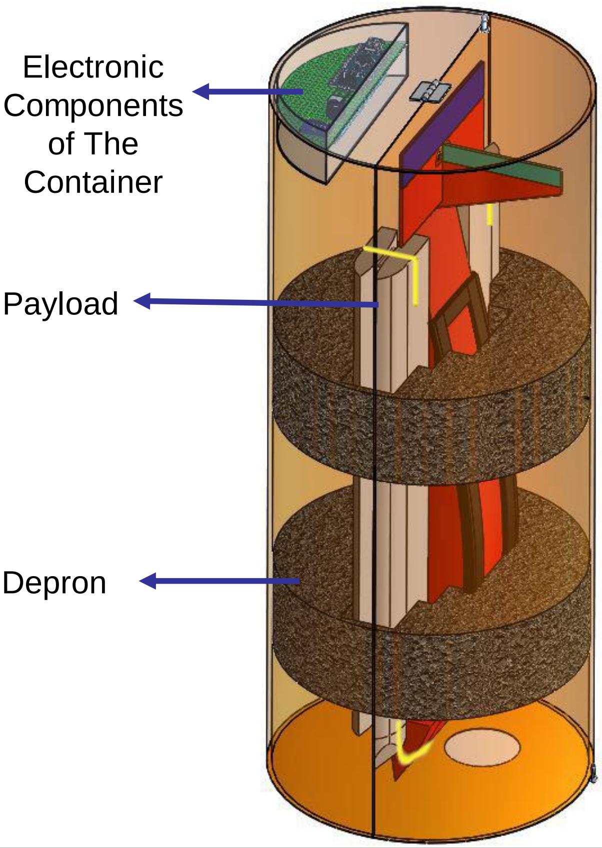
Payload Parachute Calculations

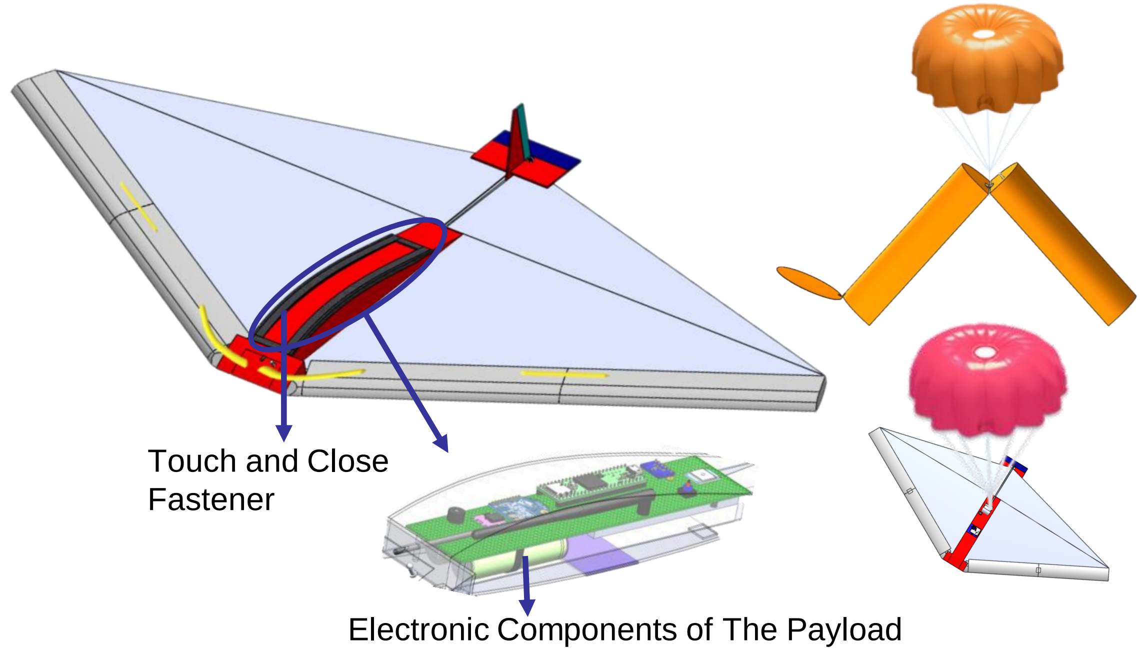
- *Spill hole diameter:* $56\ mm$
- *The diameter of the parachute:* $253\ mm$
- *Descent speed:* $10\ m/s$

Mechanical Subsystem Design

Ömer ÖZ

Mechanical Subsystem Overview





CONTAINER
Material: Fiberglass **Parachute Material:** Silnylon 30D Nylon 66.

PAYLOAD
Body Material: Fiberglass. The part in front of the camera will be made of plexiglass for image acquisition. **Delta Wing Material:** Silnylon 30D Nylon 66. **Delta Wing Structural:** Stretched fabric elastic, hinges, carbon fiber sticks. **Parachute Material:** Silnylon 30D Nylon 66. •The active rotation of the payload is provided by the elevator and the rudder on the wings. •Rudder and elevator will be controlled by servo motors. •There will be a telescopic system in the payload. This system will extend the wing area. •To the batteries and electronic components will be easily reached by touch and close fastener.

Mechanical Sub-System Requirements (1 of 3)

Requirement Number	Requirement	Rationale	Priority	VM			
				A	I	T	D
RN#1	Total mass of the CanSat (science payload and container) shall be 600 grams +/- 10 grams.	Competition requirement	HIGH	✓	✓	✓	
RN#2	CanSat shall fit in a cylindrical envelope of 125 mm diameter x 310 mm length. Tolerances are to be included to facilitate container deployment from the rocket fairing.	Competition requirement	HIGH		✓	✓	✓
RN#3	The container shall not have any sharp edges to cause it to get stuck in the rocket payload section which is made of cardboard.	Competition requirement	HIGH		✓	✓	
RN#4	The container shall be a fluorescent color; pink, red or orange.	Competition requirement	HIGH		✓		
RN#5	The container shall be solid and fully enclose the science payload. Small holes to allow access to turn on the science payload is allowed. The end of the container where the payload deploys may be open.	Competition requirement	HIGH		✓	✓	
RN#6	The rocket airframe shall not be used to restrain any deployable parts of the CanSat.	Competition requirement	HIGH		✓		✓
RN#7	The CanSat shall deploy from the rocket payload section and immediately deploy the container parachute.	Competition requirement	HIGH		✓		✓

Mechanical Sub-System Requirements (2 of 3)

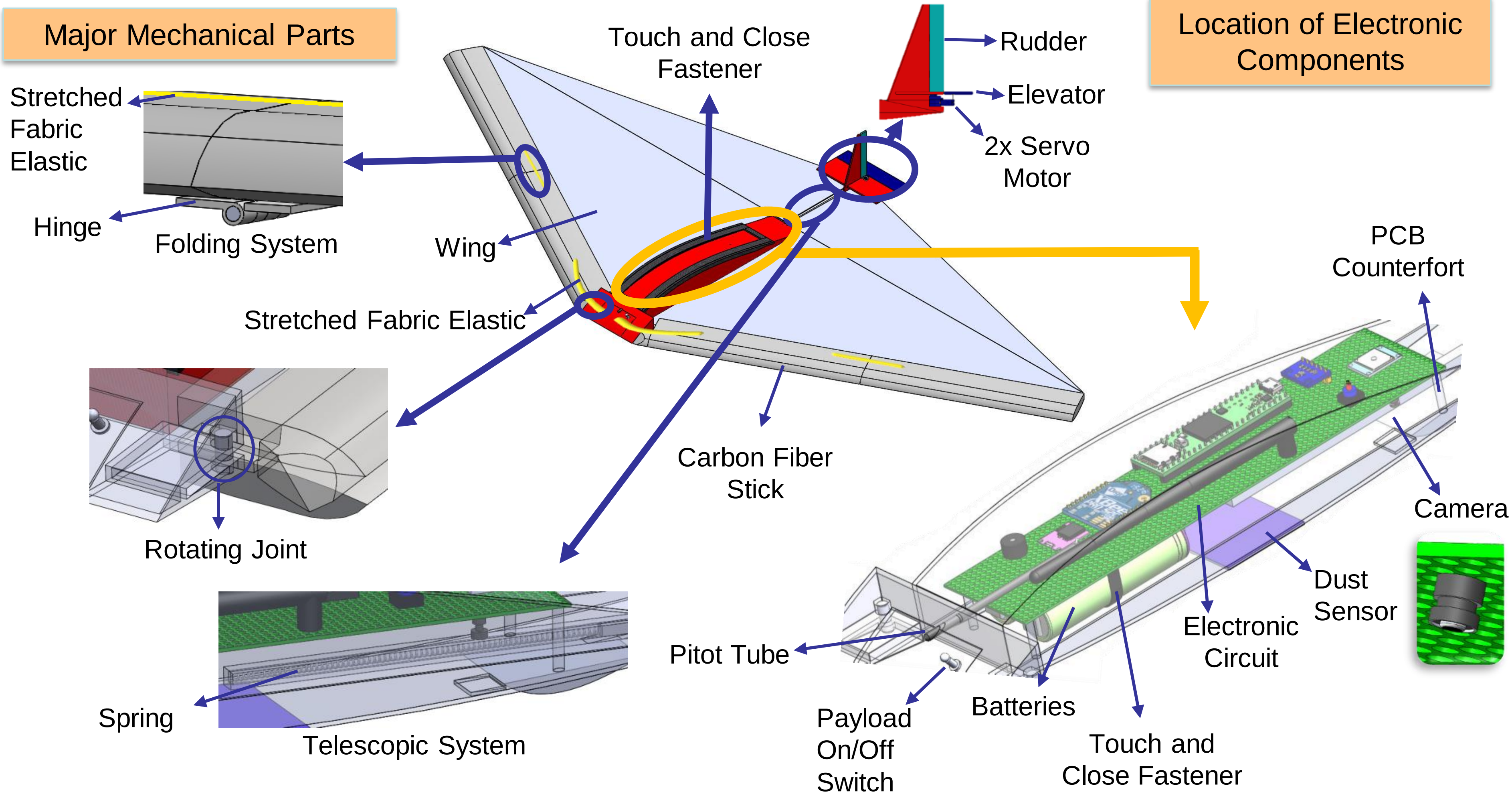
Requirement Number	Requirement	Rationale	Priority	VM			
				A	I	T	D
RN#8	The container parachute shall not be enclosed in the container structure. It shall be external and attached to the container so that it opens immediately when deployed from the rocket.	Competition requirement	HIGH		✓	✓	✓
RN#9	The descent rate of the CanSat (container and science payload) shall be 20 meters/second +/- 5m/s.	Competition requirement	HIGH		✓	✓	✓
RN#10	The container shall release the payload at 450 meters +/- 10 meters.	Competition requirement	HIGH		✓	✓	✓
RN#11	The science payload shall glide in a circular pattern with a 250 m radius for one minute and stay above 100 meters after release from the container.	Competition requirement	HIGH	✓	✓	✓	✓
RN#12	The science payload shall be a delta wing glider.	Competition requirement	HIGH	✓	✓		✓
RN#14	All descent control device attachment components shall survive 30 Gs of shock.	Competition requirement	HIGH	✓	✓	✓	
RN#15	All electronic components shall be enclosed and shielded from the environment with the exception of sensors.	Competition requirement	HIGH		✓	✓	✓
RN#16	All structures shall be built to survive 15 Gs of launch acceleration.	Competition requirement	HIGH	✓	✓	✓	

Mechanical Sub-System Requirements (3 of 3)

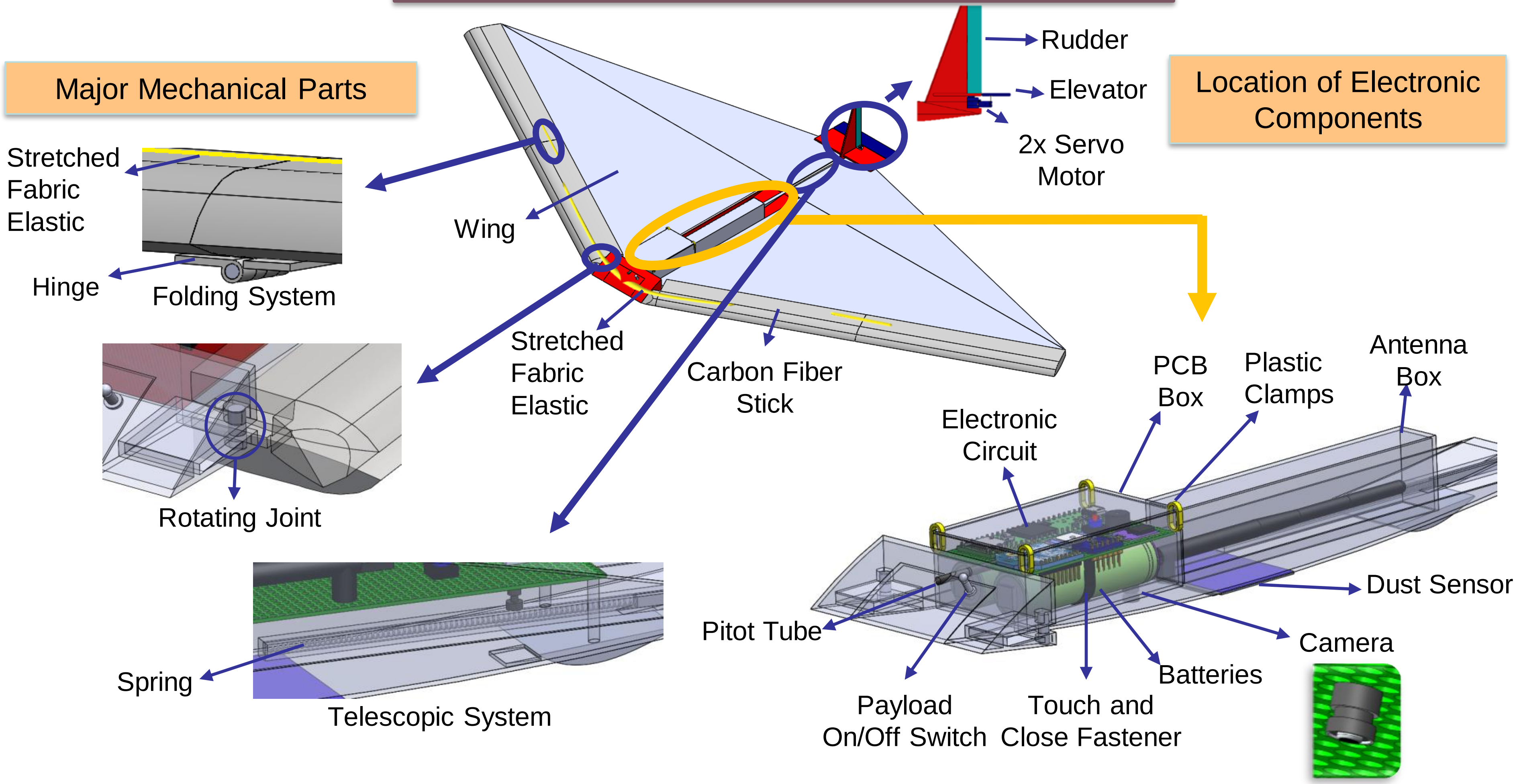
Requirement Number	Requirement	Rationale	Priority	VM			
				A	I	T	D
RN#17	All structures shall be built to survive 30 Gs of shock.	Competition requirement	HIGH	√	√	√	
RN#18	All electronics shall be hard mounted using proper mounts such as standoffs, screws, or high-performance adhesives.	Competition requirement	HIGH	√	√		
RN#19	All mechanisms shall be capable of maintaining their configuration or states under all forces.	Competition requirement	HIGH	√		√	
RN#20	Mechanisms shall not use pyrotechnics or chemicals.	Competition requirement	HIGH	√	√		
RN#21	Mechanisms that use heat (e.g., nichrome wire) shall not be exposed to the outside environment to reduce potential risk of setting vegetation on fire.	Competition requirement	HIGH	√	√	√	
RN#38	Cost of the CanSat shall be under $1000. Ground support and analysis tools are not included in the cost.	Competition requirement	MEDIUM	√	√		
RN#54	An easily accessible battery compartment must be included allowing batteries to be installed or removed in less than a minute and not require a total disassembly of the CanSat.	Competition requirement	HIGH	√	√		
RN#56	The CANSAT must operate during the environmental tests laid out in Section 3.5.	Competition requirement	HIGH	√	√	√	√

Payload Mechanical Layout of Components Trade & Selection (1 of 7)

PAYLOAD MECHANICAL LAYOUT DESIGN 1

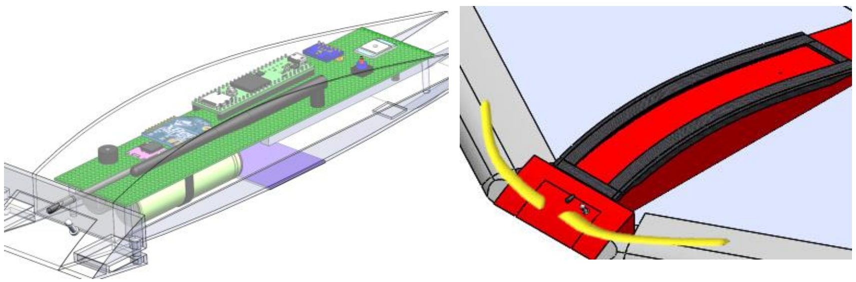


PAYLOAD MECHANICAL LAYOUT DESIGN 2

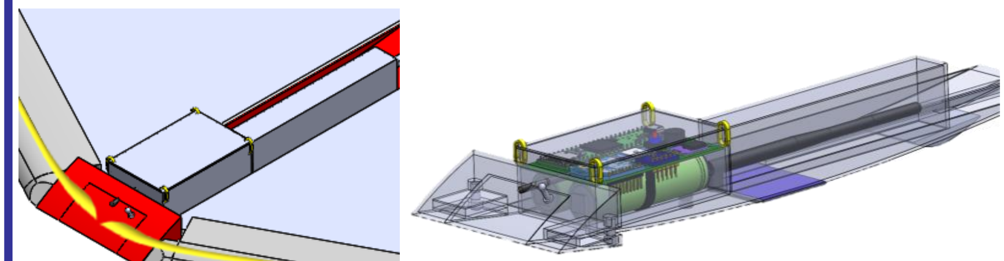


Payload Mechanical Layout of Components Trade & Selection (3 of 7)

DESIGN 1



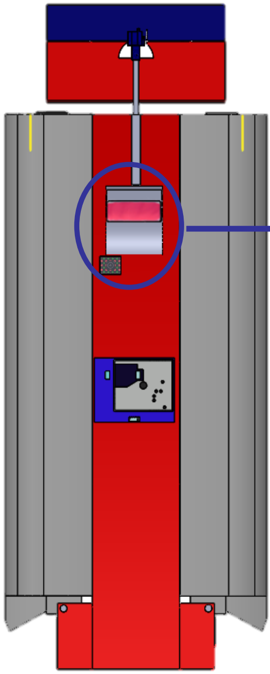
DESIGN 2



SELECTED DESIGN 1

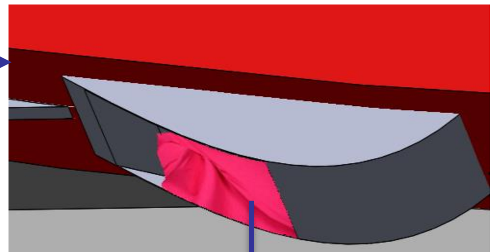
- Design 1 has an airfoil structure. Therefore it provides a more stable flight.
- In Design 1, there is more area for PCB design.
- In Design 1, access to electronic components is easier with touch and close fastener.

THE PAYLOAD'S PARACHUTE OPENING MECHANISM

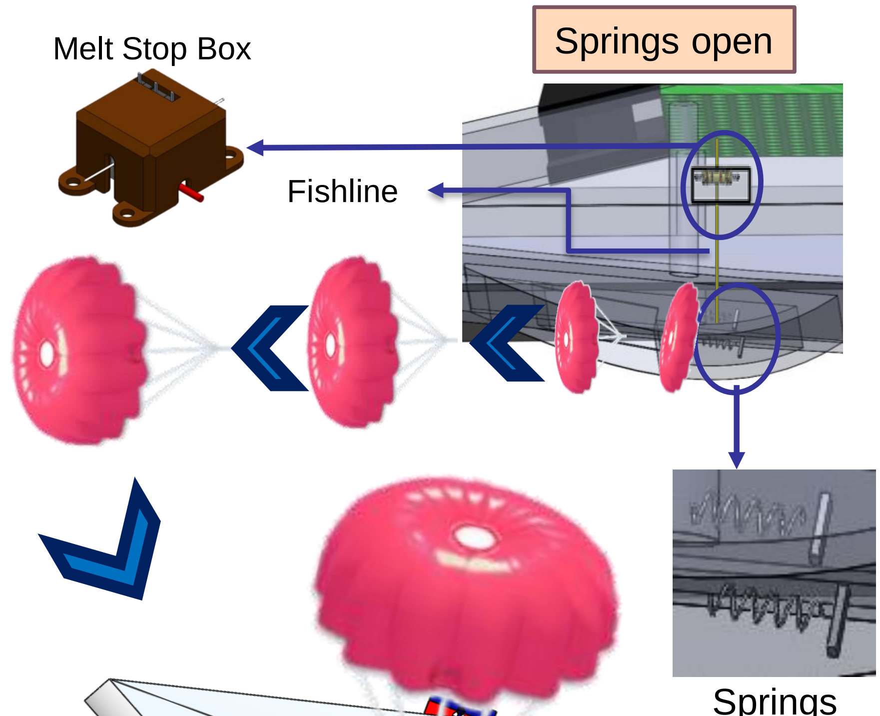


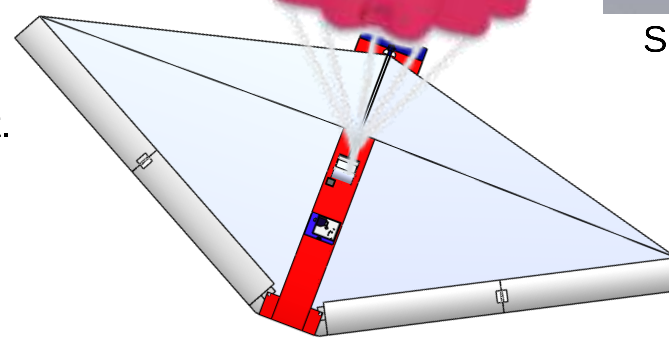
Payload's bottom view

Folded parachute



Stowed Parachute Point





- The springs in the parachute nest will be compressed.
- The payload's parachute will be stowed in the parachute nest.
- The folded parachute will be fixed with fishline.
- The melt of fishline method will be realized and the fixed parachute will be opened with the thrust of the springs.

Payload Mechanical Layout of Components Trade & Selection (5 of 7)

PAYLOAD				
Part	**Material**	**Density (g/cm³)**	**Durability (MPa)**	**Price ($/m²)**
Payload Body	Aluminum	2.70	240	4.81
	Carbon Fiber	1.80	1570	7.38
	Fiberglass	2.27	448	3.53

SELECTED MATERIAL	REASONS
Fiberglass	• It can be shaped easily. • It doesn’t prevent the data transmission. • It’s cheaper than the others. • We have already gained enough experience with the use of the component.

Payload Mechanical Layout of Components Trade & Selection (6 of 7)

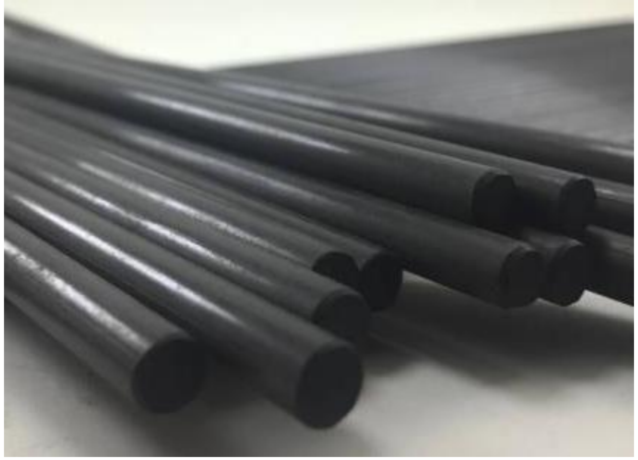
PAYLOAD				
Part	**Material**	**Air Permeability (mm/s)**	**Tear Strength (N)**	**Price ($/m²)**
Payload Wing and Parachute	400D Nylon	138.70	68.80	3.43
	Silnylon 30D Nylon 66	10.80	196.13	12.50
	Fabric	513.70	145.03	14.00

SELECTED MATERIAL	REASONS
Silnylon 30D Nylon 66	• Low air permeability compared to others. • High tear strength compared to others. • We have already gained enough experience with the use of the component.

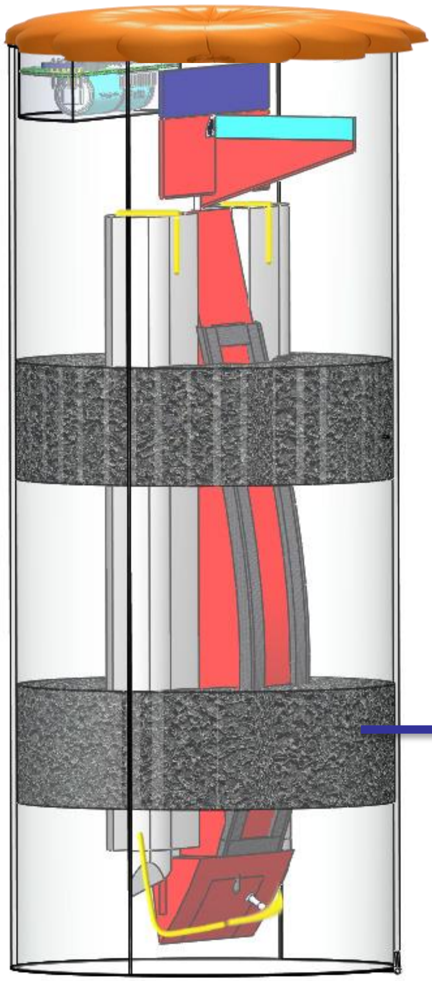
Payload Mechanical Layout of Components Trade & Selection (7 of 7)

PAYLOAD				
Part	**Material**	**Density (g/cm³)**	**Durability (MPa)**	**Price ($/m)**
Payload Wing Frame	Aluminum Stick	2.70	505	4.26
	Fiberglass Stick	2.27	448	5.67
	Carbon Fiber Stick	1.80	1570	9.00

SELECTED MATERIAL	REASONS
Carbon Fiber Stick	• It's more durability than the others. • The low density than the others.

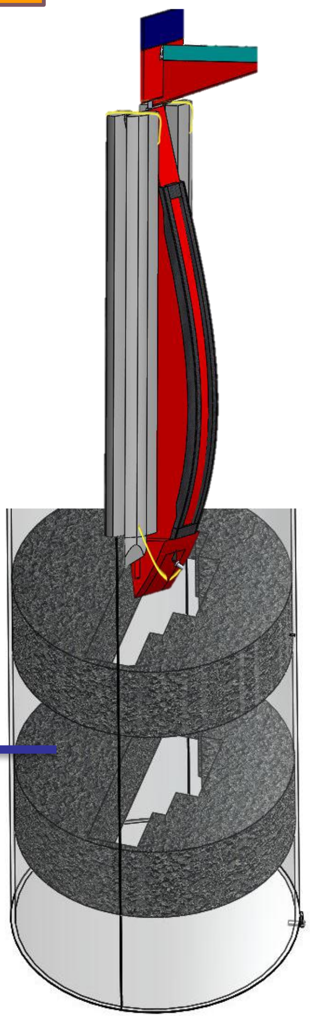


PAYLOAD PRE-DEPLOYMENT (DEPRON) DESIGN 1

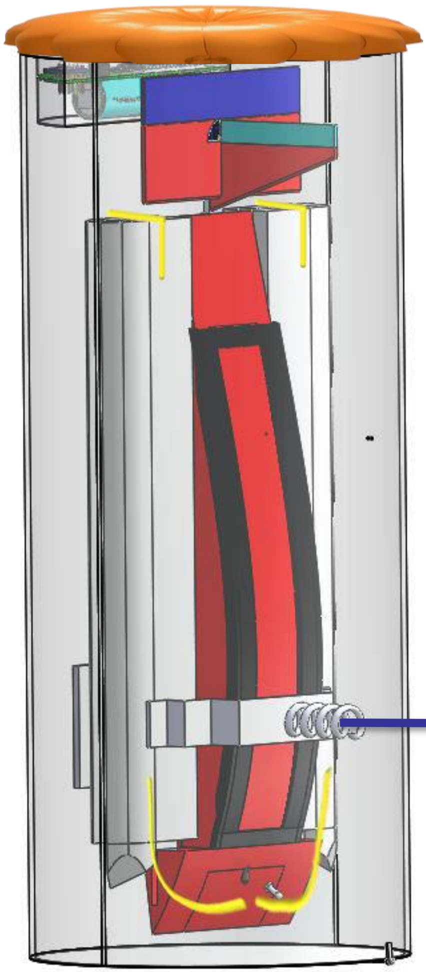


- The protective material will be depron.
- The payload will be placed in the container with protective material.
- Deprons are prevent vibration and the payload will be protected while inside the rocket.
- Depron does not crumble like foam.

DEPRONS

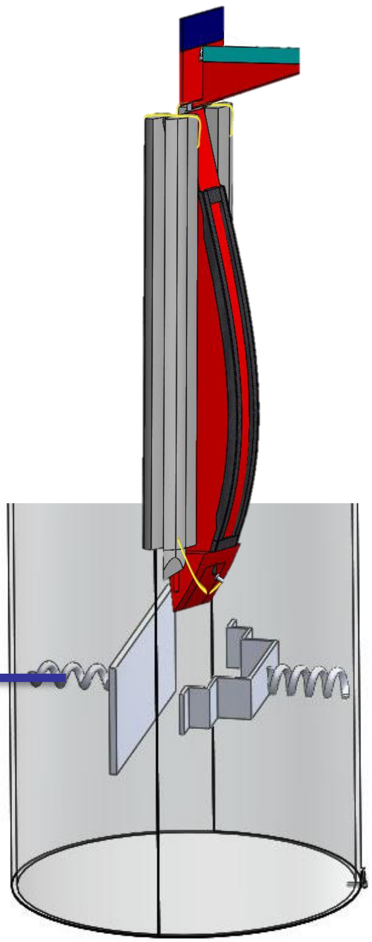


PAYLOAD PRE-DEPLOYMENT (HOLDER SPRINGS) DESIGN 2



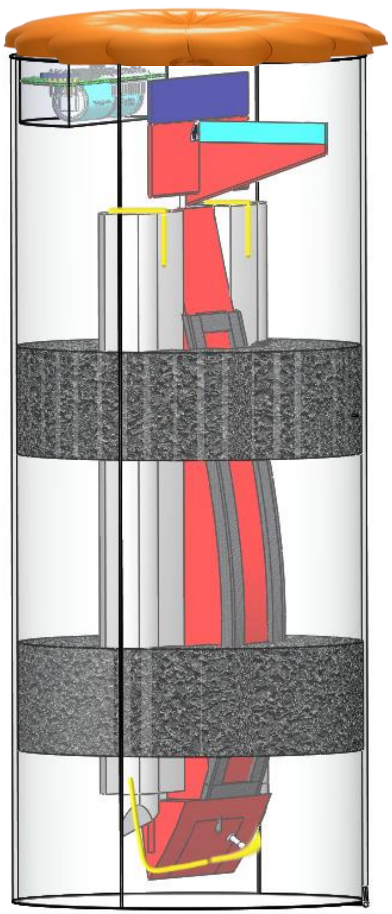
- The payload will be kept in the container with holder springs.
- The holder springs that are mutually fastened in the container will be compressed and the payload will be placed inside it.

Holder Springs



SELECTED PAYLOAD

DESIGN 1



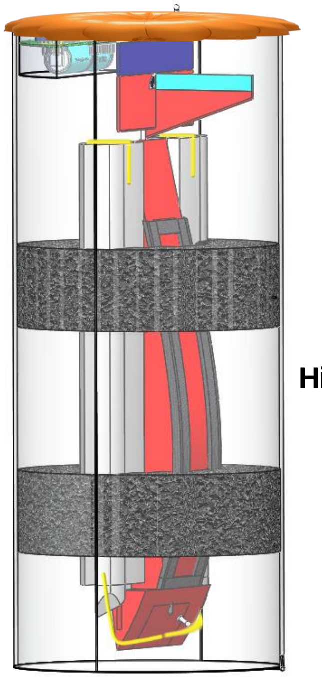
DESIGN 2

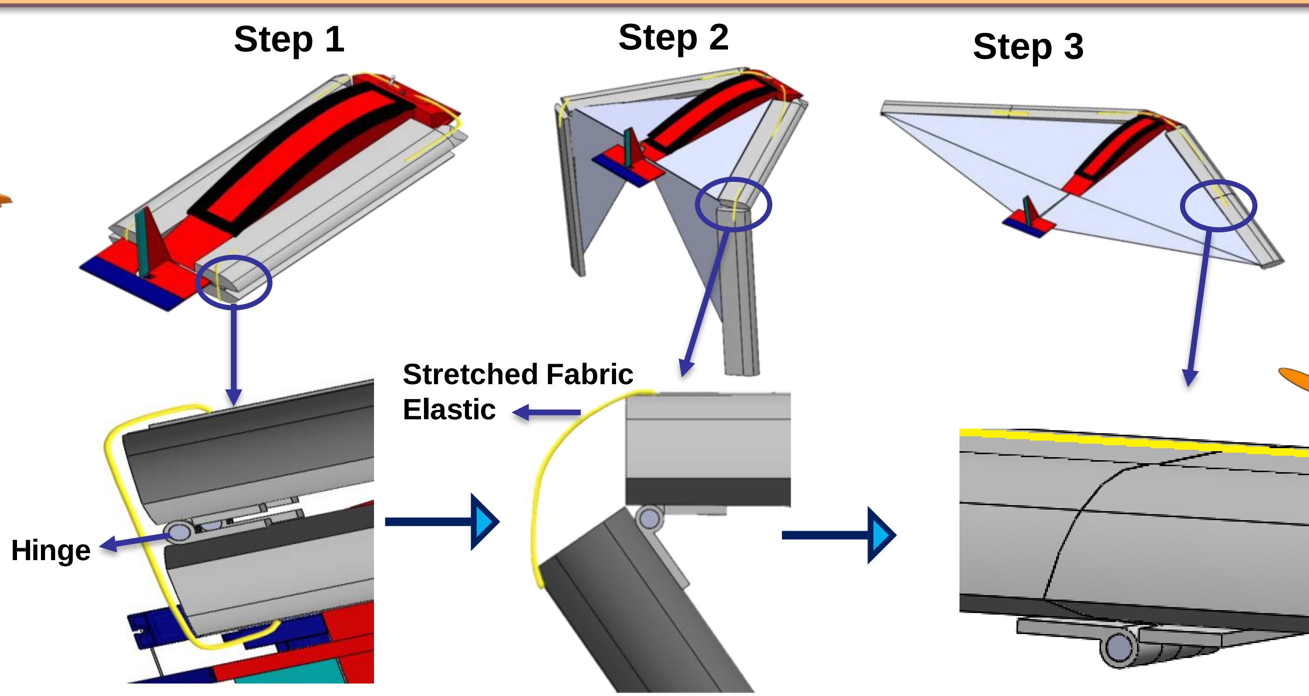
SELECTED DESIGN 1:

- ❖ Because depron is lighter than the holder springs.
- ❖ Holder springs cannot remain constant in rocket vibration.
- ❖ The depron has higher vibration damping capability.
- ❖ The depron is easier to manufacture and assembly.
- ❖ We used and tested depron in previous years.

PAYLOAD DEPLOYMENT CONFIGURATION (Hinge and Stretched Fabric Elastic)

DESIGN 1

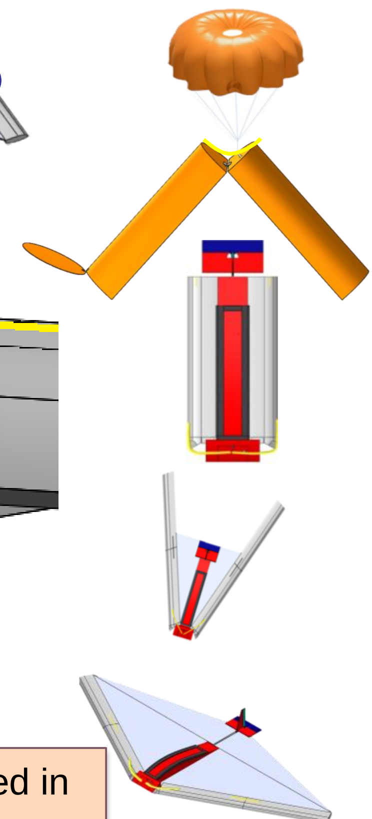




*Closed of wings

*Semi-opened of wings

*Opened of wings



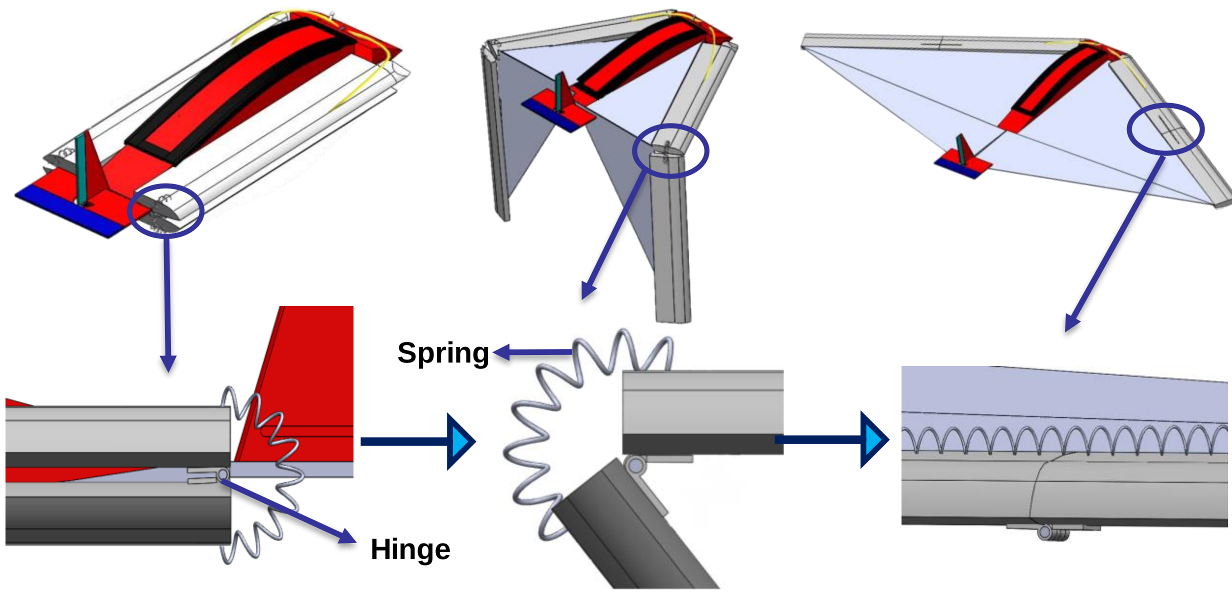
- The stretched fabric elastic on the wing will be stretched and the payload placed in the container.
- The wings will be opened through stretched fabric elastic, hinges and rotating joint.

Payload Deployment Configuration Trade & Selection (2 of 4)

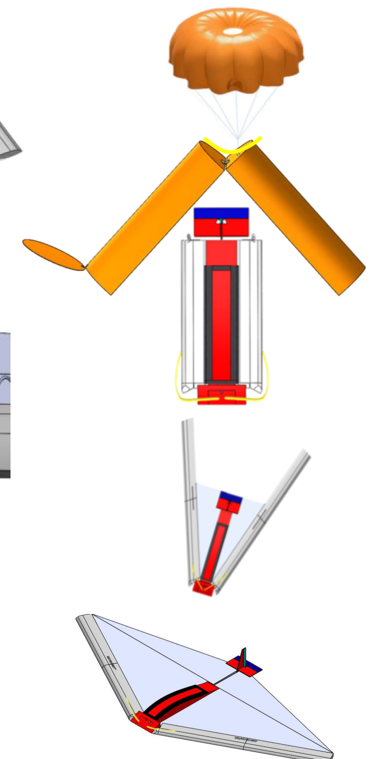
PAYLOAD DEPLOYMENT CONFIGURATION (Hinge and Spring)

DESIGN 2

Step 1 | **Step 2** | **Step 3**



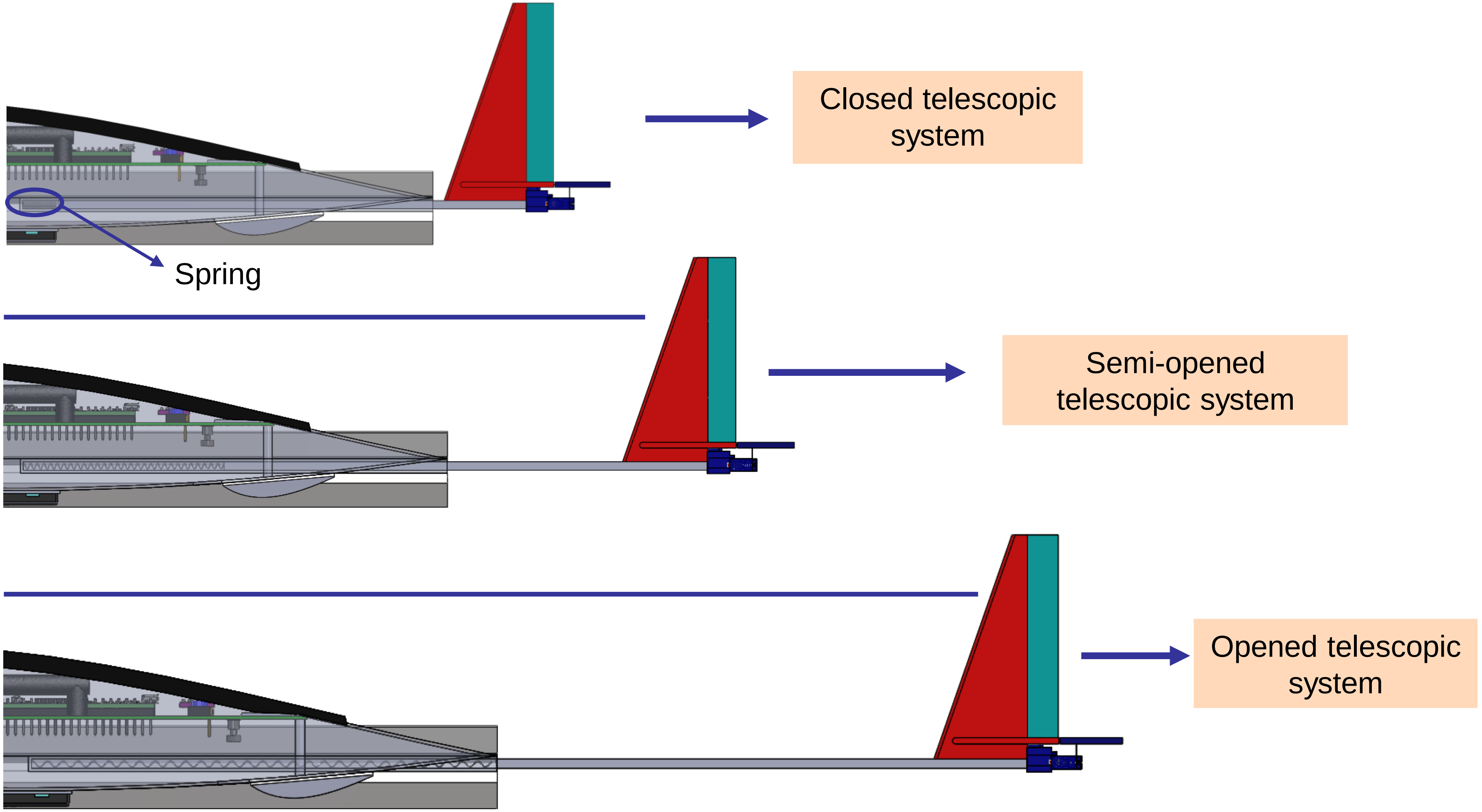
*Closed of wings | *Semi-opened of wings | *Opened of wings



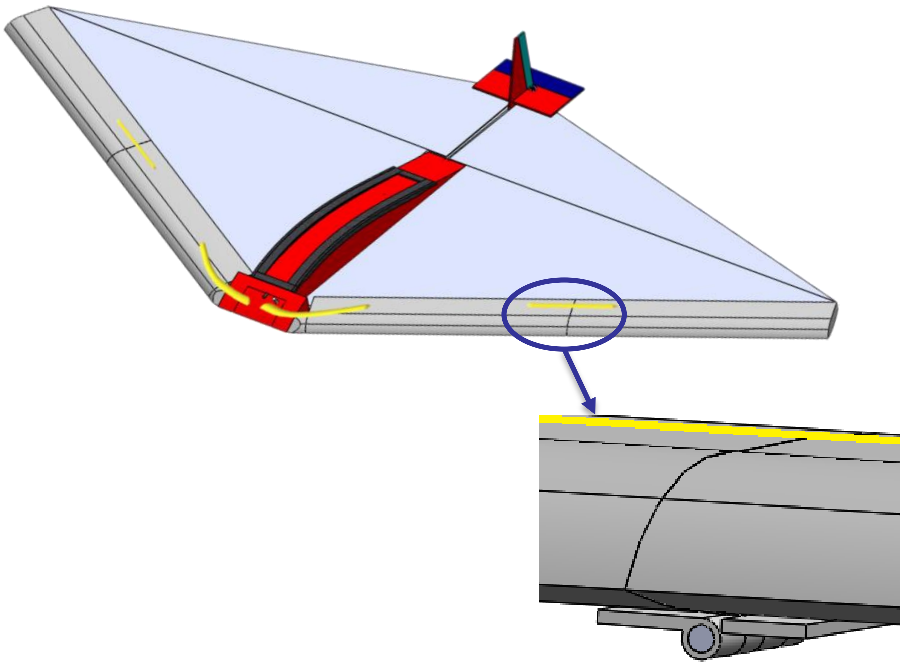
- ❖ The springs on the wing will be stretched and the payload placed in the container.
- ❖ The payload system will be opened with the pulling force of the springs.

Payload Deployment Configuration Trade & Selection (3 of 4)

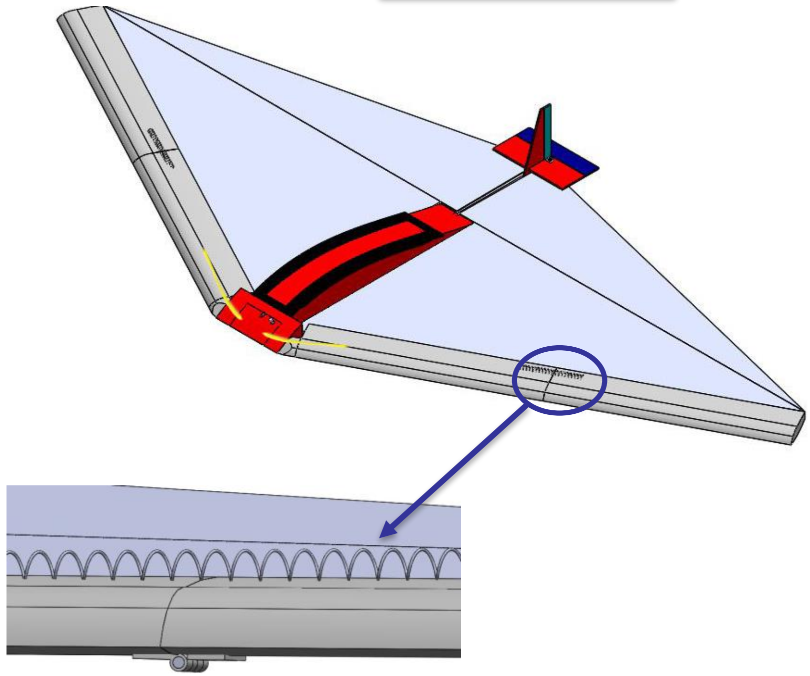
OPEN VIEW OF THE TELESCOPIC SYSTEM FOR DESIGN 1 and DESIGN 2



DESIGN 1



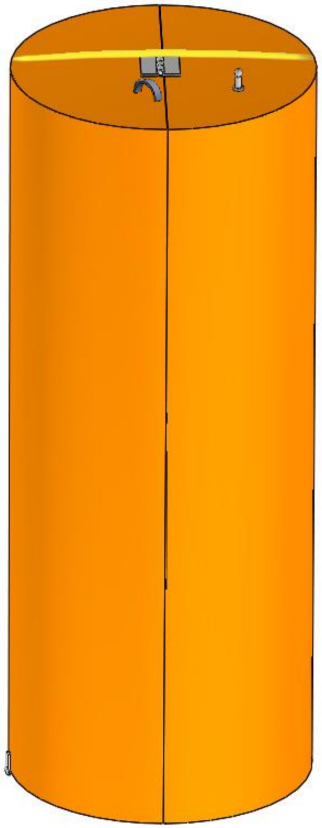
DESIGN 2

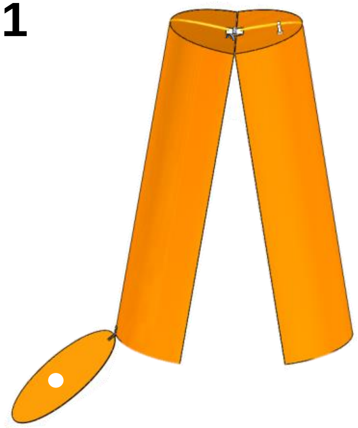


SELECTED DESIGN 1:

- It is easy to assemble.
- Stretched fabric elastic is more useful for holding wings as a whole.
- In our prototype tests, stretched fabric elastic was more successful.

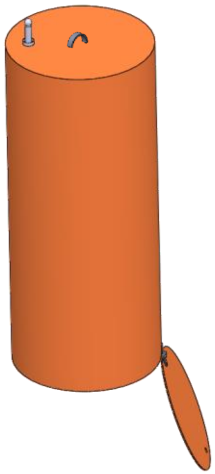
Design 1





The bottom cover and container body will be opened simultaneously.

Design 2

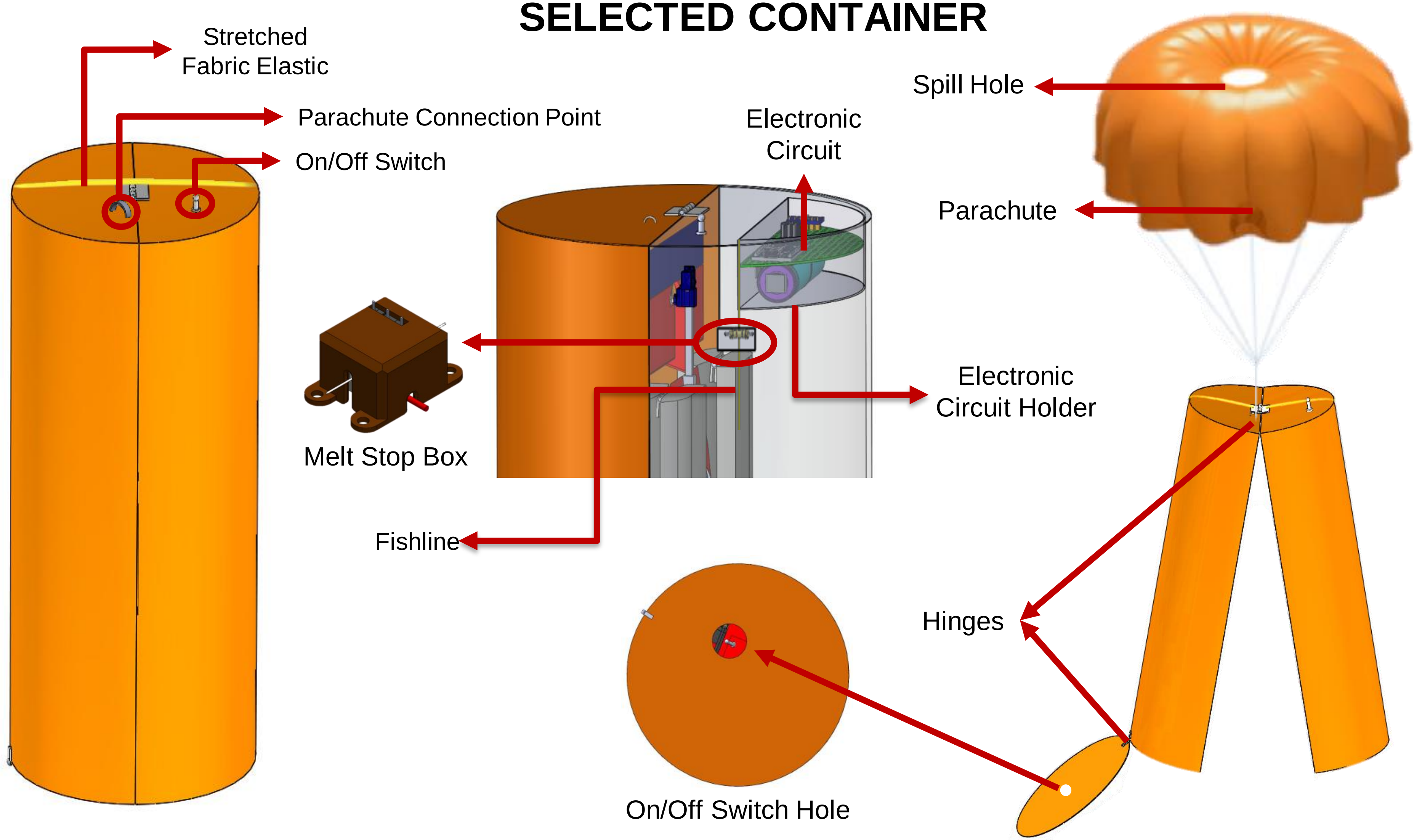


Only the bottom cover opens.

SELECTED DESIGN 1

- It will be easily to open through the stretched fabric elastic.
- It provides more area.
- The container will be not blocked the payload during separation.

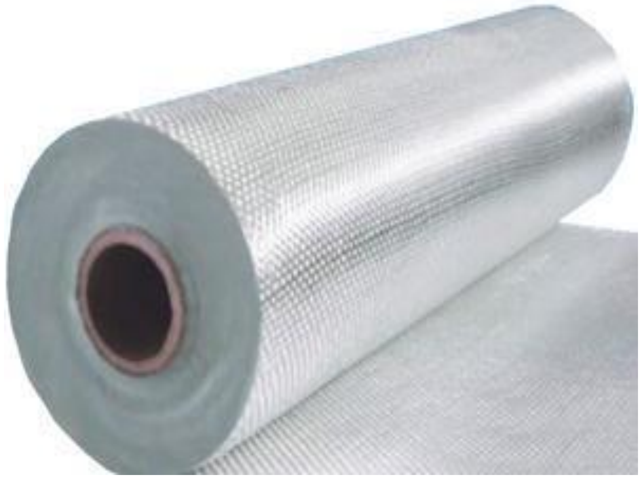
SELECTED CONTAINER



Container Mechanical Layout of Components Trade & Selection (3 of 4)

CONTAINER				
Part	**Material**	**Density (g/cm^3)**	**Durability (MPa)**	**Price ($\$/m^2$)**
Container Body	Fiberglass	2.27	448	3.53
	Carbon Fiber	1.80	1570	7.18
	ABS	1.04	73	20.00

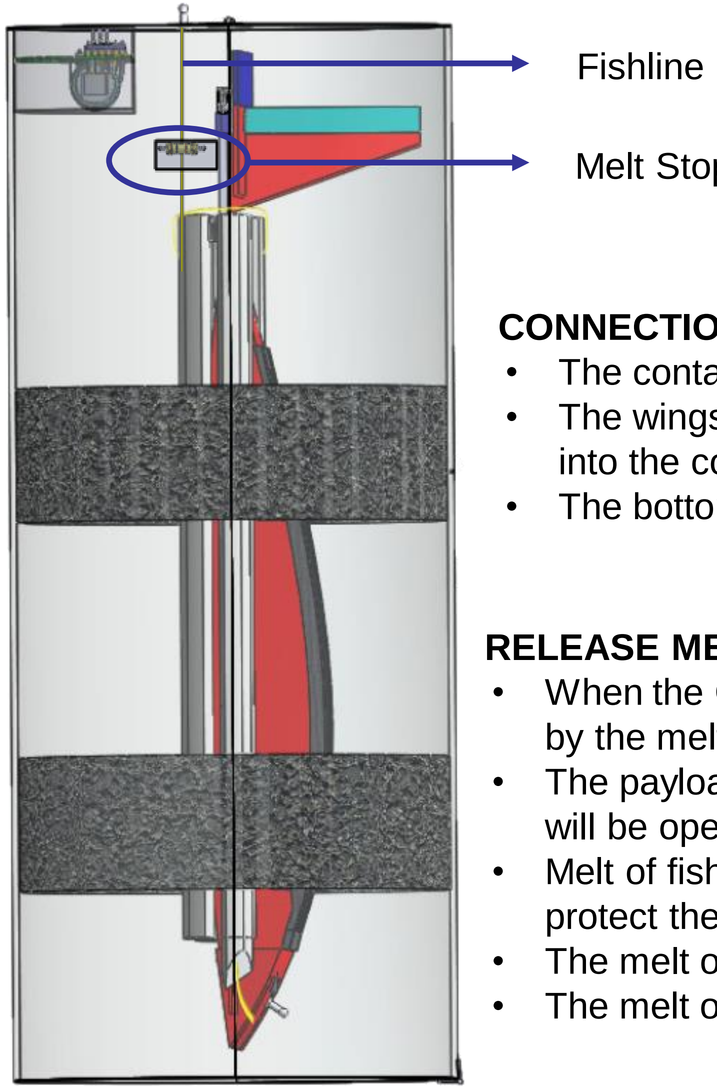
SELECTED MATERIAL	REASONS
Fiberglass	• It doesn't prevent data transmission. • It's cheaper than the others. • We have already gained enough experience with the use of the component.

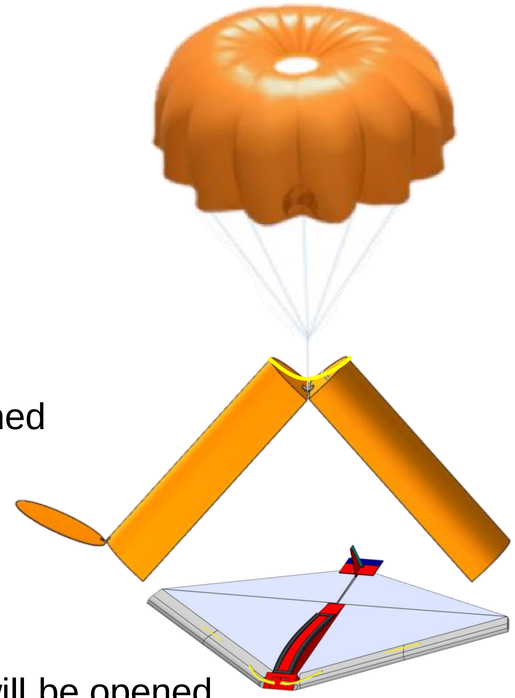


Container Mechanical Layout of Components Trade & Selection (4 of 4)

CONTAINER				
Part	**Material**	**Air Permeability (mm/s)**	**Tear Strength (N)**	**Price ($/m²)**
Container Parachute	400D Nylon	138.70	68.80	3.43
	Fabric	513.70	145.03	14.00
	Silnylon 30D Nylon 66	10.80	196.13	12.50

SELECTED MATERIAL	REASONS
Silnylon 30D Nylon 66	• Low air permeability compared to others. • High tear strength compared to others. • We have already gained enough experience with the use of the component.





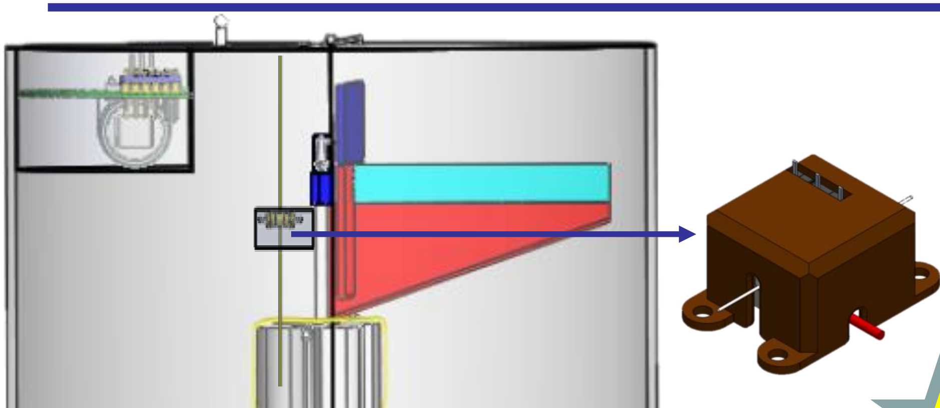
CONNECTION METHOD

- The container bottom cover will be opened.
- The wings of the payload will be folded and pushed into the container.
- The bottom cover of the container will be closed.

RELEASE METHOD

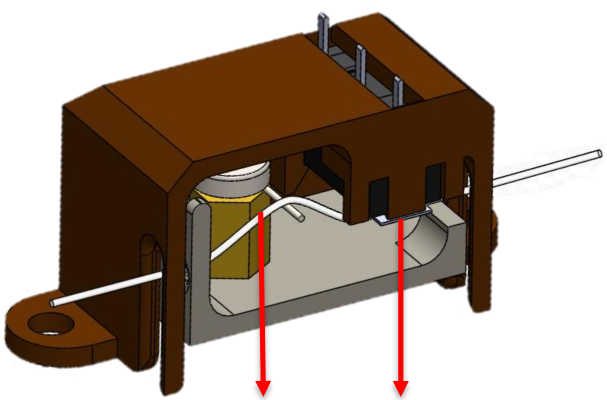
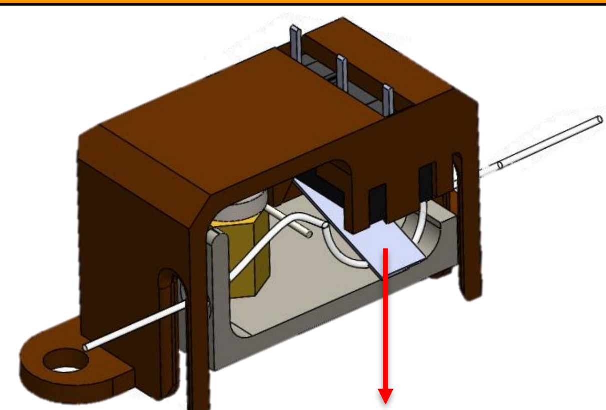
- When the CanSat reaches 450 m the container will be opened by the melt of fishline method.
- The payload will be released with the effect of gravity. The wings will be opened due to the tension of the stretched fabric elastic.
- Melt of fishline method will be carried out in a box in order to protect the system from possible harmful effects.
- The melt of fishline method draws a current of 1.4 amperes.
- The melt of fishline takes less than 1 second.

Payload Release Mechanism (2 of 2)

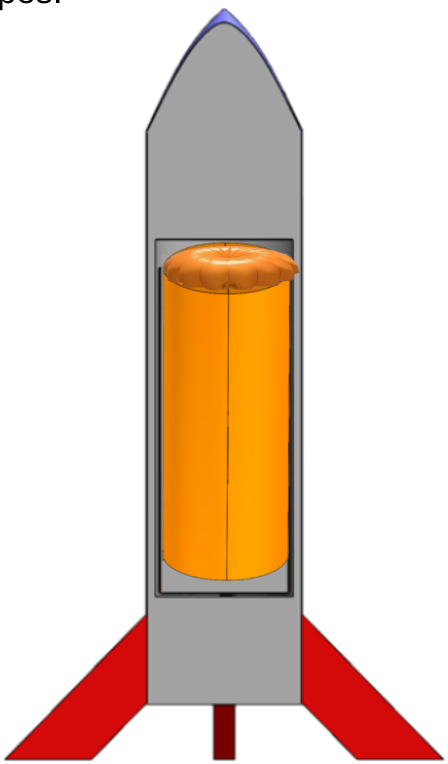
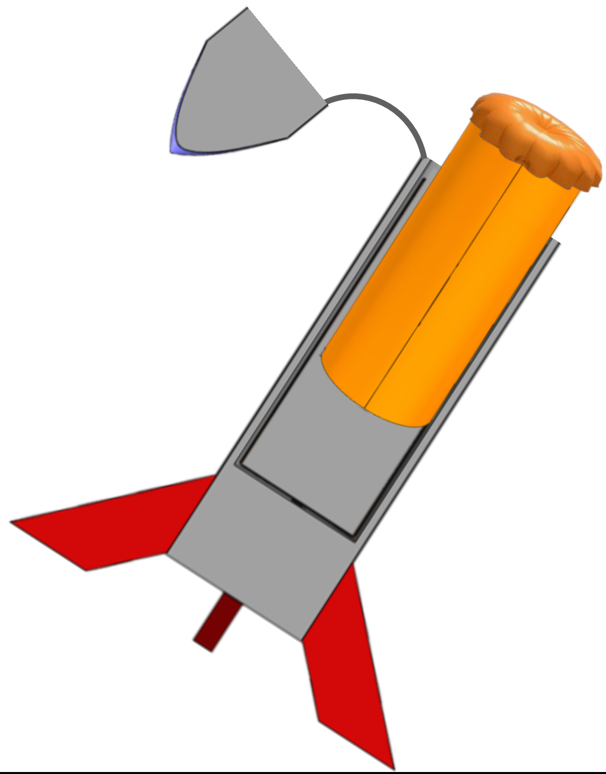
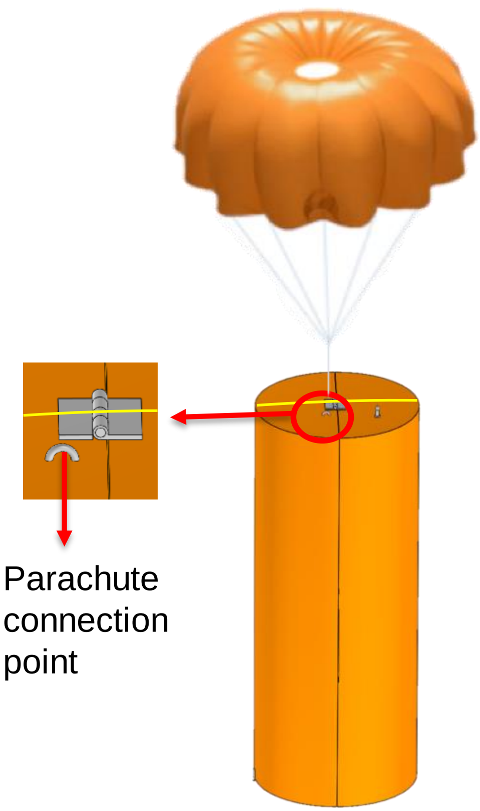


- **The melt stop box will be used for safety.**
- We will be used the melt of fishline method for reuse.
- After the fishline melt, the switch is activated and sends data to the microcontroller.
- Then the power to the fishline will be stopped.
- **We had no problems in our previous competition experiences.**

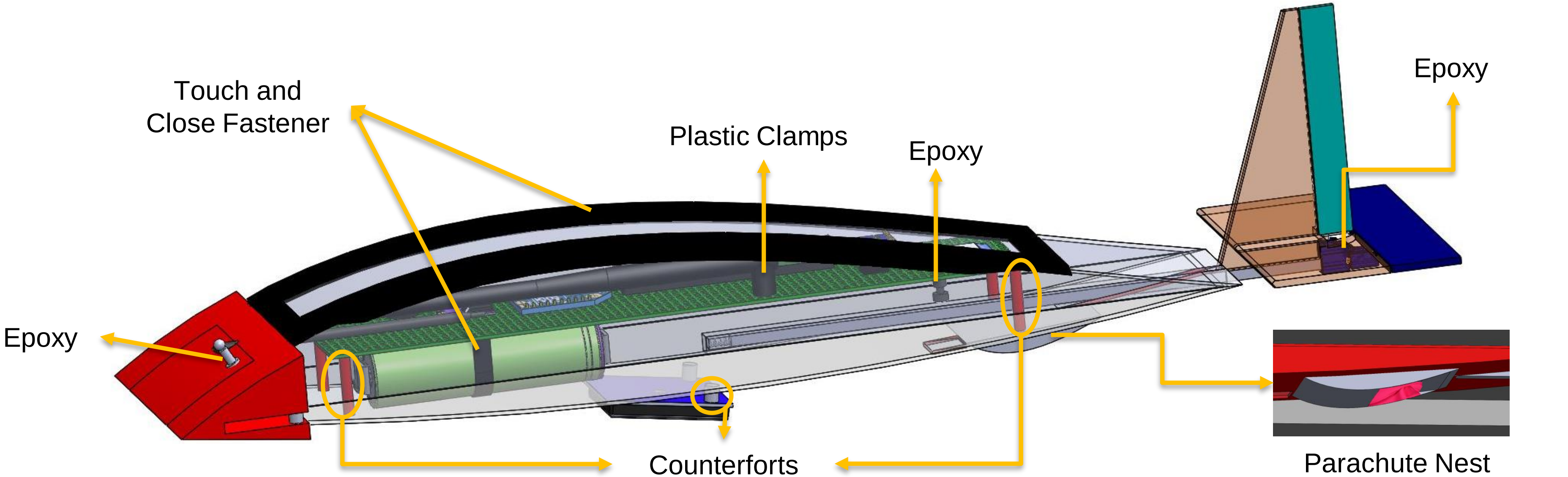
Separation of the payload’s parachute will also be by the melt of fishline method.

STEP 1	STEP 2
 	

Container Parachute Attachment Mechanism

STEP 1 (GROUND STATION)	STEP 2 (at 670-725 m)	STEP 3
1. The CanSat will be placed in the rocket. **2.** Parachute will be folded and placed over the container and then attached to the container by the ropes. 	**1.** The rocket will be reached to (670-725 m). **2.** The CanSat will be separated from the rocket (670-725 m). 	**1.** The parachute on the top of the container will be opened by air resistance. **2.** The CanSat will be descent at a speed of 20 m/s. 

Electronics Structural Integrity



Connection	Enclosure	Mounting	Descent Control Attachments
• Connectors of electronic components will be soldered to the PCB.	•Batteries and electronic components are easily reached by touch and close fastener. • PCB will be fixed via using plastic screw with counterforts in the payload. • Batteries will be connected to the PCB with touch and close fastener.	• Pitot tube and servo motors will be glued to payload with epoxy. • Dust sensor will be attached to the counterforts formed at an angle with epoxy. • Servo motors will be glued to each other with epoxy. • The switch will be glued to payload with epoxy. • The camera will be glued to PCB with epoxy. • The antenna will be connected to the PCB by plastic clamps.	• Descent will be provided by parachute fixed to the container. • Payload's parachute will be placed in the nest. • The parachute nest will be glued to payload with epoxy. • The payload frame will be constructed using carbon fiber sticks. The top surface of the payload will be covered with Silnylon 30D Nylon 66. • The rudder and elevator will be connected to the telescopic system.

Mass Budget (1 of 3)

	Electronic Components:	Quantity:	Unit weight (g):	Weight (g):	Determination:	Margins (g):
PAYLOAD	10-DOF IMU (MPU-9255+BMP280)	1	2	2	MS	
	Air Speed Sensor Kit (APM 2.6 MPXV7002DP)	1	15	15	DS	
	GPS Sensor (NEO-7M)	1	16	16	MS	
	Microcontroller (Teensy 3.6)	1	4.9	4.9	DS	
	Optical Dust Sensor (Sharp GP2Y10)	1	20	20	DS	
	Camera (SQ11)	1	4	4	MS	
	Battery (Sony VTC6)	2	48.5	97	DS	
	Servo Motor (Feetech FS5106R)	2	39	78	DS	
	Buzzer (KSTG951AP RS Pro)	1	1	1	DS	
	XBee Radio (XBee Pro S2C)	1	11	11	DS	
	On/Off Switch (KTS102)	1	2	2	DS	
	Reset Button	1	1	1	MS	
	Coin Cell (CR2032 3V)	1	1.2	1.2	DS	
	SD Card (SanDisk Ultra)	2	1	2	MS	
	DC-DC 5V Regulator (S7V7F5)	1	2	2	MS	
	DC-DC 3.3V Regulator (AMS1117)	1	1	1	MS	
	Antenna (TP-LINK TL-ANT2405CL)	1	25	25	E	6.25
	Structural Components:					
	Payload Body	1	30	30	E	7.5
	Elevator	1	7	7	E	1.75
	Rudder	1	7	7	E	1.75
	Wing Frame	1	120	120	MS	
	Hinge	2	2	4	MS	
	Parachute	1	15	15	MS	
	Melt Stop Box	1	5	5	E	1.25

Acronyms:
MS:Measurement
DS: DataSheet
E: Estimate

Error margin for estimated data is selected as 25%.

Electronic Components	Structural Components	TOTAL MASS
283.1 (±6.25) g	188 (±12.25) g	471.1 (±18.5) g

Mass Budget (2 of 3)

CONTAINER	Electronic Components:	Quantity:	Unit weight (g):	Weight (g):	Determination:	Margins (g):
	Microcontroller (Arduino Nano)	1	7	7	DS	
	Buzzer (KSTG951AP RS Pro)	1	5	5	DS	
	SD Card Module	1	6	6	DS	
	Battery (Orion 14500 AA)	1	19.5	19.5	DS	
	Air Pressure Sensor (BMP280)	1	1	1	MS	
	DC-DC Regulator (S7V7F5)	1	2	2	MS	
	SD Card (SanDisk Ultra)	2	1	2	MS	
	On/Off Switch (KTS102)	1	2	2	DS	
	Structural Components:					
	Melt Stop Box	1	5	5	E	1.25
	Container Body	1	48	48	E	12
	Parachute	1	10	10	MS	
	Depron	2	6.5	13	MS	
	Hinge	2	2	4	MS	

Acronyms:
MS: Measurement
DS: DataSheet
E: Estimate

Measurement (Electronic Balance)
Max Capacity: 1200 g
Readability: 0.01 g

Error margin for estimated data is selected as 25%.

Electronic Components	Structural Components	TOTAL MASS
44.5 g	80 (±13.25) g	124.5 (±13.25) g

Mass Budget (3 of 3)

CONTAINER	124.5 (±13.25) g
PAYLOAD	471.1 (±18.5) g
Total Mass of CanSat	595.6 g

Total Mass Margin of CanSat
∣ Mass Requirement - Total Mass ∣ = Margin
∣ 600 – 595.6 ∣ = 4.4 g

CORRECTION METHODS	
If weight of Cansat < 590 g	The container with thicker wall will be used. (For example container weight 138 g)
If weight of CanSat > 610 g	The container with thinner wall will be used. (For example container weight 107 g)

Communication and Data Handling (CDH) Subsystem Design

Sedef ÖZEL

Payload CDH Overview (1 of 2)

MCU - Teensy 3.6
• This is the microcontroller that is used to control all other components.

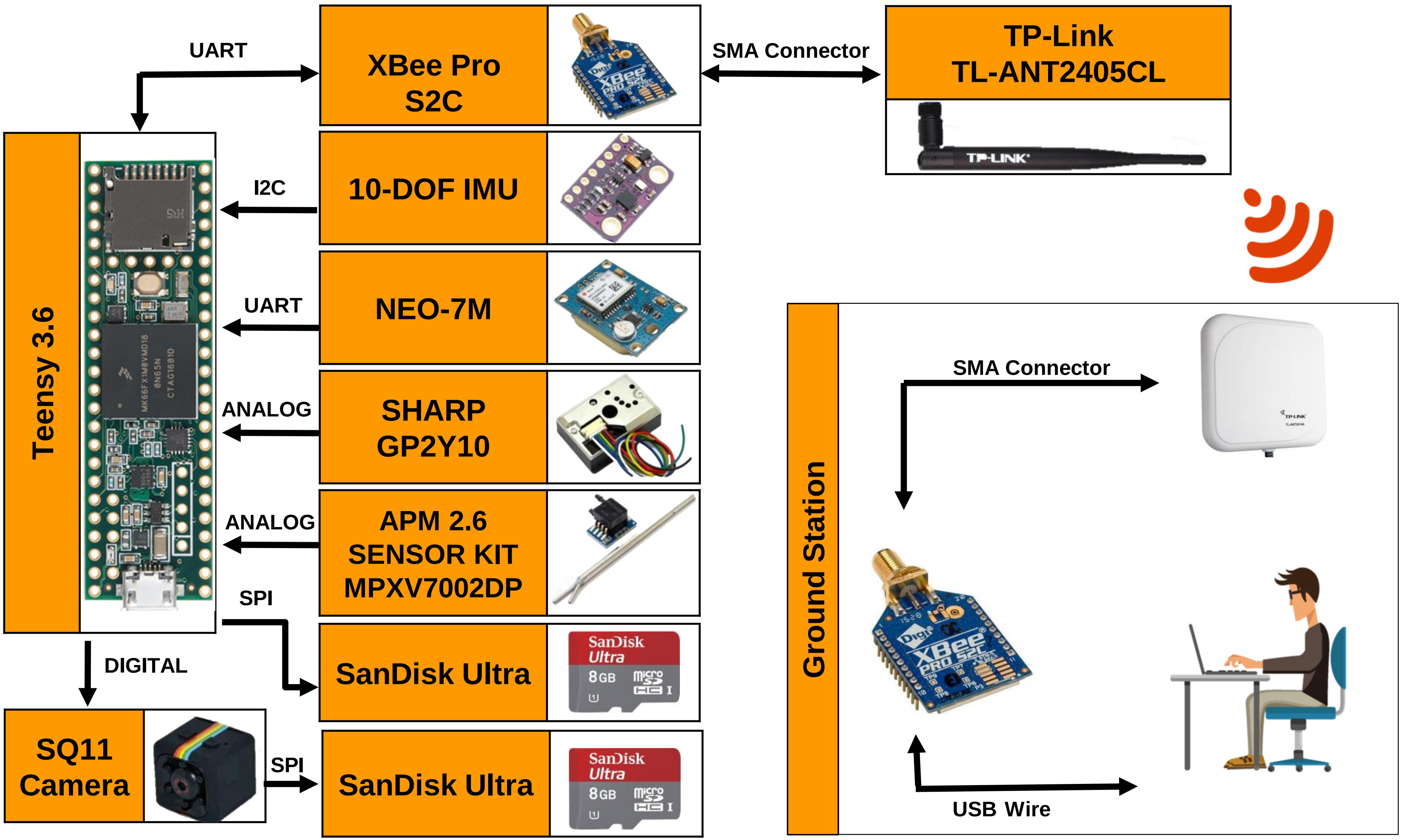
XBee Radio - XBee Pro S2C
• The XBee radio is used for conducting communication between the payload and the ground station.

Antenna - TP-Link TL-ANT2405CL
• An external antenna is used to increase the gain of the XBee radio.

Data Storing - SanDisk Ultra
• This memory card is used to record telemetry data.

Sensors
• Particulate/dust sensor, air speed sensor, GPS, air temperature-pressure sensor and magnetometer on the 10-DOF IMU.

Other
• The camera is used for bonus mission (camera has an internal SD card module). • Buzzer 92 dB loud audio beacon.



UART
XBee Pro S2C
SMA Connector
TP-Link TL-ANT2405CL
TP-LINK
Teensy 3.6
I2C
10-DOF IMU
UART
NEO-7M
ANALOG
SHARP GP2Y10
ANALOG
APM 2.6 SENSOR KIT MPXV7002DP
SPI
SanDisk Ultra
SanDisk Ultra 8GB micro SD HC I
DIGITAL
SQ11 Camera
SPI
SanDisk Ultra
SanDisk Ultra 8GB micro SD HC I
Ground Station
SMA Connector
USB Wire

Payload CDH Requirements (1 of 2)

Requirement Number	Requirement	Rationale	Priority	VM			
				A	I	T	D
RN#31	The ground system shall command the science vehicle to start transmitting telemetry prior to launch.	Competition Requirement	HIGH	✓	✓	✓	
RN#32	The ground station shall generate a csv file of all sensor data as specified in the telemetry section.	Competition Requirement	HIGH	✓	✓	✓	
RN#33	Telemetry shall include mission time with one second or better resolution. Mission time shall be maintained in the event of a processor reset during the launch and mission.	Competition Requirement	HIGH	✓		✓	
RN#34	Configuration states such as if commanded to transmit telemetry shall be maintained in the event of a processor reset during launch and mission.	Competition Requirement	HIGH	✓	✓	✓	
RN#35	XBee radios shall be used for telemetry. 2.4 GHz Series radios are allowed. 900 MHz XBee Pro radios are also allowed.	Competition Requirement	HIGH	✓	✓	✓	
RN#36	XBee radios shall have their NETID/PANID set to their team number.	Competition Requirement	MEDIUM	✓	✓		
RN#37	XBee radios shall not use broadcast mode.	Competition Requirement	HIGH	✓	✓		
RN#40	All telemetry shall be displayed in real time during descent.	Competition Requirement	HIGH		✓	✓	

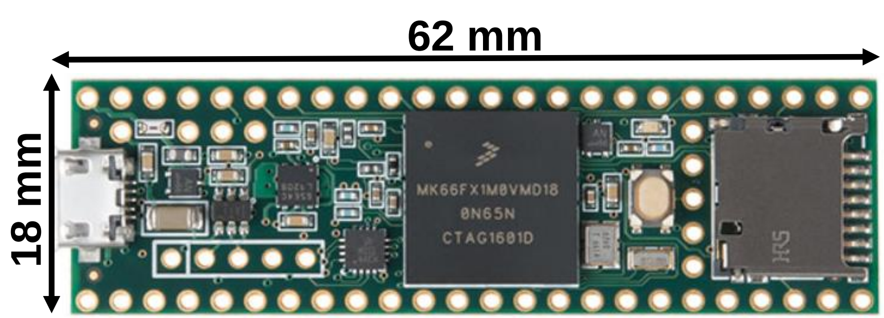
Payload CDH Requirements (2 of 2)

Requirement Number	Requirement	Rationale	Priority	VM			
				A	I	T	D
RN#41	All telemetry shall be displayed in engineering units (meters, meters/sec, Celsius, etc.).	Competition Requirement	MEDIUM	√			√
RN#42	Teams shall plot each telemetry data field in real time during flight.	Competition Requirement	HIGH	√	√	√	√
RN#44	The ground station shall include one laptop computer with a minimum of two hours of battery operation, XBee radio and a hand-held antenna.	Competition Requirement	HIGH	√		√	√

Payload Processor & Memory Trade & Selection (1 of 2)

Payload Processor	Boot Time (ms)	Processor Speed (MHz)	RAM (kB)	Flash Memory (kB)	Operating Voltage (V)	Data Interface (Number)		Price ($)
Teensy 3.2	0.3	72	64	256	5	Digital Pins (34) PWM Pins (12)	Serial Pins (3) SPI Pins (1) I2C Pins (2)	19.80
Teensy 3.6	0.3	180	256	1024	3.3	Digital Pins (62) PWM Pins (22)	Serial Pins (6) SPI Pins (3) I2C Pins (4)	29.25
Arduino Nano	3.3	16	2	32	5	Digital Pins (14) PWM Pins (6)	Serial Pins (2) SPI Pins (4) I2C Pins (2)	29.80

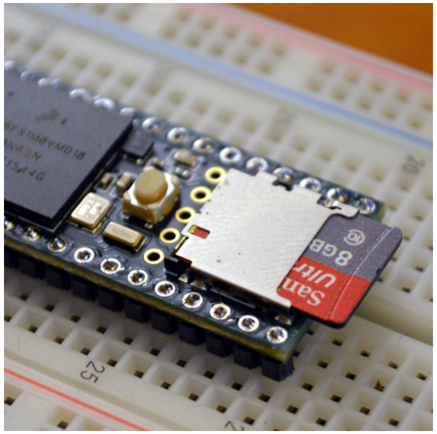
SELECTED	REASONS
Teensy 3.6	• Low operating voltage. • Suitable processor speed. • Suitable flash memory. • Includes RTC. • Includes SD card slot.



Boot Time = The time it takes for a device to be ready to operate after the power has been turned on.

Memory Model	Memory (GB)	Interface	Speed (Mb/s)		Price ($)
			Write	Read	
SanDisk Ultra	8	SPI	75	80	4.56
Link Tech	4	SPI	30-45	30-45	7.47
Team Class6	8	SPI	30	40	8

SELECTED	REASONS
SanDisk Ultra	• Cheaper than the others. • Suitable storage capacity. • Faster than the others.



Payload Real-Time Clock

Selected RTC Type: HARDWARE

The RTC has a built-in power detection circuit that detects power failures and automatically switches to a back up source. **The RTC is an always powered block that remains active in all low power modes and is powered by the battery power supply.** The battery power supply ensures that the RTC registers retain their state during chip power-down and that the RTC time counter remains operational. **So saves the data to the EEPROM in Teensy 3.6 during the power failure and the data doesn't reset.**

SOFTWARE

We will not use software type clock method, since RTC data will puts extra strain on the microcontroller. The microcontroller's internal timer is used to form time counters and formed time counters can be used as RTC.

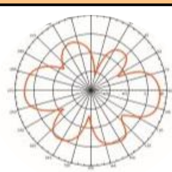
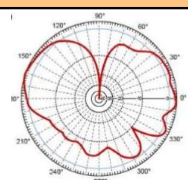
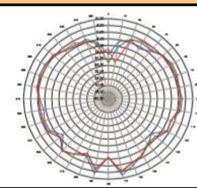
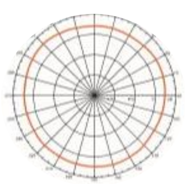
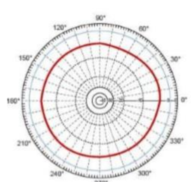
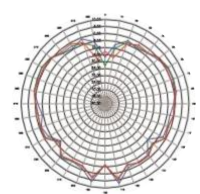
But always using **hardware RTC**, we can get the time value with more precision and minimal error.

Payload RTC Model	Type	Size (mm)			Weight (g)	Operating Voltage (V)	Interface	Price ($)
		Length	Width	Heigth				
DS1307	Hardware	9.91	7.87	4.45	2.3	5	I2C	0.95
Teensy 3.6 RTC	Hardware	Included in the microcontroller				3	I2C	Free

SELECTED	REASONS
Teensy 3.6 RTC	• Free because included in the microcontroller. • Small in size and weight. • **The RTC will not reset if the power to the microcontroller is lost.**

Payload Antenna Trade & Selection

Payload Antenna	Size (mm)		Range (km)	Frequency (GHz)	Gain (dBi)	Connector Type	Radiation Pattern	Price ($)
	Length	Diameter						
TP-Link TL-ANT2405CL	190	13	~1	2.4	5	RP-SMA	Omni-directional	5
Rubber Duck Antenna HG2402RD-RSF	105	10	~1	2.4	2.2	RP-SMA	Omni-directional	9.81
ANT-2.4-LCW-RPS	83.1	9.4	~1	2.4	2.8	RP-SMA	Omni-directional	3.11

	TP-Link TL-ANT2405CL	Rubber Duck Antenna	ANT-2.4-LCW-RPS
Vertical			
Horizontal			

SELECTED	REASONS
TP-LinkTL-ANT2405CL	• Higher gain than other antennas. • Easily available. • Better price/ performance ratio.

Payload Radio Configuration

Radio Model	Sensitivity (dBm)	Range (km)	Transmit Current (mA)	Supply Voltage (V)	Transmit Power (mW)	Operating Frequency (GHz)
XBee Pro S2C	-101	3.2	120	2.7 – 3.6	63	2.4

Overview of Radio Configuration

- **XBee Radio Model Selection:** XBee Pro S2C has been selected.
- XBee configuration will be accomplished with XCTU Software.
- XBees are operating in one network with the same PANID/NETID number. PANID/NETID will be set through to the team number **(#7840**).
- The XBee communicates in **unicast** mode**.**

CanSat XBee Module	Ground Station XBee Module
• CanSat XBee is the **coordinator** in this network.	• Ground station XBee is an **enddevice**.

Transmission Control

- When CanSat will be turned on, communication will then established between the ground station and the payload. And data will be sent with a frequency of **1 Hz**.
- Transmission control will be managed by the ground station while the payload stop off in the launch pad, and managed by FSW during flight.
- **At 5 m the ground, the buzzer will be activated via FSW and data transmission will be stopped.**

We started radio communications tests. The tests will be presented in detail in section CanSat Integration and Test.

Payload Telemetry Format (1 of 2)

TEAM ID	is the assigned team identification.
MISSION TIME	is the time since initial power up in seconds.
PACKET COUNT	is the count of transmitted packets, which is to be maintained through processor reset.
ALTITUDE	is the altitude in units of meters and must be relative to ground level. The resolution must be 0.1 meters.
PRESSURE	is the measurement of atmospheric pressure in units of pascals. The resolution must be 1 pascals.
TEMP	is the sensed temperature in degrees C with one tenth of a degree resolution.
VOLTAGE	is the voltage of the CanSat power bus. The resolution must be 0.01 volts.
GPS TIME	is the time generated by the GPS receiver. The time must be reported in 11 UTC and have a resolution of a second.
GPS LATITUDE	is the latitude generated by the GPS receiver in decimal degrees with a resolution of 0.0001 degrees.

GPS LONGITUDE		is the longitude generated by the GPS receiver in decimal degrees with a resolution of 0.0001 degrees.
GPS ALTITUDE		is the altitude generated by the GPS receiver in meters above mean sea level with a resolution of 0.1 meters.
GPS SATS		is the number of GPS satellites being tracked by the GPS receiver. This must be an integer number.
AIR SPEED		is the air speed relative to the payload in meters/second.
SOFTWARE STATE		is the operating state of the software (boot, idle, launch detect, deploy, etc.).
PARTICLE COUNT		is a decimal value representing the measured particle count in mg/m^3.
BONUS DATA	PITCH	is the tilt angle in the pitch axis in degrees.
	ROLL	is the tilt angle of the roll axis in degrees.
	YAW	İs the tilt angle of the yaw axis in degrees.

Payload Telemetry Format (2 of 2)

Data Format

<TEAM ID>,<MISSION TIME>,<PACKET COUNT>,<ALTITUDE>,<PRESSURE>, <TEMP>,<VOLTAGE>,<GPS TIME>,<GPS LATITUDE>,<GPS LONGITUDE>,<GPS ALTITUDE>,<GPS SATS>,<AIR SPEED>,<SOFTWARE STATE>,<PARTICLE COUNT>,<PITCH>,<ROLL>,<YAW>

Example Data Format

7840,15,60,550.6,1079.4,40,12.67,12:10:01,42.1526,73.8061,102.5,22,23.02,1, 0.31,75,82,70

- **The values shown in blue are for the bonus data.**
- **Data will be transmitted at a rate of 1 Hz in bursts.**
- **The telemetry data file shall be named as follows: Flight_7840.csv**

★ **The presented telemetry format match the competition guide requirements.**

Container CDH Overview

MCU - Arduino Nano

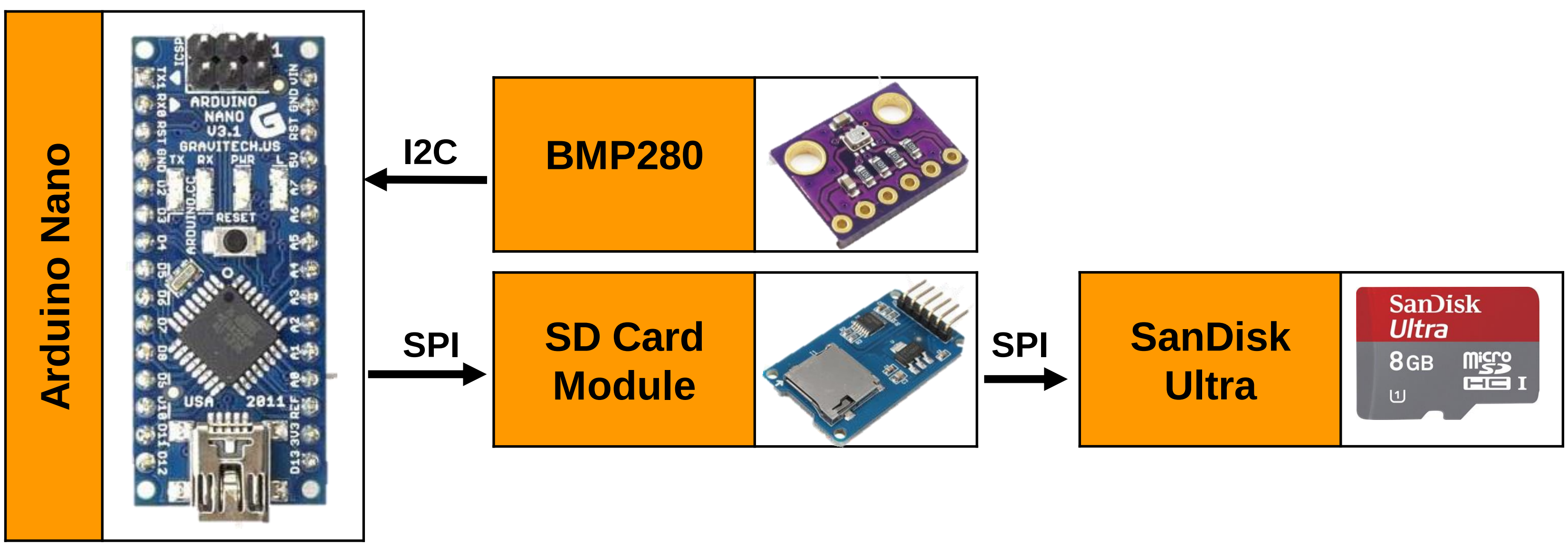
- The microcontroller is required for controlling the release mechanism, measuring the air pressure and activating the buzzer.

Electronic Components

- It will be used to retrieve the required data.

Data Storing - SanDisk Ultra

- It will be used to save taken data from required components.



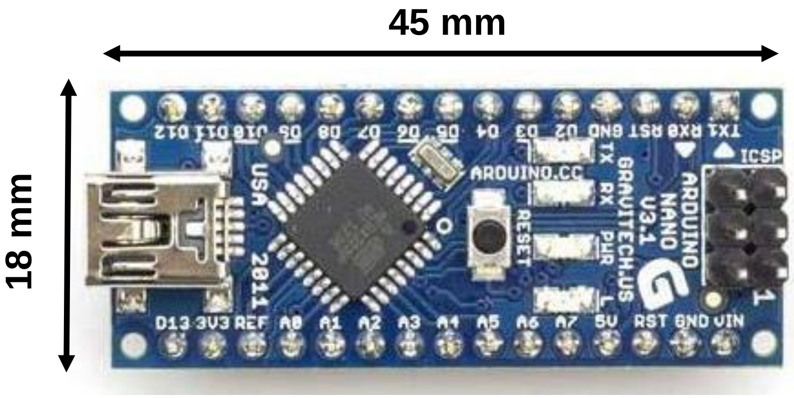
Container CDH Requirements

Requirement Number	Requirement	Rationale	Priority	VM			
				A	I	T	D
RN#9	The descent rate of the CanSat (container and science payload) shall be 20 meters/second +/- 5m/s.	Competition Requirement	HIGH		✓	✓	✓
RN#10	The container shall release the payload at 450 meters +/- 10 meters.	Competition Requirement	HIGH		✓	✓	✓
RN#57	Payload/Container shall operate for a minimum of two hours when integrated into rocket.	Competition Requirement	HIGH	✓	✓		

Container Processor & Memory Trade & Selection (1 of 2)

Container Processor	Boot Time (ms)	Processor Speed (MHz)	RAM (kB)	Flash Memory (kB)	Operating Voltage (V)	Weight (g)	Data Interface (number)	Price ($)
ATtiny85	0.04	16	0.5	8	4.5 – 5.5	1	Analog Pins (4) Digital Pins (6) PWM Pins (3)	6.50
Arduino Nano	3.3	16	2	32	5	7	Analog Pins (8) Digital Pins (16) PWM Pins (6)	22

SELECTED	REASONS
Arduino Nano	• High flash memory. • More pin count. • High RAM capacity.



★ **Boot Time** = The time it takes for a device to be ready to operate after the power has been turned on.

Container Processor & Memory Trade & Selection (2 of 2)

Memory Model	Memory (GB)	Interface	Speed (Mb/s)		Price ($)
			Write	Read	
SanDisk Ultra	8	SPI	75	80	4.56
Link Tech	4	SPI	30-45	30-45	7.47
Team Class 6	8	SPI	30	40	8

SELECTED	REASONS
SanDisk Ultra	• Cheaper than the others. • Suitable storage capacity. • Faster than the others.

SD card will be used with **SD Card Module (SPI)**

Electrical Power Subsystem (EPS) Design

Hüseyin SERTKAYA

EPS Overview (1 of 4)

PAYLOAD COMPONENTS

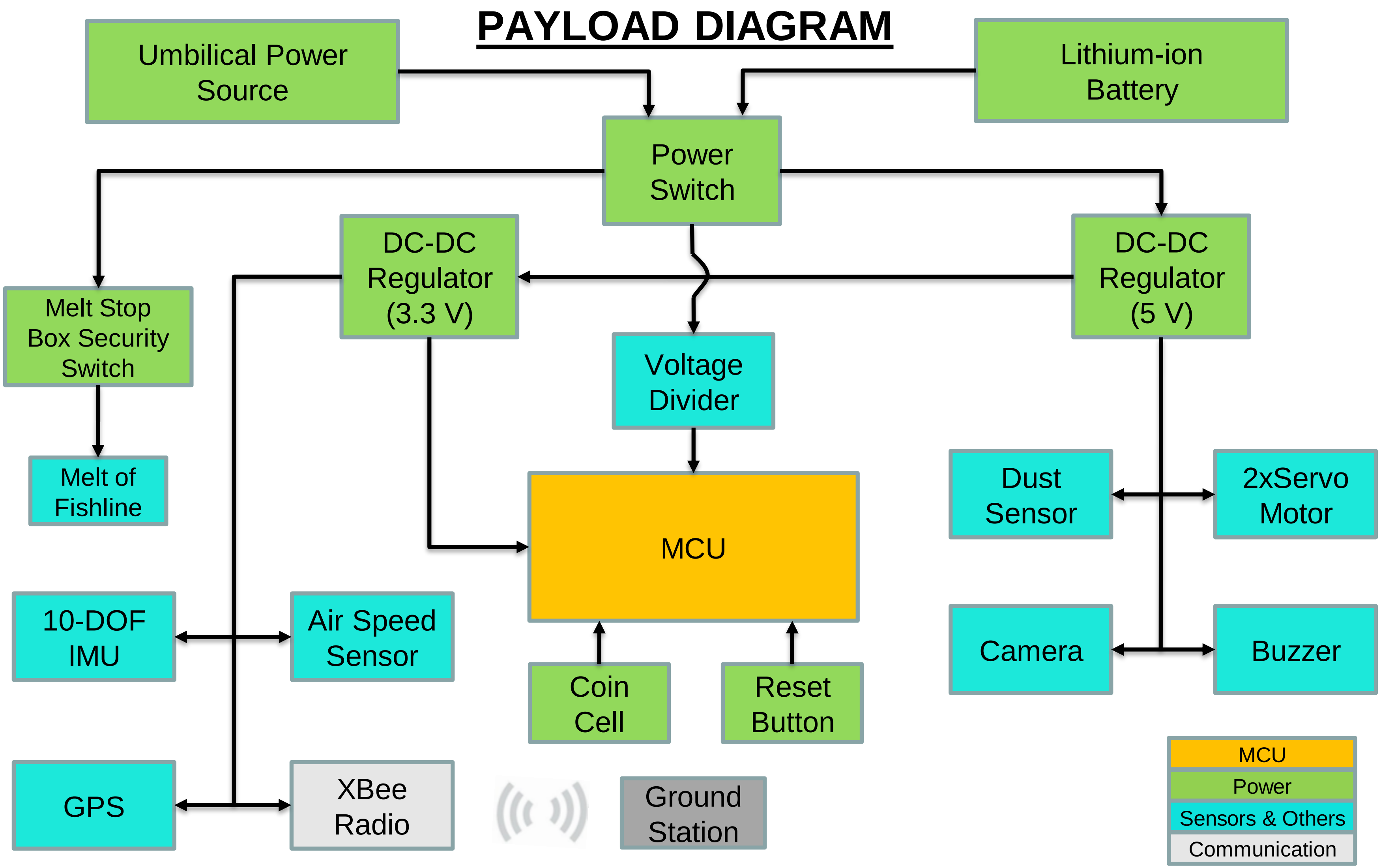
MCU
- All sensors in the payload will be connected to the MCU and powered by lithium-ion batteries.

Power
- The umbilical power supply is used for an external supply.
- A 3 V battery will also be used for the an internal RTC.
- We will be used the reset button to reset the payload.
- The voltage regulators will be used to arrange the required voltages.
- A power switch (external on/off switch) will be used to control the system power of the payload.

Sensors & Others
- 92 dB buzzer will be used for payload recovery.
- The camera will be powered by 5 V for the bonus mission.
- We will be used an air speed sensor powered by 3.3 V line.
- The battery voltage will be measured by the voltage divider method.
- We will be used GPS powered by 3.3 V line to find the location of the payload.
- We will be used 10-DOF IMU and servo motors for active control and 3D simulation.
- Air temperature and air pressure will be taken from the BMP280 sensor powered by 3.3 V line.
- We will be used a particulate/dust sensor powered by a 5 V line to measure dust particles.
- The melt of fishline method will be used to opening the parachute of the payload.

Communication
- We will be used XBee Pro S2C powered by 3.3 V line for telemetry transmission.

EPS Overview (2 of 4)



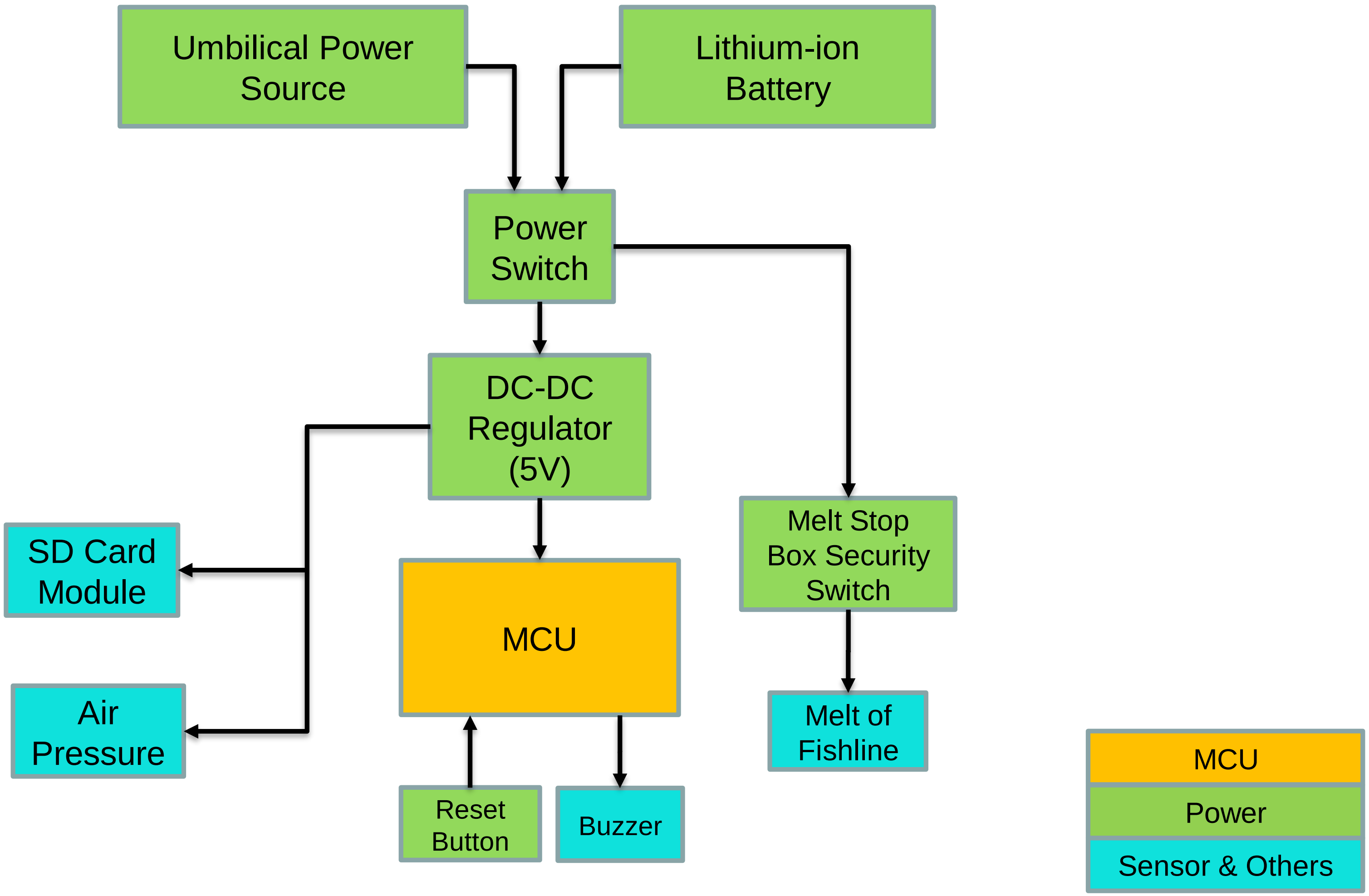
CONTAINER COMPONENTS

MCU
- Major components in the container will be connected to the MCU and powered by a lithium-ion battery.

Power
- The battery voltage is measured by the Arduino Nano analog pin.
- We will be used the reset button for container reset.
- The voltage regulator is used to arrange voltage arriving from the battery.
- A power switch (external on/off switch) will be used to control the system power of the container.

Sensor & Others
- 92 dB buzzer will be used for container recovery.
- We will be used an air pressure sensor with powered by 5 V line for separation system control.
- The SD card module will be powered by 5 V line to save the data.
- The melt of fishline method will be used to the payload release from the container.

CONTAINER DIAGRAM



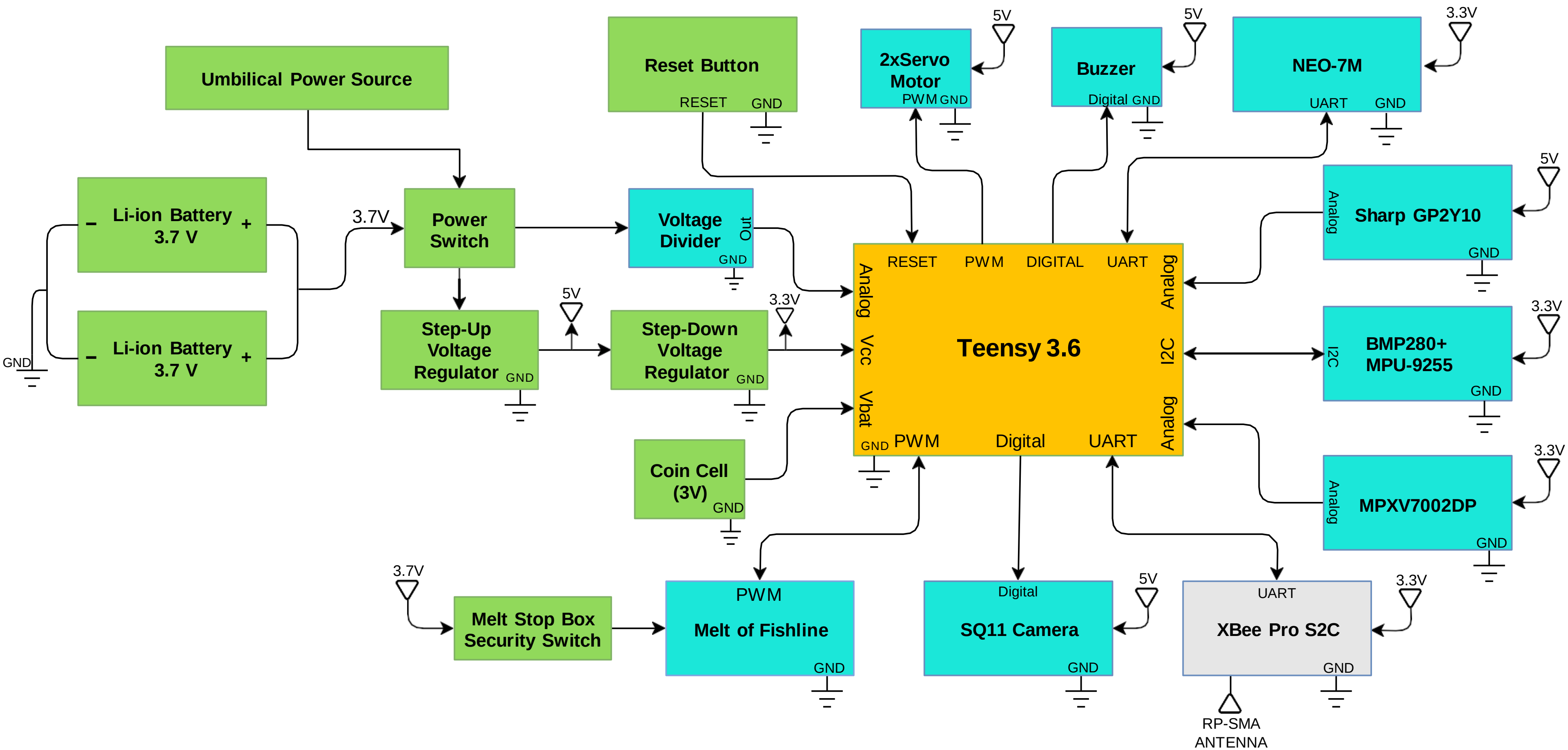
EPS Requirements (1 of 2)

Requirement Number	Requirement	Rationale	Priority	VM			
				A	I	T	D
RN#22	The science payload shall measure altitude using an air pressure sensor.	Competition Requirement	HIGH	✓		✓	✓
RN#23	The science payload shall provide position using GPS.	Competition Requirement	HIGH	✓		✓	✓
RN#24	The science payload shall measure its battery voltage.	Competition Requirement	HIGH	✓		✓	✓
RN#25	The science payload shall measure outside temperature.	Competition Requirement	HIGH	✓		✓	✓
RN#26	The science payload shall measure particulates in the air as it glides.	Competition Requirement	HIGH	✓		✓	✓
RN#27	The science payload shall measure air speed.	Competition Requirement	HIGH	✓		✓	✓
RN#28	The science payload shall transmit all sensor data in the telemetry.	Competition Requirement	HIGH	✓	✓	✓	✓
RN#29	Telemetry shall be updated once per second.	Competition Requirement	HIGH		✓	✓	

EPS Requirements (2 of 2)

Requirement Number	Requirement	Rationale	Priority	VM			
				A	I	T	D
RN#49	The probe must include an easily accessible power switch that can be accessed without disassembling the cansat and in the stowed configuration.	Competition Requirement	MEDIUM	√	√	√	
RN#50	The probe must include a power indicator such as an LED or sound generating device that can be easily seen without disassembling the cansat and in the stowed state.	Competition Requirement	MEDIUM	√	√	√	√
RN#51	An audio beacon is required for the probe. It may be powered after landing or operate continuously.	Competition Requirement	HIGH	√		√	
RN#52	The audio beacon must have a minimum sound pressure level of 92 dB, unobstructed.	Competition Requirement	HIGH	√		√	
RN#53	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.	Competition Requirement	HIGH	√	√		
RN#54	An easily accessible battery compartment must be included allowing batteries to be installed or removed in less than a minute and not require a total disassembly of the CanSat.	Competition Requirement	HIGH	√	√		
RN#55	Spring contacts shall not be used for making electrical connections to batteries. Shock forces can cause momentary disconnects.	Competition Requirement	MEDIUM	√	√		
RN#57	Payload/Container shall operate for a minimum of two hours when integrated into rocket.	Competition Requirement	HIGH	√	√		

Payload Electrical Block Diagram



- MCU
- Power
- Sensors & Others
- Communication

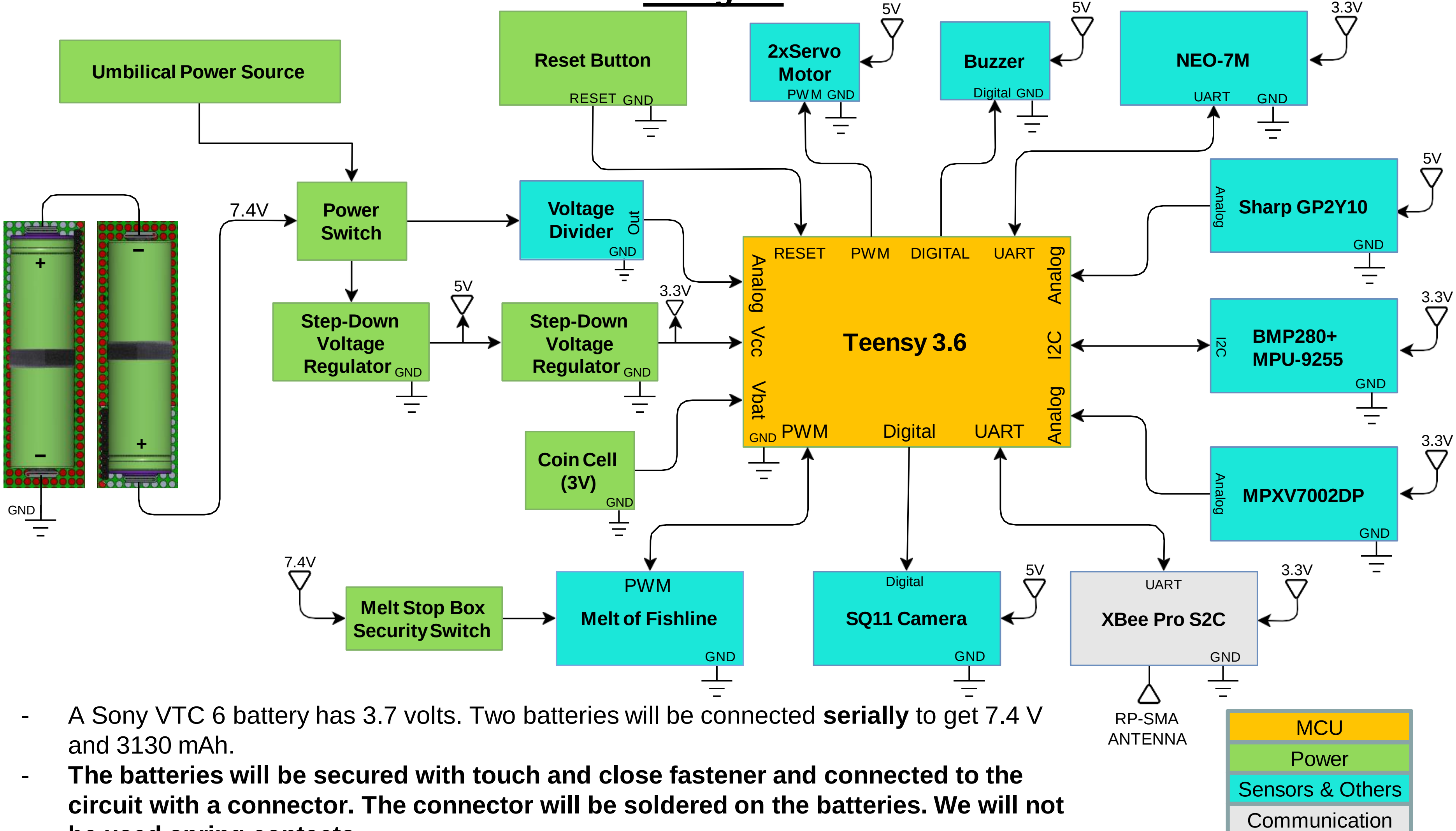
- The electronic system will be easily accessible on/off by a switch.
- The led turn light and buzzer beeps when the system is powered on.

Payload Power Trade & Selection (1 of 3)

Payload Battery	Voltage (V)	Capacity (mAh)	Weight (g)	Size (mm)		Price ($)	Battery Chemistry
				Heigth	Diameter		
Sony VTC6	3.7	3130	48.5	65.0	18.3	5.5	Lithium-ion
GP ReCyko+ GP270AAHC	1.2	2500	31.5	50.0	14.5	4.0	Nickel Metal Hydride (Ni-MH)

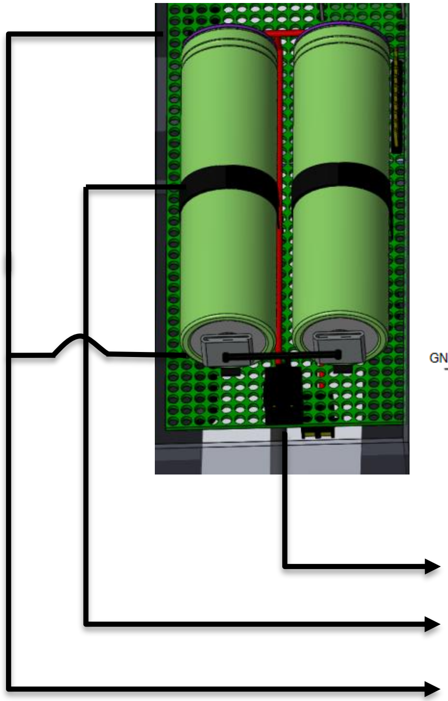
SELECTED	REASONS
SONY VTC 6	• High capacity. • Better price/performance ratio. • High power density. • Suitable power/weight ratio. • Experienced with the use of the battery.

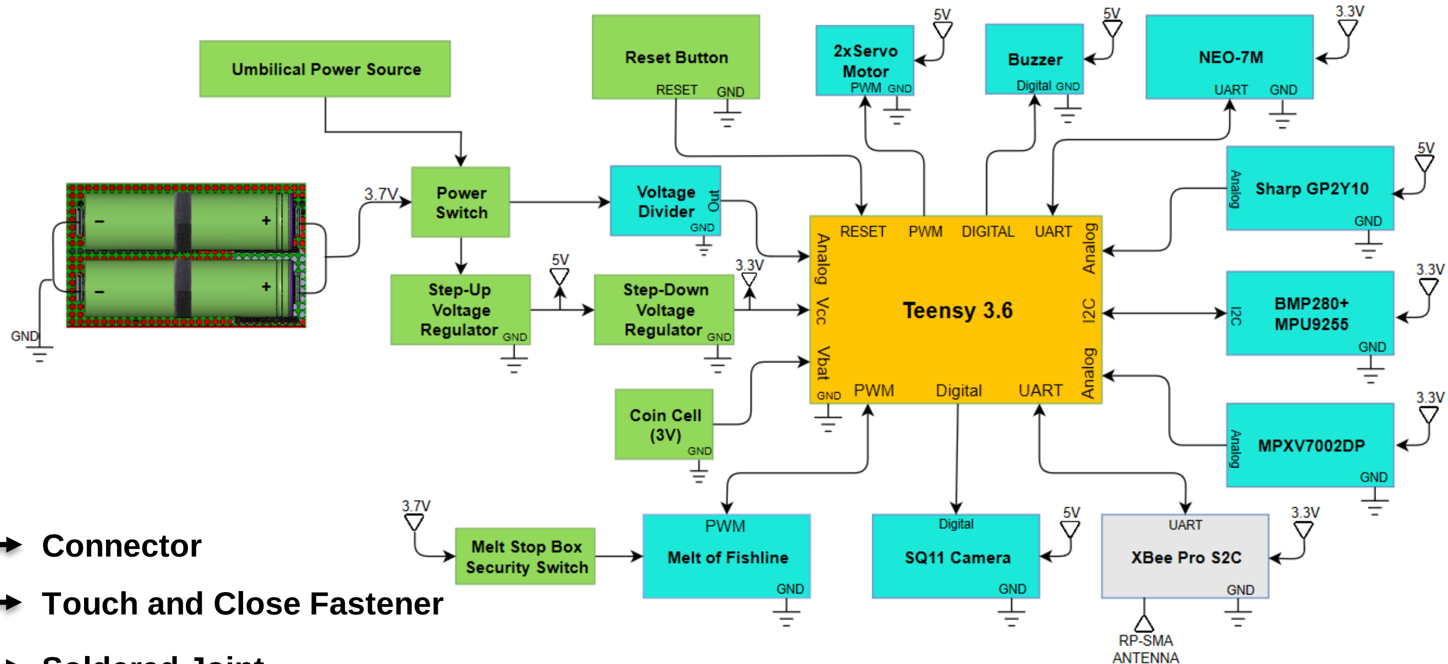
Design 1



- A Sony VTC 6 battery has 3.7 volts. Two batteries will be connected **serially** to get 7.4 V and 3130 mAh.
- **The batteries will be secured with touch and close fastener and connected to the circuit with a connector. The connector will be soldered on the batteries. We will not be used spring contacts.**

Design 2 (SELECTED)





- A Sony VTC 6 battery supply 3.7 volts. Two batteries will be connected in **parallel** to get 3.7 V and 6260 mAh.
- **The batteries will be secured with the touch and close fastener and connected to the circuit with a connector. The connector will be soldered on the batteries. We will not be used spring contacts.**
- **We selected design 2. We get more current and undervoltage design 2. If the connection between the two batteries is damaged, the system continues to operate.**

MCU
Power
Sensors & Others
Communication

Payload Power Budget (1 of 3)

Components	Voltage (V)	Current (mA)	Duty Cycles (h:min:s)	Power Consumption (Wh)	Source
Teensy 3.6	3.3	79.13	02:00:00	0.522	DS
Buzzer	5	80	00:15:00	0.1	DS
SQ11 - Camera	5	200	00:01:00	0.0167	MS
XBee Pro S2C	3.3	120	02:00:00	0.792	DS
NEO-7M GPS	3.3	35	02:00:00	0.231	DS
10-DOF IMU	3.3	4.42	02:00:00	0.03	DS
Melt Of Fishline	3.7	1400	00:00:01	0.001438	MS
2xServo Motor	5	2x500	00:01:00	2x0.0417	MS
Sharp GP2Y10	5	11	02:00:00	0.11	DS
MPXV7002DP	3.3	10	02:00:00	0.066	DS

Payload Power Budget (2 of 3)

Available Power (Max)	23.162Wh
Total Power Consumption	1.952Wh
Margins	21.21Wh

Available Power (Max) - Total Power Consumption = Margins

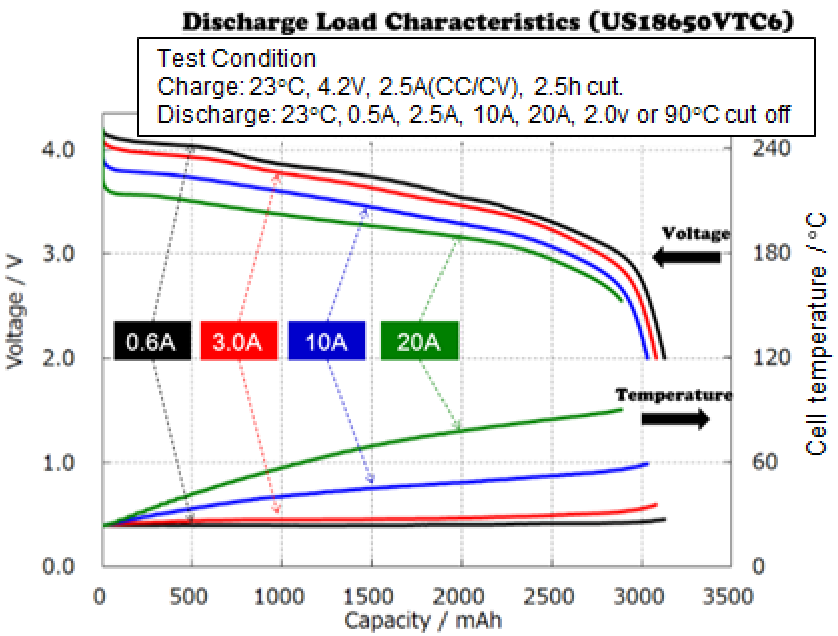
- The margin is changing according to the current consumption by sensors at different working temperatures.

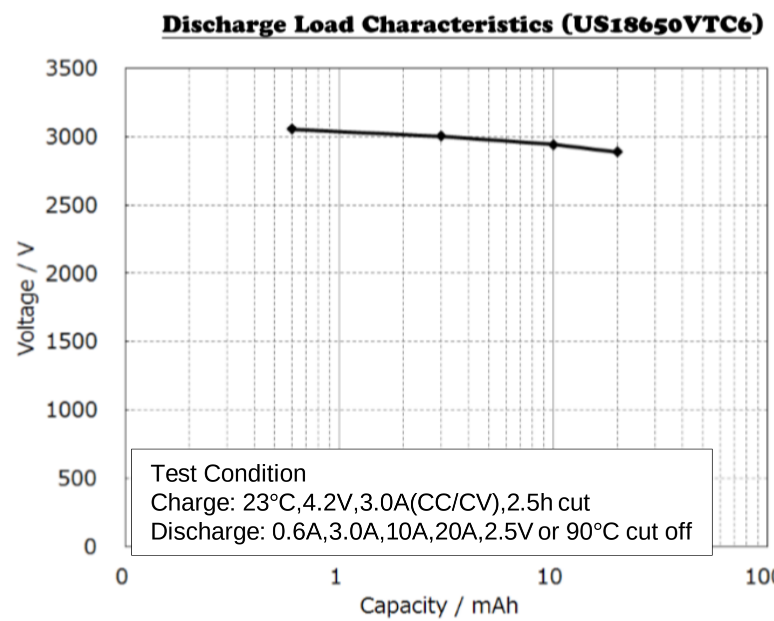
Payload Power Strategy:

(Battery Capacity (Max) / Current Consumption) * 0.707 = Battery operating time

((6260 mAh) / (1539.55 mA)) * 0.707 = 2.87 h

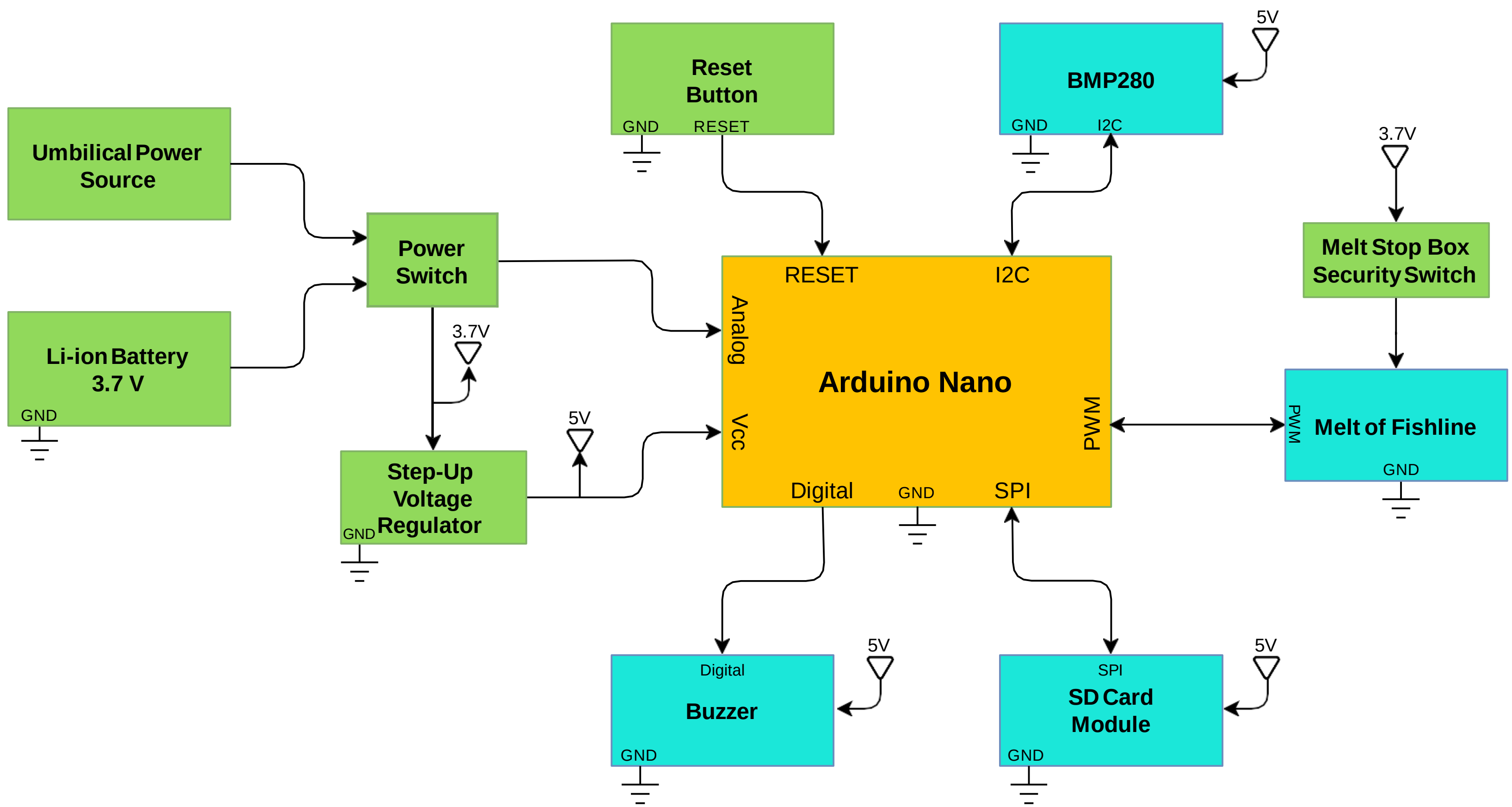
- **The system will be powered only with the battery.**
- **The system will be operated for more than two hours.**
- **The melt of fishline method draw current less than one second so this current is not included in the calculations.**





Source: Sony VTC 6 Datasheet

Container Electrical Block Diagram



- The electronic system will be easily accessible on/off by a switch.
- The led turn light and buzzer beeps when the system is powered on.

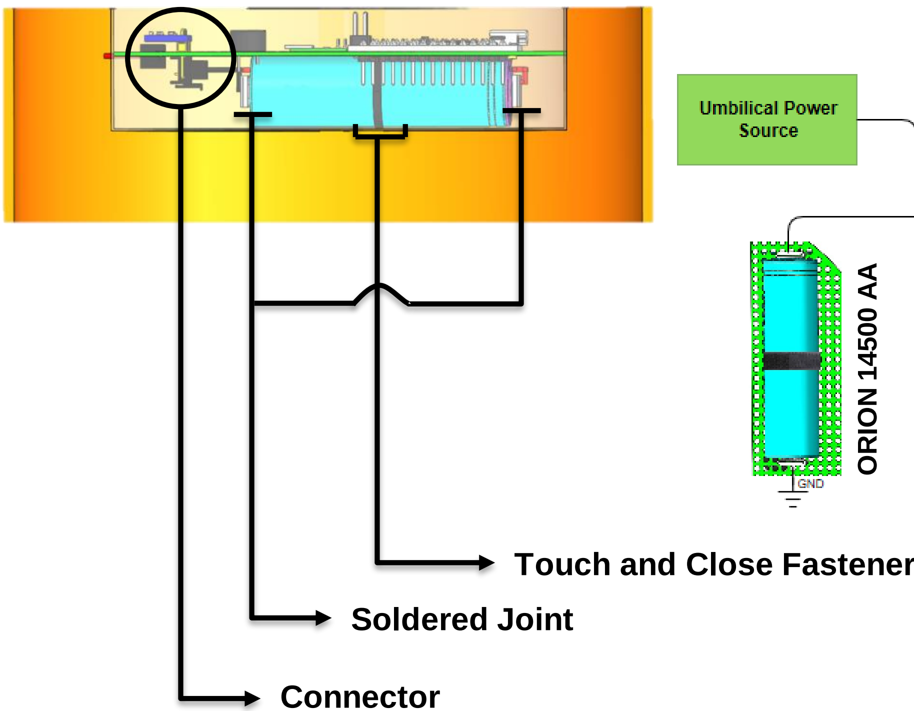
MCU
Power
Sensor & Others

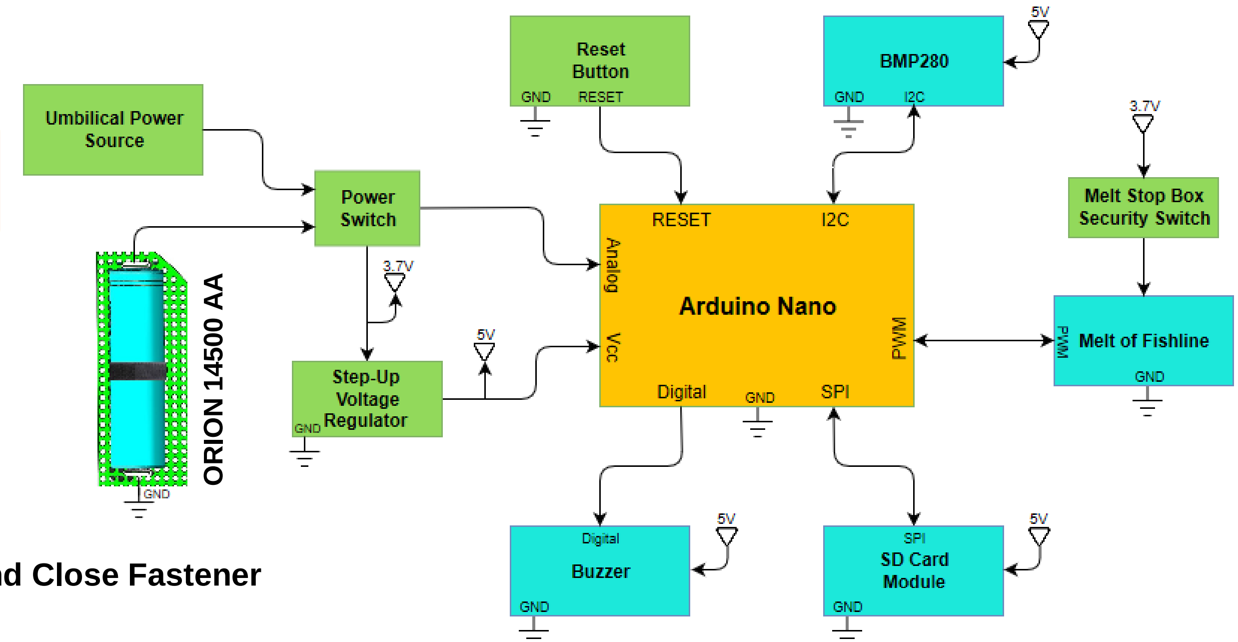
Container Power Trade & Selection (1 of 2)

Container Battery	Voltage (V)	Capacity (mAh)	Weight (g)	Size (mm)		Price ($)	Battery Chemistry
				Heigth	Diameter		
ORION 14500 AA	3.7	900	19.5	50.0	14.5	4.5	Lithium-ion
Panasonic HHR-110AA	1.2	1100	26	50.0	14.5	3.0	Nickel Metal Hydride (Ni-MH)

SELECTED	REASONS
ORION 14500 AA	• Light weight. • Better price/performance ratio. • Suitable capacity. • Suitable voltage. • Experienced with the use of the battery.

Design





- An Orion 14500 AA battery has 3.7 V. A single battery will be used then we get 3.7 V and 900 mAh. **<u>The battery will be used singular, no serial or parallel configuration has been made.</u>**
- **The battery will be secured with the touch and close fastener and connected to the circuit with a connector. The connector will be soldered on the battery. We will not be used spring contacts.**

MCU
Power
Sensor & Others

Container Power Budget

Components	Voltage (V)	Current (mA)	Duty Cycles (h:min:s)	Power Consumption (Wh)	Source
Arduino Nano	5	19	02:00:00	0.19	DS
Buzzer	5	80	00:15:00	0.1	DS
BMP280	5	0.325	02:00:00	0.00325	DS
Melt of Fishline	3.7	1400	00:00:01	0.001438	MS
SD Card Module	5	0.016	02:00:00	0.00016	MS

Available Power (Max)	3.33 Wh
Total Power Consumption	0.2948 Wh
Margins	3.0352 Wh

Available Power (Max) - Total Power Consumption = Margin

- The margin is changing according to the current consumption by sensors at different working temperatures.

Container Power Strategy:

(Battery Capacity (Max) / Current Consumption) * 0.707 = Battery operating time

((900 mAh) / (99.341 mA)) * 0.707 = 6.4 h

- **The system will be powered only with a battery.**
- **The system will be operated for more than two hours.**
- **The melt of fishline method draw current less than one second so this current is not included in the calculations.**

Flight Software (FSW) Design

Osman SERİNKAN

Overview of The Cansat FSW Design

- The CanSat will be gathered data from sensors during the flight, data will be saved to SD card and transmitted to the ground station via XBee.
- Bonus mission include a camera and it will be recorded video during the flight.

Programming Language

- C/C++

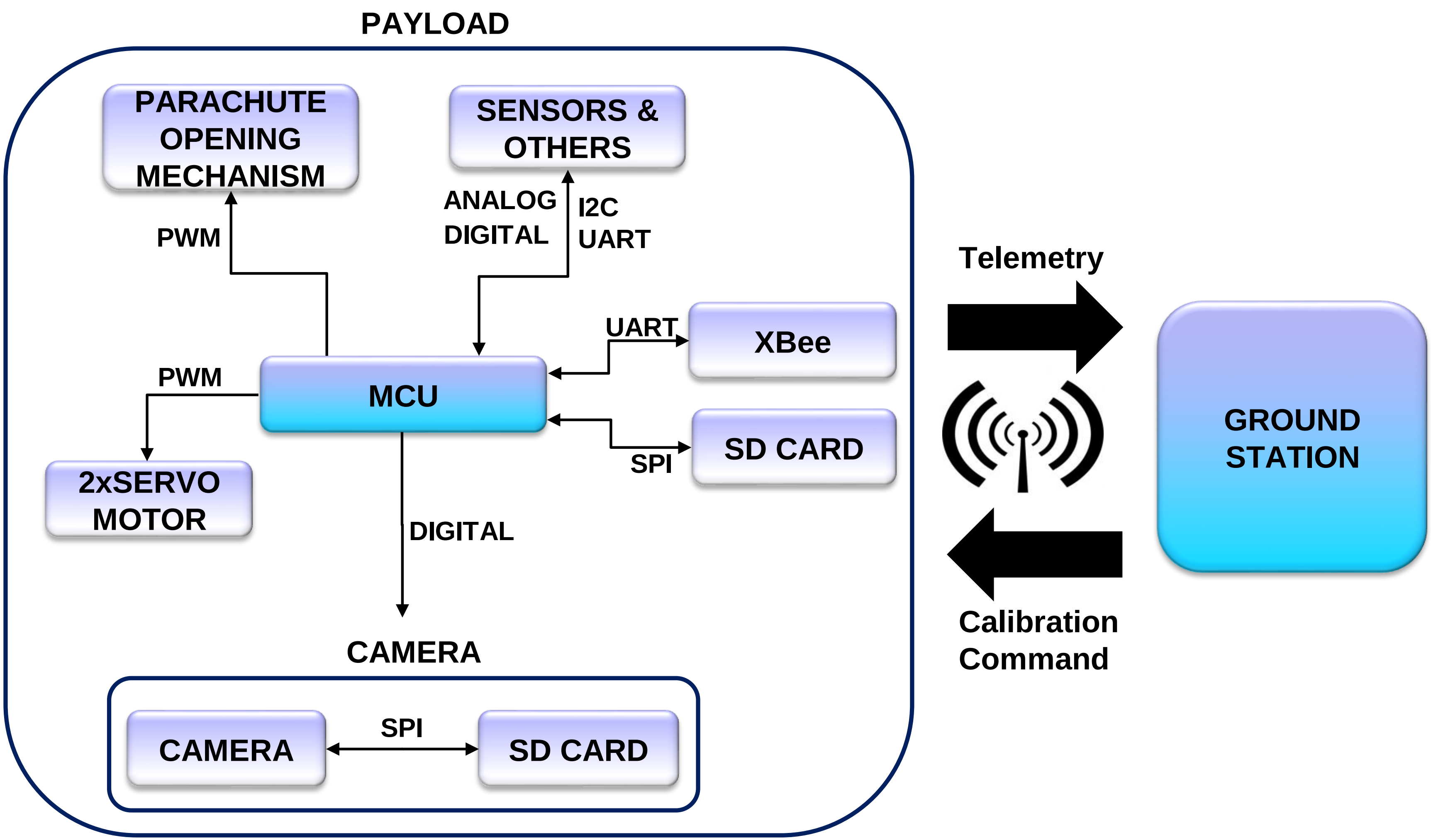
Development Environments

- Arduino IDE
- ClickCharts by NCH software
- Atom Text Editor

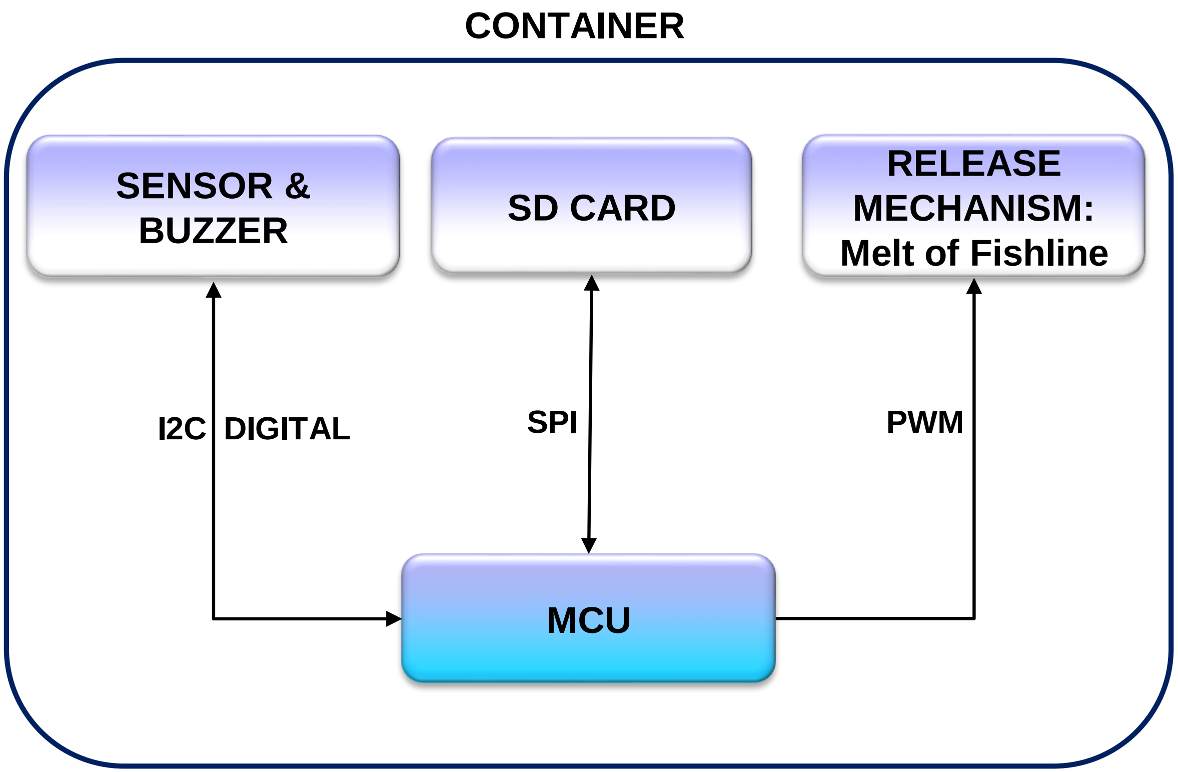
Brief summary of the FSW tasks

- The electronic system will be activated by the power (on/off) button.
- If "System calibrate" command will be received from ground station, EEPROM will be reset, the reference altitude, will be determined and system will be calibrated.
- The container will be gathered data from the sensor and saved to the SD card.
- The payload will be gathered data from the sensors and save to the SD card transmit it to the ground station via XBee at same time.
- Release mechanism and parachute opening mechanism will be activated by FSW.
- CanSat will be launched with a rocket and will be released after completing the rocket rise and container's parachute will be opened.
- The payload will be released from container at 450 m (±10 m) via melt of fishline then camera will be started to record video according to the reference point.
- The payload glides with an active descent at above 100 m for one minute within a radius of 250 m. The payload’s parachute will be opened at above 100 m.
- The buzzer will be activated when the altitude drops below 5 m and data transmission will be stopped. The buzzer will continue to beep until the electronic system is turned off by the power (on/off) button.
- The mission will be completed.

FSW Design of Basic Flow Chart for Payload



FSW Design of Basic Flow Chart for Container



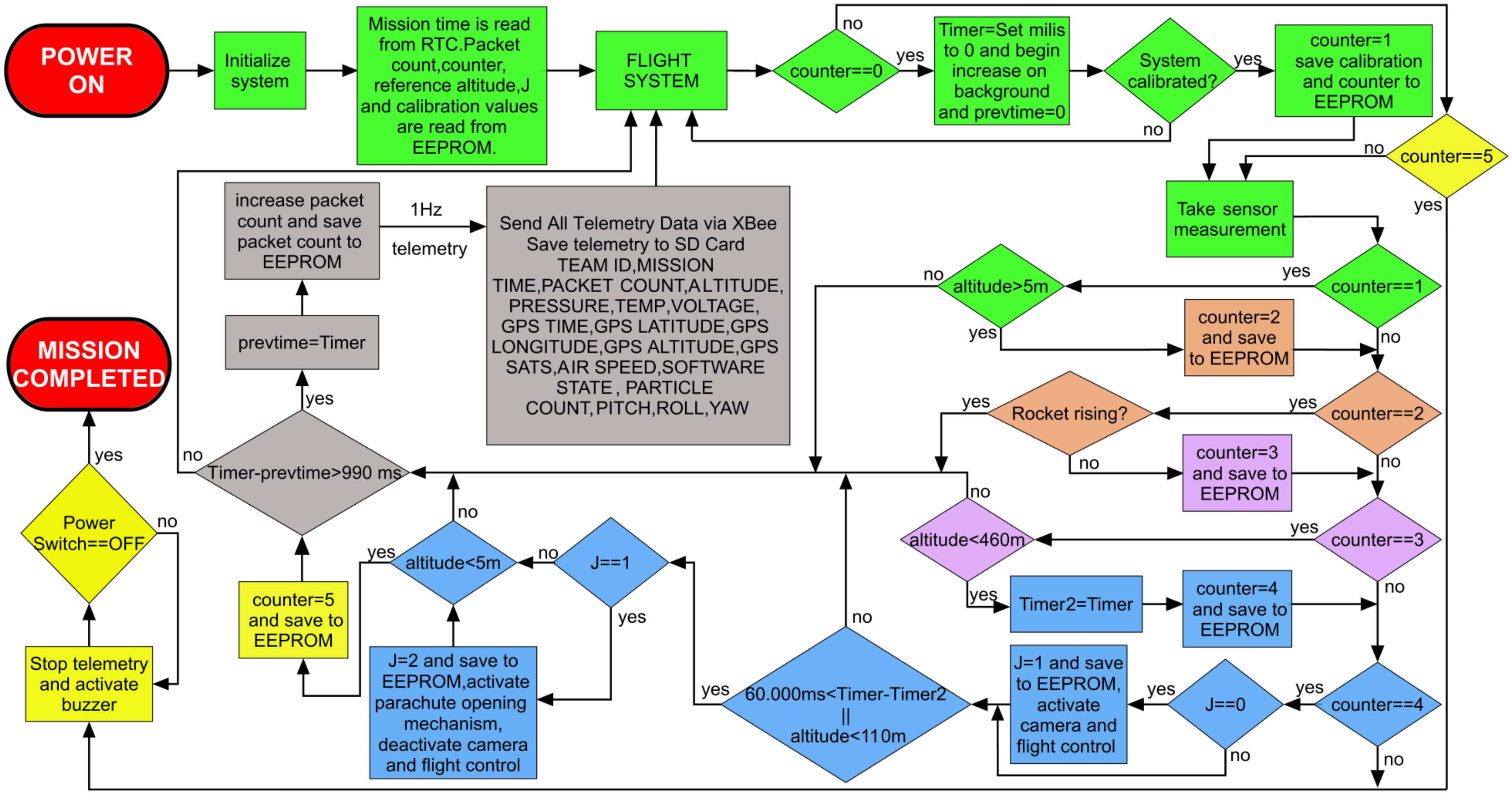
FSW Requirement (1 of 2)

Requirement Number	Requirement	Rationale	Priority	VM			
				A	I	T	D
RN#10	The container shall release the payload at 450 meters +/- 10 meters.	Competition Requirement	HIGH		✓	✓	✓
RN#11	The science payload shall glide in a circular pattern with a 250 m radius for one minute and stay above 100 meters after release from the container.	Competition Requirement	HIGH	✓	✓	✓	✓
RN#22	The science payload shall measure altitude using an air pressure sensor.	Competition Requirement	HIGH	✓		✓	✓
RN#23	The science payload shall provide position using GPS.	Competition Requirement	HIGH	✓		✓	✓
RN#24	The science payload shall measure its battery voltage.	Competition Requirement	HIGH	✓		✓	✓
RN#25	The science payload shall measure outside temperature.	Competition Requirement	HIGH	✓		✓	✓
RN#26	The science payload shall measure particulates in the air as it glides.	Competition Requirement	HIGH	✓		✓	✓
RN#27	The science payload shall measure air speed.	Competition Requirement	HIGH	✓		✓	✓
RN#28	The science payload shall transmit all sensor data in the telemetry.	Competition Requirement	HIGH	✓	✓	✓	✓
RN#29	Telemetry shall be updated once per second.	Competition Requirement	HIGH		✓	✓	

FSW Requirement (2 of 2)

Requirement Number	Requirement	Rationale	Priority	VM			
				A	I	T	D
RN#31	The ground system shall command the science vehicle to start transmitting telemetry prior to launch.	Competition Requirement	HIGH	✓	✓	✓	
RN#33	Telemetry shall include mission time with one second or better resolution. Mission time shall be maintained in the event of a processor reset during the launch and mission.	Competition Requirement	HIGH	✓		✓	
RN#34	Configuration states such as if commanded to transmit telemetry shall be maintained in the event of a processor reset during launch and mission.	Competition Requirement	HIGH	✓	✓	✓	
RN#40	All telemetry shall be displayed in real time during descent.	Competition Requirement	HIGH		✓	✓	
RN#41	All telemetry shall be displayed in engineering units (meters, meters/sec, Celsius, etc.).	Competition Requirement	HIGH	✓			✓
RN#47	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.	Competition Requirement	HIGH	✓	✓		
RN#51	An audio beacon is required for the probe. It may be powered after landing or operate continuously.	Competition Requirement	HIGH	✓		✓	

Payload FSW State Diagram (1 of 2)



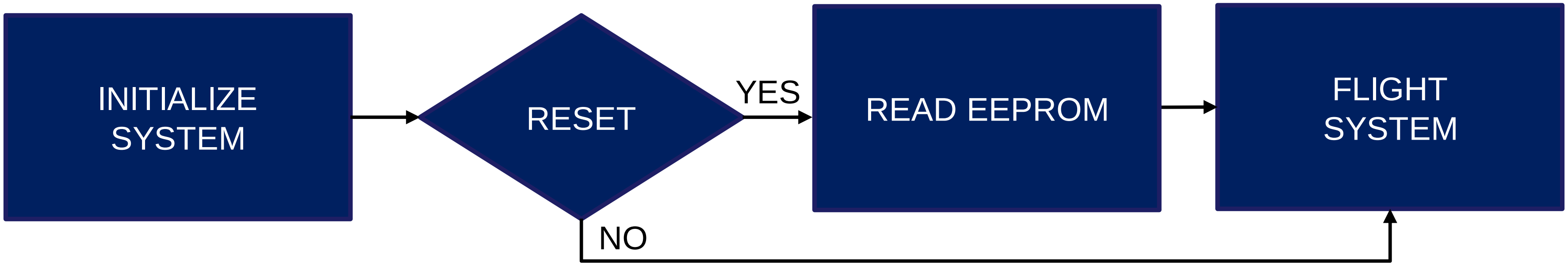
STATES	Pre Launch	Launch	CanSat Released	Payload Released	Landed

Data Recovery for Payload

- Microcontroller will be reset when a temporary power failure occurs.

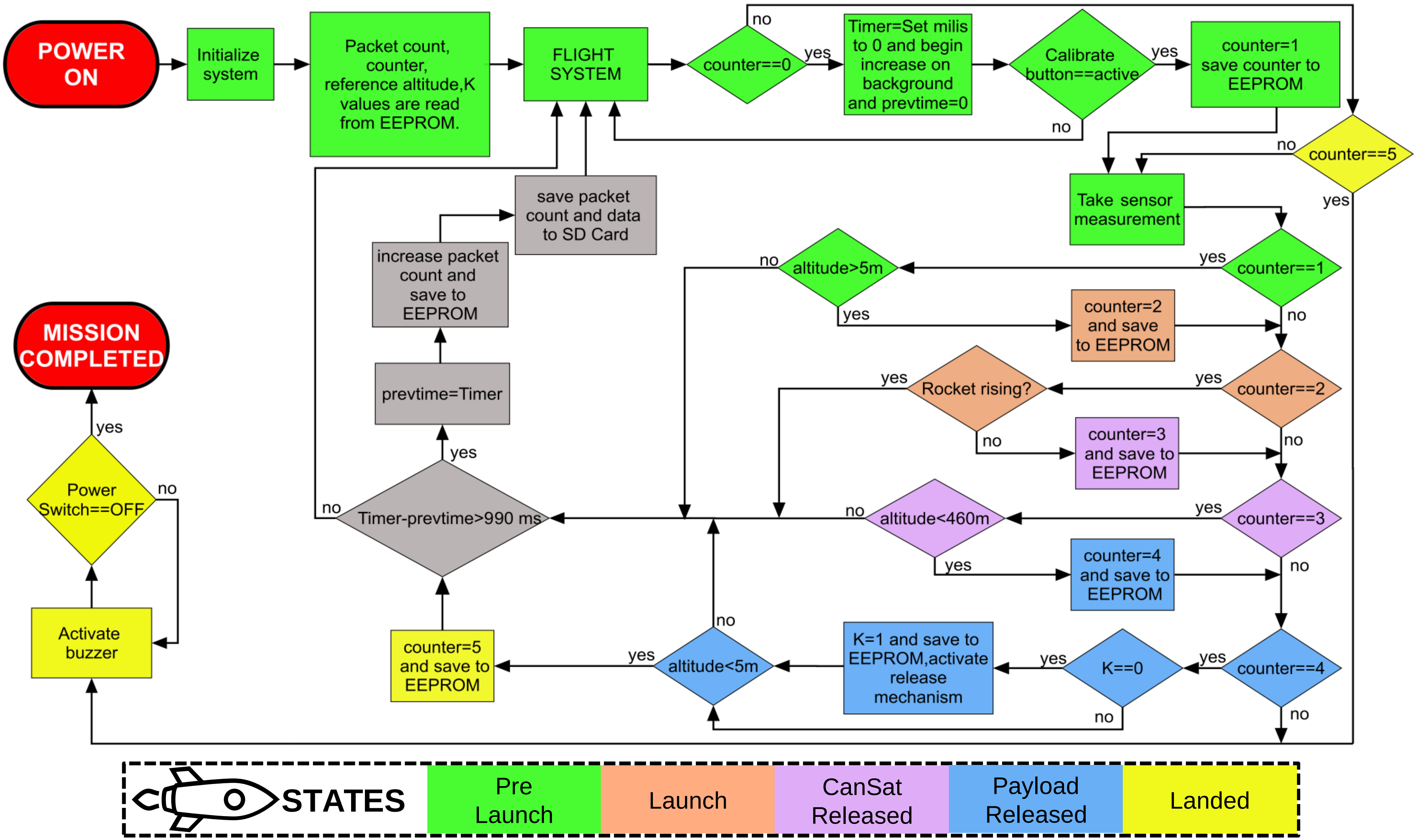
- Mission time will be saved in the internal EEPROM of the RTC module. In this way, data loss will be prevented if a momentary power failure occurs.

- Packet count, referance altitude, calibration state and counter data will be saved in the internal EEPROM of the MCU. In this way data loss will be prevented if microcontroller reset occurs.



If the microcontroller will be reset, the necessary data will be received from the EEPROM.

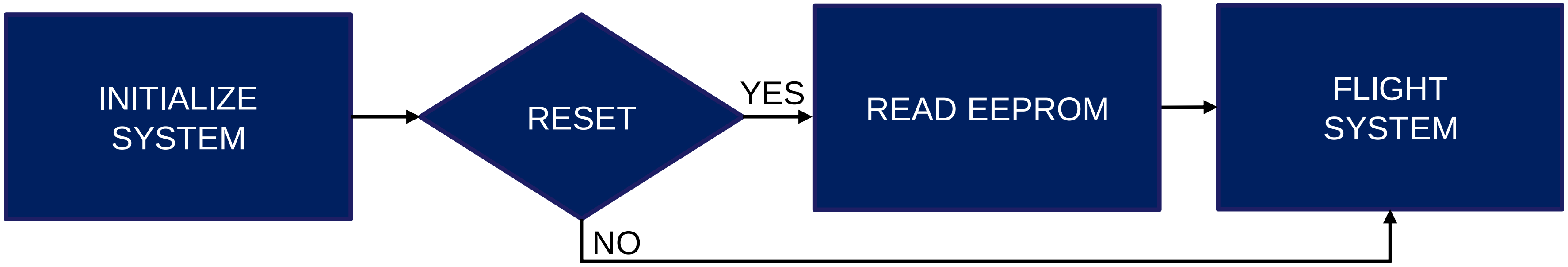
Container FSW State Diagram (1 of 2)



Data Recovery for Container

- Microcontroller will be reset when a temporary power failure occurs.

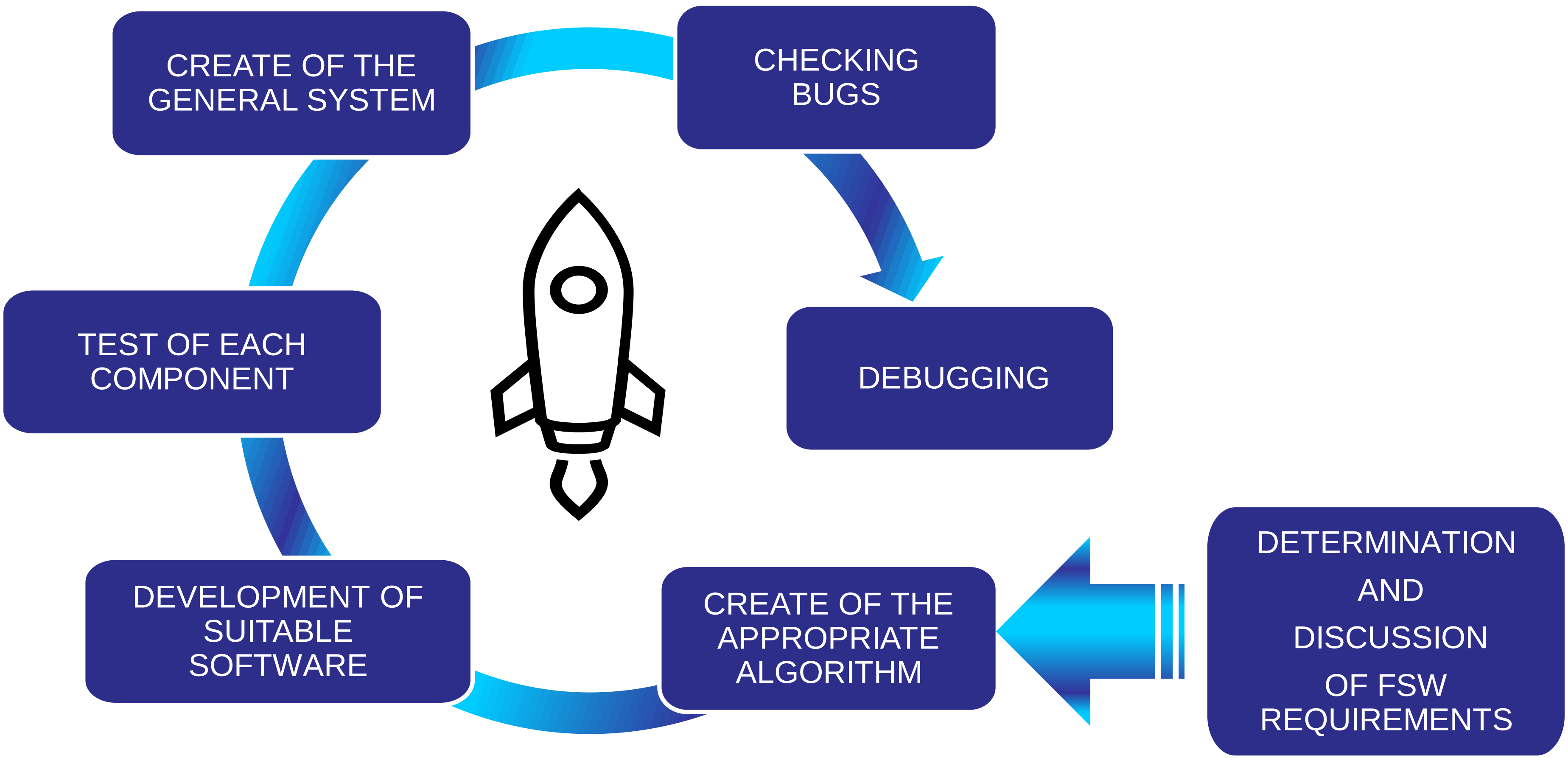
- Packet count, reference altitude, counter data will be saved in the internal EEPROM of the MCU. In this way data loss will be prevented if microcontroller reset occurs.



If the microcontroller will be reset, the necessary data will be received from the EEPROM.

Software Development Plan (1 of 2)

Subsystem Software Development Sequence Plan



Software Development Plan (2 of 2)

Prototype and Prototyping Environments

- The necessary software is installed on the microcontroller.
- Each component is tested separately on breadboard.
- The data stream is checked from the Arduino Serial monitor.

Test Methodology

- Appropriate software will be installed in Arduino IDE.
- Sensors to be used in the system will be tested.
- Release and parachute mechanism algorithms will be tested.
- Data recovery algorithm will be tested.
- Checking whether the FSW meets the CanSat competition requirements.
- FSW will be tested on the general CanSat system.

Development Team

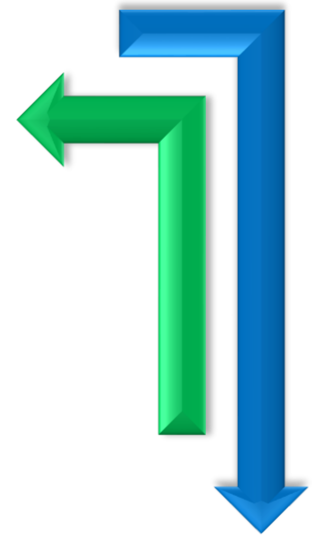
- Osman SERİNKAN
- Süleyman ARİŞ

Ground Control System (GCS) Design

Süleyman ARİŞ

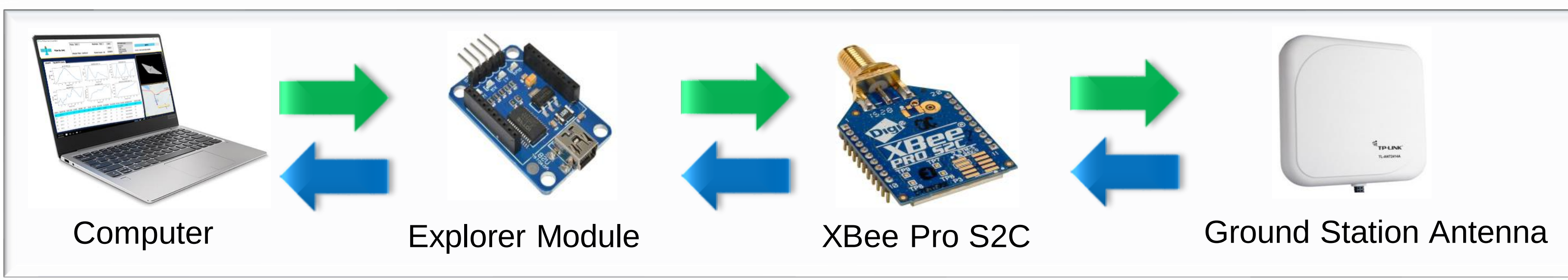
GCS Overview

PAYLOAD



The calibration command will be transmitted from the ground station to the payload.

Telemetry data will be transmitted from the payload to the ground station.



GROUND STATION

GCS Requirements (1 of 2)

Requirement Number	Requirement	Rationale	Priority	VM			
				A	I	T	D
RN#31	The ground system shall command the science vehicle to start transmitting telemetry prior to launch.	Competition Requirement	HIGH	✓	✓	✓	
RN#32	The ground station shall generate a csv file of all sensor data as specified in the telemetry section.	Competition Requirement	HIGH	✓	✓	✓	
RN#33	Telemetry shall include mission time with one second or better resolution. Mission time shall be maintained in the event of a processor reset during the launch and mission.	Competition Requirement	MEDIUM	✓		✓	
RN#34	Configuration states such as if commanded to transmit telemetry shall be maintained in the event of a processor reset during launch and mission.	Competition Requirement	MEDIUM	✓	✓	✓	
RN#35	XBEE radios shall be used for telemetry. 2.4 GHz Series radios are allowed. 900 MHz XBEE Pro radios are also allowed.	Competition Requirement	HIGH	✓	✓	✓	
RN#36	XBEE radios shall have their NETID/PANID set to their team number.	Competition Requirement	HIGH	✓	✓		
RN#37	XBEE radios shall not use broadcast mode.	Competition Requirement	HIGH	✓	✓		

GCS Requirements (2 of 2)

Requirement Number	Requirement	Rationale	Priority	VM			
				A	I	T	D
RN#39	Each team shall develop their own ground station.	Competition Requirement	HIGH	✓	✓	✓	
RN#40	All telemetry shall be displayed in real time during descent.	Competition Requirement	HIGH		✓	✓	
RN#41	All telemetry shall be displayed in engineering units (meters, meters/sec, Celsius, etc.).	Competition Requirement	HIGH	✓			✓
RN#42	Teams shall plot each telemetry data field in real time during flight.	Competition Requirement	HIGH	✓	✓	✓	✓
RN#44	The ground station shall include one laptop computer with a minimum of two hours of battery operation, XBEE radio and a hand-held antenna.	Competition Requirement	HIGH	✓		✓	✓
RN#45	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.	Competition Requirement	HIGH	✓	✓		
RN#47	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.	Competition Requirement	MEDIUM	✓	✓		

GCS Design

SMA Connector

2 mm Header

Ground Station Antenna

XBee Pro S2C

Explorer Module

USB Wire

Specifications

★ **The computer has got at least 2 hours of battery power.**

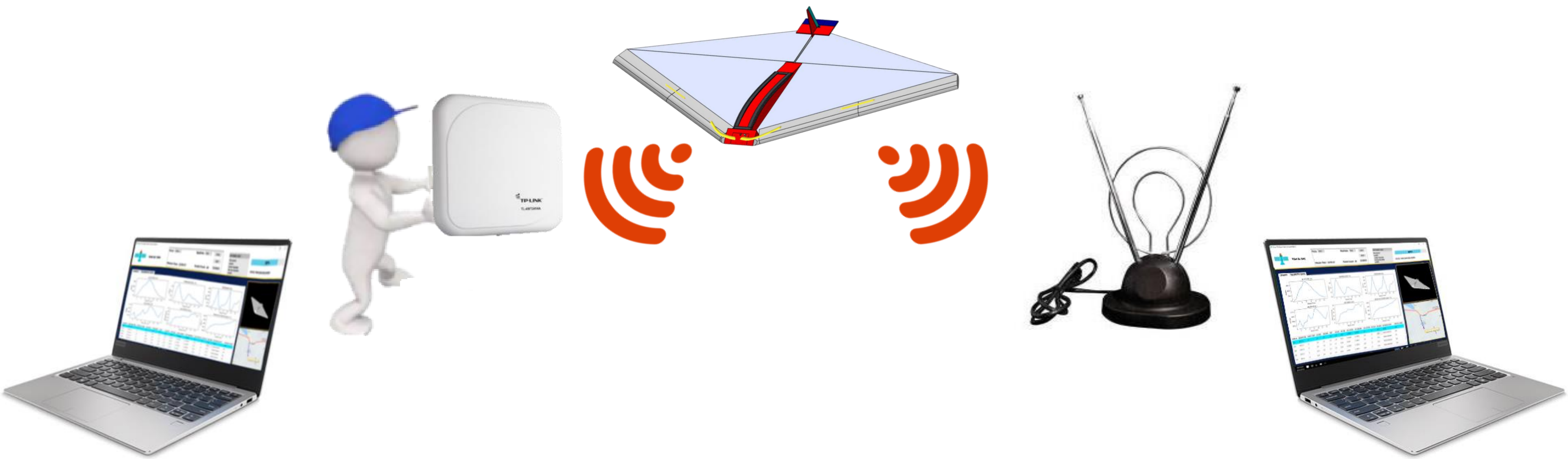
- ✓ An umbrella will be used to protect the computer from sunlight.
- ✓ A fan will be used the cool the computer.
- ✓ **The power bank will be used for supplying the required energy to the fan for not consuming the computer battery.**
- ✓ The computer will be updated prior to the competition. Then the updates will be disabled. Finally, the computer will be disconnected from the internet.

Computer

GCS Antenna Trade & Selection (1 of 2)

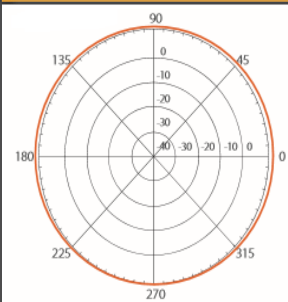
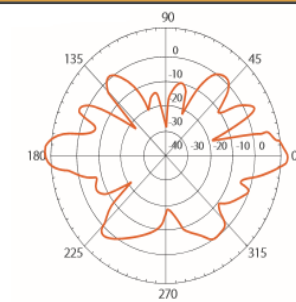
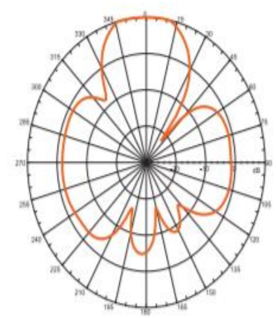
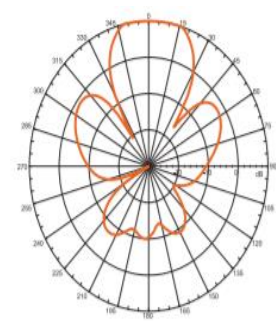
Hand-Held Antenna (SELECTED)

Table Top Antenna



We Selected Mounting Antenna Design: Hand-Held Antenna

The antenna must be hand-held for easy targeting and minimize data loss since the payload will glide in a circular pattern with a radius of 250 meters.

Antenna Image	Model	Spread	Frequency Range (GHz)	Gain (dBi)	Beamwidth (Horizontal/ Vertical)	Antenna Patterns	
						Horizontal	Vertical
	TL-ANT 2412D	Omni-Directional	2.4~2.5	12	360°/12°		
	TL-ANT 2414A	Directional	2.4~2.5	14	30°/30°		

Selected Antenna	Reasons
TL-ANT2414A	★ It is a directional antenna. ➢ Provide higher gain during signal transmission for the targeted direction. ➢ Suitable beamwidth for targeting.

GCS Software (1 of 3)

Telemetry display prototypes	•We used tables, charts, 3D simulation, list and map to show telemetry data from the payload to the ground station.
Commercial off the shelf software packages used	•Anaconda [(Spyder)(Python distribution)] •XCTU (XBee Program Software (Free))
Real time plotting software design	•We plot the data read from the serial port in real time with Python using the matplotlib and PyQt5 library. Then we show charts in the interface of the ground station.
Calibration command and verification	•**The calibration command** will be transmitted to the payload with the button added to the ground station interface. •**After the pre-launch calibration command has been transmitted, telemetry data will be sent from the payload to the ground station and will be started save to csv file format on the ground station.** •**The calibration verification** will be performed according to the telemetry data sent from the barometric sensor and row/pitch angles in the payload to the ground station.
Telemetry data recording and media presentation to judges	•Telemetry data in csv extension file format, the screenshot of the interface, the media data recorded using the camera recorded in the SD card will be transferred to the judge’s USB memory at the end of the mission and presentation on judges.
.csv telemetry file creation for judges	•Telemetry data transmitted to the ground station will be saved in csv file format by using ',' among the received telemetry data.

Table, Charts, 3D Simulation, Map

Grizu-263 Space Team| Ground Station

TEAM ID: 7840

Ports: COM-4 Baudrate: 9600 START STOP CALIBRATE

Mission Time: 00:14:31 Packet Count: 15

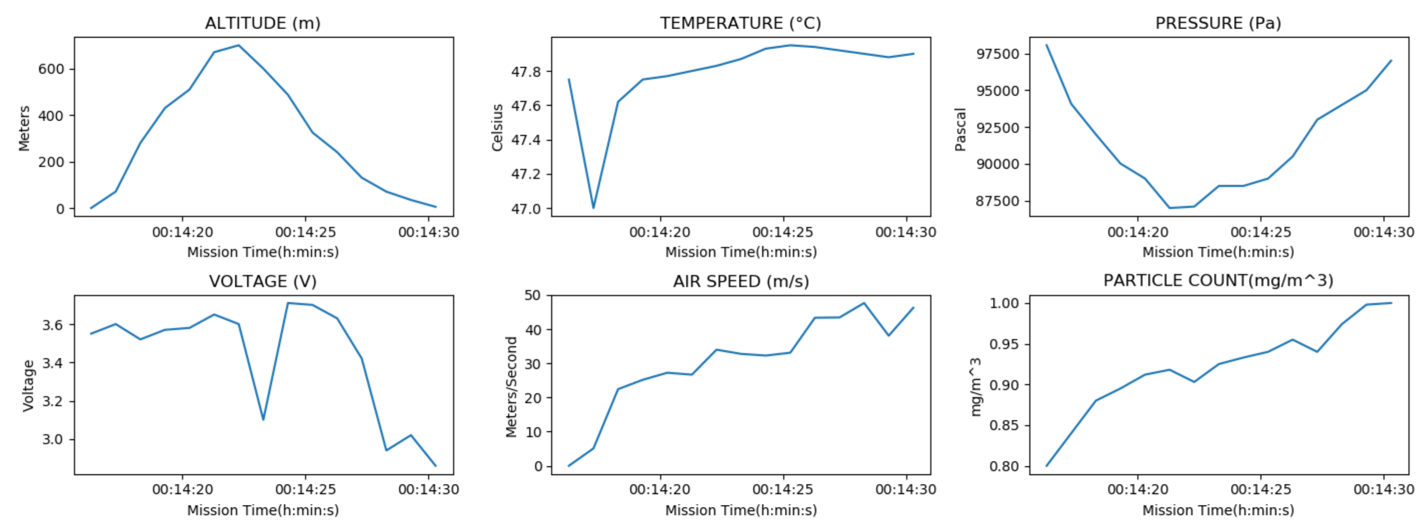
SOFTWARE STATE

PRE LAUNCH
LAUNCH
CANSAT RELEASED
PAYLOAD RELEASED
LANDED

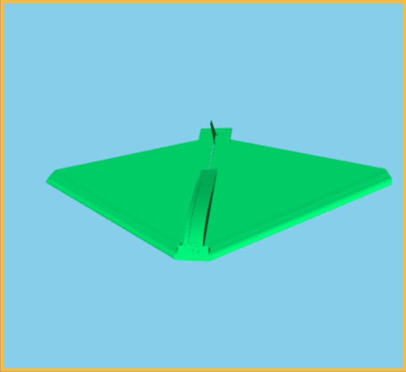
100%

STATE: LANDED

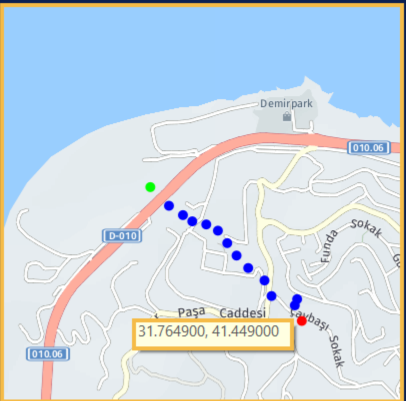
CHARTS TELEMETRY DATA



TEAM ID	MISSION TIME	PACKET COUNT	ALTITUDE	PRESSURE	TEMP	VOLTAGE	GPS TIME	GPS LATITUDE	GPS LONGITUDE	GPS ALTITUDE	GPS SATS	AIR SPEED	SOFTWARE STATE	PARTICLE COUNT	PITCH	ROLL	YAW
7840	00:14:30	15	5.2	97000	47.9	2.86	00:00	41.4485	31.7652	0.2	21	46.24	Landed	1.0	50	75	80
7840	00:14:29	14	34.8	95000	47.88	3.02	00:00	41.4483	31.7645	34.8	21	38.07	Payload Released	0.998	120	45	60
7840	00:14:28	13	70.5	94000	47.9	2.94	00:00	41.449	31.7649	70.0	21	47.64	Payload Released	0.974	100	240	40
7840	00:14:27	12	130.6	93000	47.92	3.42	00:00	41.4492	31.765	128.7	21	43.41	Payload Released	0.94	150	140	105
7840	00:14:26	11	240.4	90500	47.94	3.63	00:00	41.4493	31.7639	239.5	21	43.33	Payload Released	0.955	200	93	20



PITCH:50 ROLL:75 YAW:80



All Telemetry Data and Software States

Grizu-263 Space Team| Ground Station

TEAM ID: 7840

Ports: COM-4 | Baudrate: 9600 | START | STOP | CALIBRATE

Mission Time: 00:14:31 | Packet Count: 15

SOFTWARE STATE

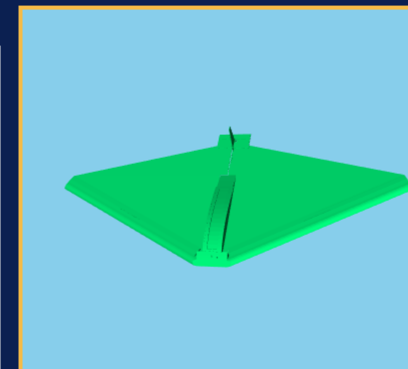
PRE LAUNCH
LAUNCH
CANSAT RELEASED
PAYLOAD RELEASED
LANDED

100%

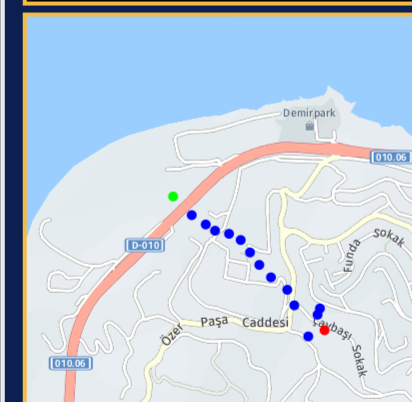
STATE: LANDED

CHARTS | TELEMETRY DATA

TEAM ID	MISSION TIME	PACKET COUNT	ALTITUDE	PRESSURE	TEMP	VOLTAGE	GPS TIME	GPS LATITUDE	GPS LONGITUDE	GPS ALTITUDE	GPS SATS	AIR SPEED	SOFTWARE STATE	PARTICLE COUNT	PITCH	ROLL	YAW
7840	00:14:30	15	4.2	97000	30	2.82	00:00	41.4485	31.7652	0.2	21	46.24	Landed	1.0	50	75	80
7840	00:14:29	14	34.8	95000	30.7	2.9	00:00	41.4483	31.7645	34.8	21	38.07	Payload Released	0.998	120	45	60
7840	00:14:28	13	70.5	93000	31.1	2.96	00:00	41.449	31.7649	70.0	21	47.64	Payload Released	0.974	100	240	40
7840	00:14:27	12	130.6	96000	31.8	3.04	00:00	41.4492	31.765	128.7	21	43.41	Payload Released	0.94	150	140	105
7840	00:14:26	11	240.4	90500	32.2	3.1	00:00	41.4493	31.7639	239.5	21	43.33	Payload Released	0.955	200	93	20
7840	00:14:25	10	325.0	89000	32.4	3.25	00:00	41.4498	31.7636	325.3	21	33.09	Payload Released	0.94	80	45	104
7840	00:14:24	9	487.3	88500	33.6	3.22	00:00	41.4502	31.7629	486.3	21	32.26	Cansat Released	0.933	55	30	55
7840	00:14:23	8	600.1	88500	33.7	3.27	00:00	41.4506	31.7624	604.2	21	32.75	Cansat Released	0.925	42	74	65
7840	00:14:22	7	700.5	90000	31.4	3.29	00:00	41.451	31.762	701.7	21	33.98	Launch	0.903	60	99	41
7840	00:14:21	6	670.7	94000	30.4	3.41	00:00	41.4514	31.7616	669.5	21	26.67	Launch	0.918	35	78	0
7840	00:14:20	5	510.2	96000	32.1	3.34	00:00	41.4516	31.7611	507.2	21	27.23	Launch	0.912	65	65	74
7840	00:14:19	4	430.4	98000	34.3	3.47	00:00	41.4517	31.7605	430.7	21	25.16	Launch	0.895	80	65	85
7840	00:14:18	3	280.0	98100	37.4	3.52	00:00	41.4519	31.7601	283.0	21	22.43	Launch	0.88	70	245	105
7840	00:14:17	2	70.9	98070	35.4	3.62	00:00	41.4522	31.7595	72.5	21	5.1	Launch	0.84	30	120	25
7840	00:14:16	1	0	98050	30.2	3.71	00:00	41.4528	31.7587	0.1	21	0	Pre Launch	0.8	0	90	0



PITCH:50 ROLL:75 YAW:80



CanSat Integration and Test

Uğurcan SORUÇ

CanSat Integration and Test Overview (1 of 5)

CanSat Integration and Test Overview

- **Subsystem Level Testing Plan**
  - Sensors
  - CDH
  - EPS
  - Radio Communications
  - FSW
  - Mechanical
  - Descent Control
- **Integrated Level Functional Test Plan**
  - Descent Test
  - Communications
  - Mechanisms
  - Deployment
- **Environmental Test Plan**
  - Drop Test
  - Thermal Test
  - Vibration Test
  - Fit Check

CanSat Integration and Test Overview (2 of 5)

Subsystem Level Testing

Sensors	• Sensors calibration • Operational tests for sensors using microcontrollers	
CDH	• XBees' communication tests • The antenna test	
EPS	• Test for the consumption of current and voltage values of electronic components • Power sufficiency calculations	
Radio Communications	• XBee communications test with the XCTU Software • Antenna range test	
FSW	• Data recovery algorithm test • The release mechanism algorithm test • Test for the accuracy of the data received from the sensors and camera	
Mechanical	• Release mechanism test • CanSat mass and size control	• Delta wing, rudder and elevator control
Descent Control	• Sufficiency test of delta wing and parachute system	• Separation test • Descent speed test

Integrated Functional Level Testing

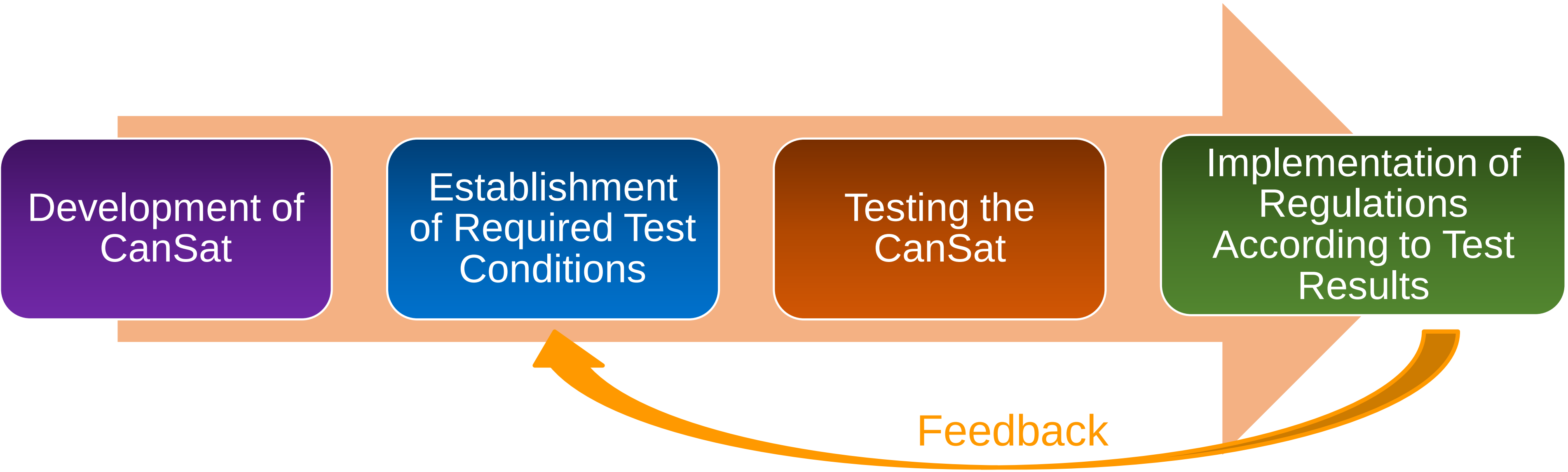
Descent Tests	• Container parachute test • Payload parachute test • Delta wing test
Communications	• Communication of XBees' (distance, reflections, different environmental conditions, etc.)
Mechanisms	• Control of release mechanism • Container opening mechanism test • Delta wing folding mechanism test
Deployment	• Payload release from container test using melt of fishline method • Payload's parachute opening test using melt of fishline method

CanSat Integration and Test Overview (4 of 5)

Environmental Testing

Drop Test	• The payload holding test of the container • Component and battery mounts test • 30 Gs shock durability test of the system
Thermal Test	• CanSat's temperature durability test at 60°C for 2 hours
Vibration Test	• This test will be conducted to verify the mounting integrity of all components, mounting connections, structural integrity, and battery connections.
Fit Check	• Checking the CanSat dimensions for the requirements

CanSat Integration and Test Overview (5 of 5)



Analyzing the mission guide and identifying the important requirements:

Mechanical System:

- Different types of delta wings prototypes are designed and tested to ensure the payload descents for the desired speed.
- The parachute test is performed with the use of a drone.
- The environmental test will be planned to be performed at our engineering faculty laboratories.

Electronic and Communication System:

- The electronic system is set on the breadboard.
- The data transfer test was carried out with XBee modules.

Sensors Tests

- First, the electronic circuits for each sensor were installed on the breadboard.
- All sensors were tested with the appropriate codes.
- The robustness of all sensors were tested.

Air Pressure/Temperature Sensor Test

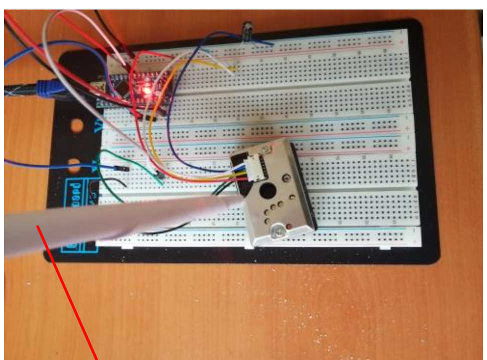
- The necessary connections of the sensor have been made on the circuit.
- Then, we calibrated the BMP280 sensor and received the data from the sensor.

Pressure: 101309 Pa	Temp: 27.66 *C
Pressure: 101303 Pa	Temp: 27.67 *C
Pressure: 101308 Pa	Temp: 27.72 *C
Pressure: 101293 Pa	Temp: 27.85 *C
Pressure: 101279 Pa	Temp: 28.05 *C
Pressure: 101282 Pa	Temp: 28.27 *C
Pressure: 101283 Pa	Temp: 28.48 *C
Pressure: 101273 Pa	Temp: 28.72 *C
Pressure: 101286 Pa	Temp: 28.95 *C
Pressure: 101289 Pa	Temp: 29.13 *C
Pressure: 101290 Pa	Temp: 29.32 *C
Pressure: 101288 Pa	Temp: 29.48 *C
Pressure: 101294 Pa	Temp: 29.62 *C
Pressure: 101294 Pa	Temp: 27.66 *C

Subsystem Level Testing Plan (2 of 7)

Particulate/Dust Sensor Test

- First of all, we connected the particulate/dust sensor to Arduino Nano. Then, we have tested the sensor by the use of baby powder.
- We checked the sensor that can sense the powder particles.

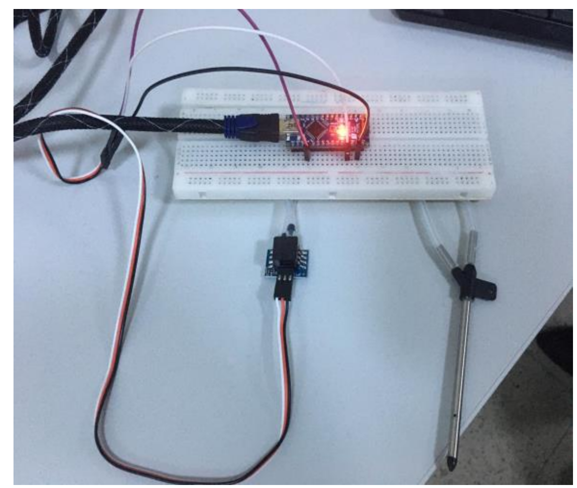


Pipe to transmit particles directly

```
Vo=1306.05mV, DustDensity=0.14mg/m3
Vo=1444.29mV, DustDensity=0.17mg/m3
Vo=1624.37mV, DustDensity=0.20mg/m3
Vo=1365.09mV, DustDensity=0.15mg/m3
Vo=1381.45mV, DustDensity=0.16mg/m3
Vo=1379.83mV, DustDensity=0.16mg/m3
Vo=1379.74mV, DustDensity=0.16mg/m3
Vo=1383.20mV, DustDensity=0.16mg/m3
Vo=1392.29mV, DustDensity=0.16mg/m3
Vo=1386.91mV, DustDensity=0.16mg/m3
Vo=1389.31mV, DustDensity=0.16mg/m3
Vo=1387.11mV, DustDensity=0.16mg/m3
Vo=1377.10mV, DustDensity=0.16mg/m3
Vo=1383.30mV, DustDensity=0.16mg/m3
Vo=1409.52mV, DustDensity=0.16mg/m3
Vo=2735.16mV, DustDensity=0.43mg/m3
Vo=3489.70mV, DustDensity=0.58mg/m3
Vo=3459.18mV, DustDensity=0.57mg/m3
Vo=2030.22mV, DustDensity=0.29mg/m3
Vo=1843.60mV, DustDensity=0.25mg/m3
Vo=1588.43mV, DustDensity=0.20mg/m3
Vo=1501.90mV, DustDensity=0.18mg/m3
Vo=1487.55mV, DustDensity=0.18mg/m3
Vo=1495.26mV, DustDensity=0.18mg/m3
```

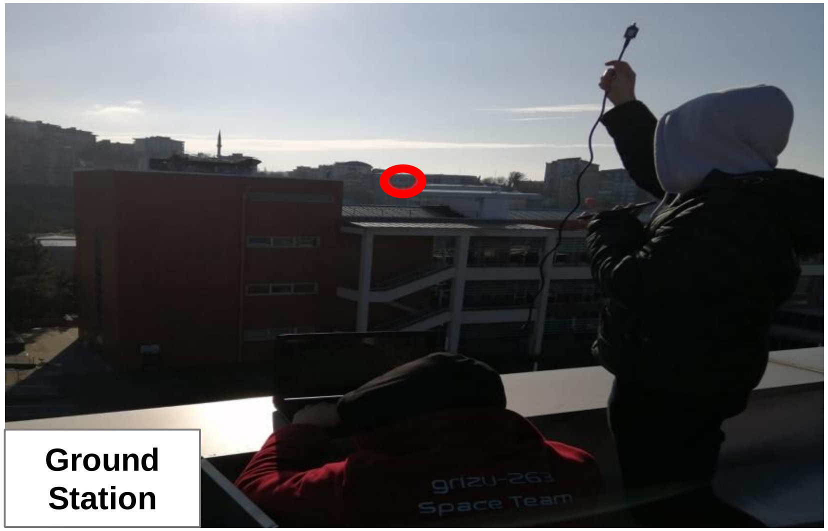
Air Speed Sensor Test

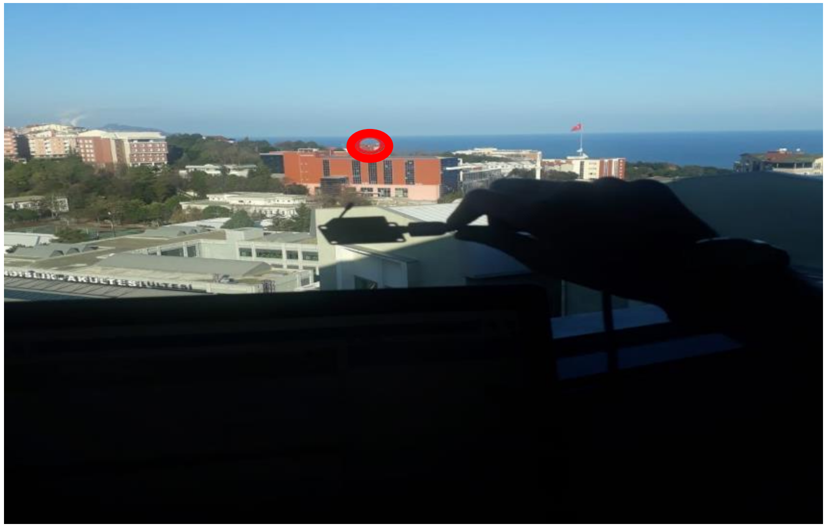
- We connected the air speed sensor to the Arduino Nano.
- We have obtained appropriate analog output when we exposed the pitot tube to air flow generated by blow-dryer.



CDH Tests

- The communication between the receiver and transmitter XBee was tested in the XCTU Software.
- After the installed of the electronic circuit on breadboard, the accuracy of the data sent to the ground station will be checked.
- The speed of sending data will be checked.
- The data transmission at high distances will be checked.
- The gain test of the antenna will be tested using the XCTU Software.

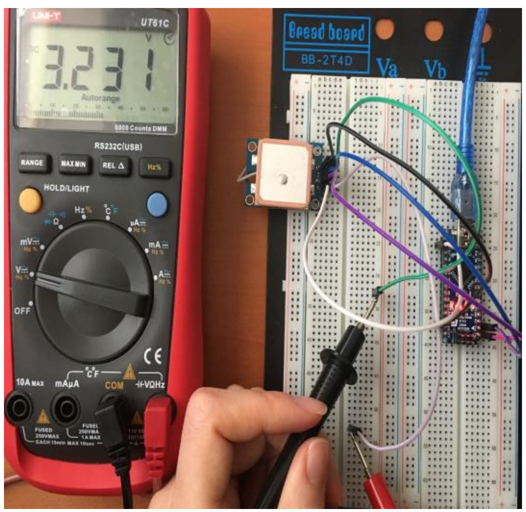


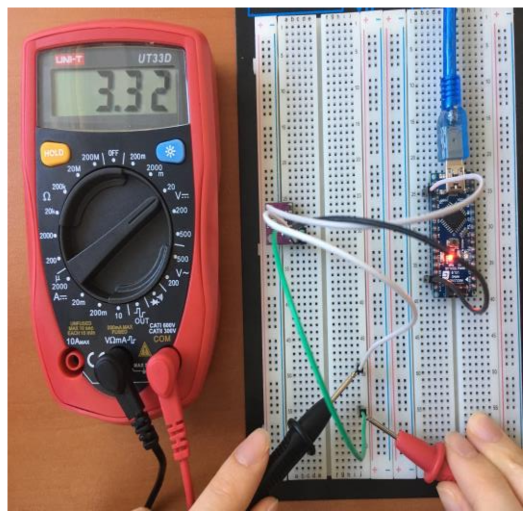


XBees' communication tests have been carried out.

EPS Tests

- The voltage and current values of battery and sensors used in CanSat were measured with a multimeter.
- The batteries connected in parallel and approximately 3.7 V measured.
- The system will be tested for 2 hours of operation.





SENSORS

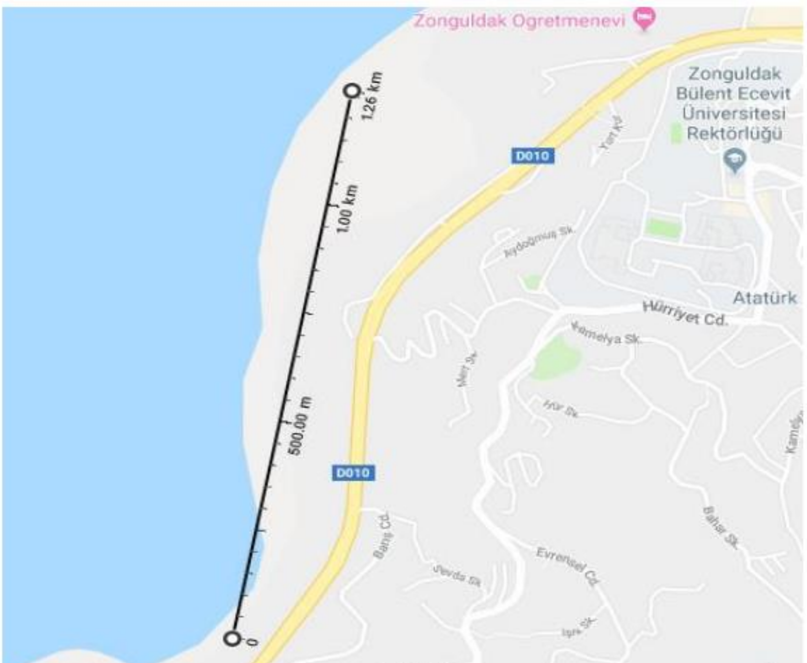
BATTERY

FSW Test

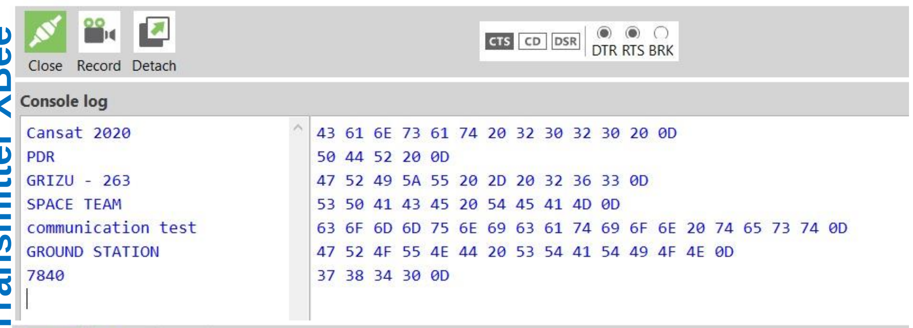
- The accuracy of the data get from the sensors will be checked (particulate/dust, air speed, GPS location, temperature, pressure, etc.).
- The calibration command will be transmitted from the ground station to the payload. Then, it will be tested whether or calibrate of the system.
- Sub-systems will be tested (release mechanisms, communication, etc.).
- The sequence of the data transmission to the ground station will be checked for consistency in the appropriate order.
- Data recovery algorithms will be tested in case of microcontroller reset.
- The system will be actively controlled for one minute from around 450 meters to above 100 meters, and the flight will be controlled with respect to given reference point.
- The opening mechanism of the payload's parachute will be activated at the height above 100 meters.

Radio Communications Tests

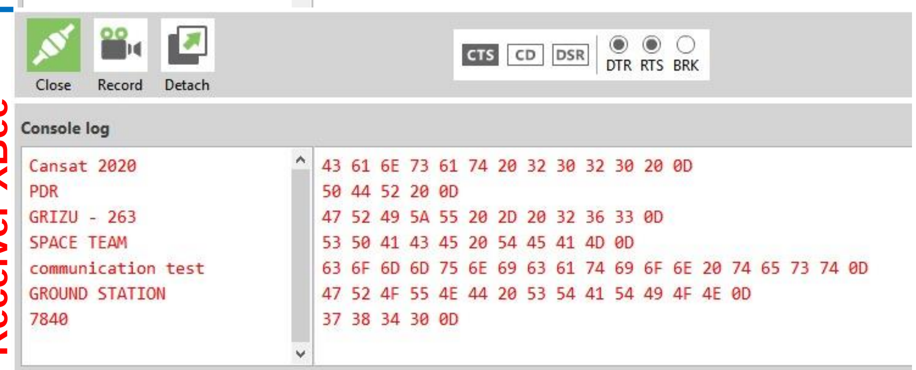
- The data transmission of XBees against various distance and environmental conditions were tested.



Transmitter XBee



Receiver XBee



Subsystem Level Testing Plan (7 of 7)

Mechanical System Tests

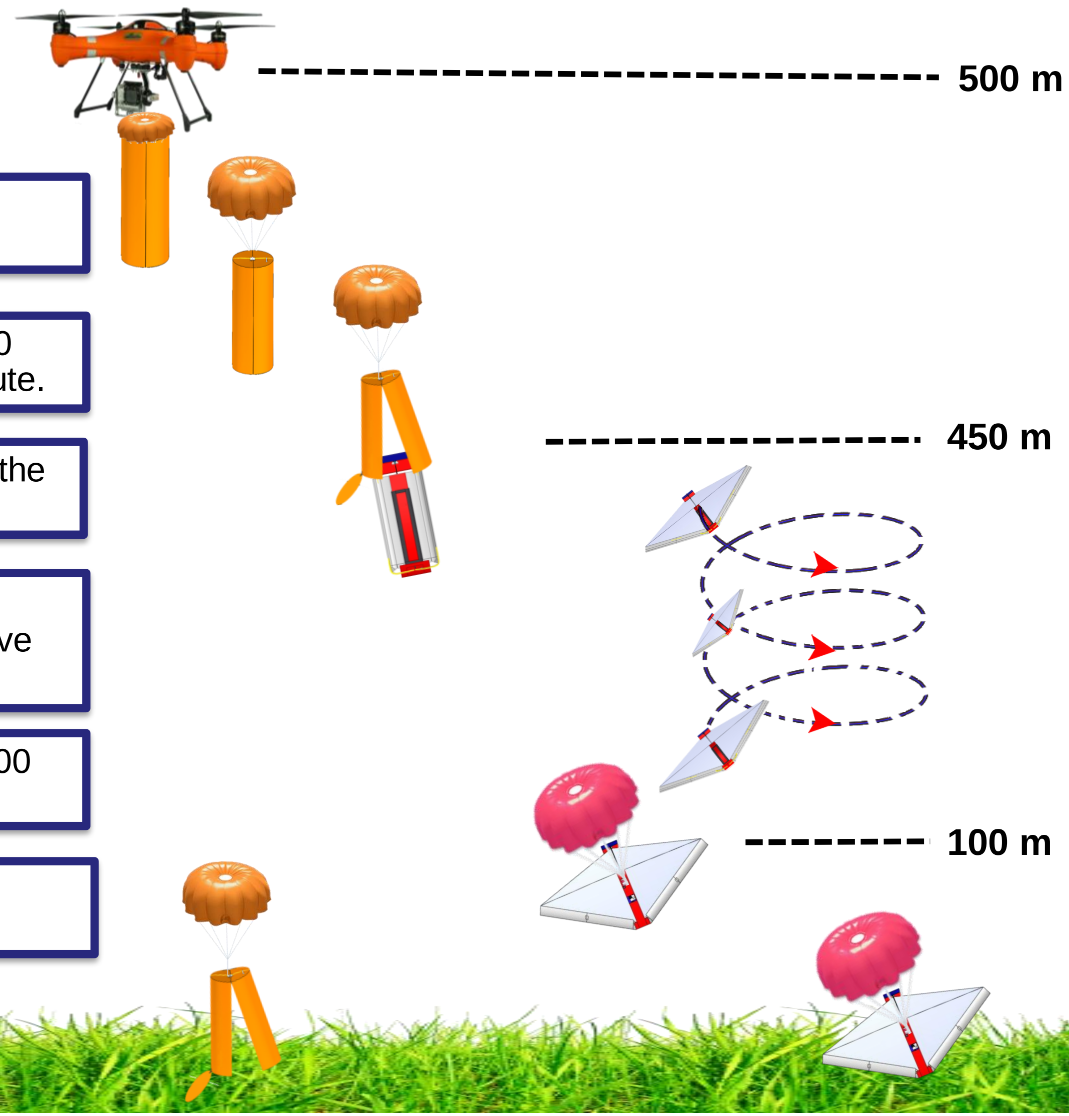
- It will be checked whether or the total mass is 600 g determined in the competition requirements (±10 g).
- The CanSat's mechanical tests will be checked (separation, drop and fit check etc.).
- The container opening mechanism will be tested.
- Delta wing folding mechanism will be tested (hinge, rotating joint, stretched fabric elastic and telescopic system).
- The CanSat's subsystems durability before and after the test flights will be checked.
- The CanSat will be checked for the given environmental test requirements.

Descent Control System Tests

- The installed electronic circuit will be placed in the payload and it will be tested at 450 meters via the drone.
- The payload's delta wings will be tested for gliding in a circular pattern with a radius of 250 meters from 450 meters to above 100 meters (actively controlled for one minute). Its aerodynamic suitability will also be checked during the test.
- The opening of the payload's parachute will be tested at a height above 100 meters.

Deployment Test

- CanSat will be carried to an altitude of 500 meters via the drone.
- The container will be descent from 500 meters to 450 meters with the parachute.
- The payload will be separated from the container at 450 meters.
- The payload will glide in a circular pattern for one minute using an active control for a radius of 250 meters.
- The payload will glide until at above 100 meters.
- The payload's parachute will be opened approximately at 100 meters.



Communications

- The entire system implemented will be taken to the competition required altitude using a drone and a communication test will be performed.
- Transmission with Xbees’ will be tested when the drone reaches the competition required altitude.

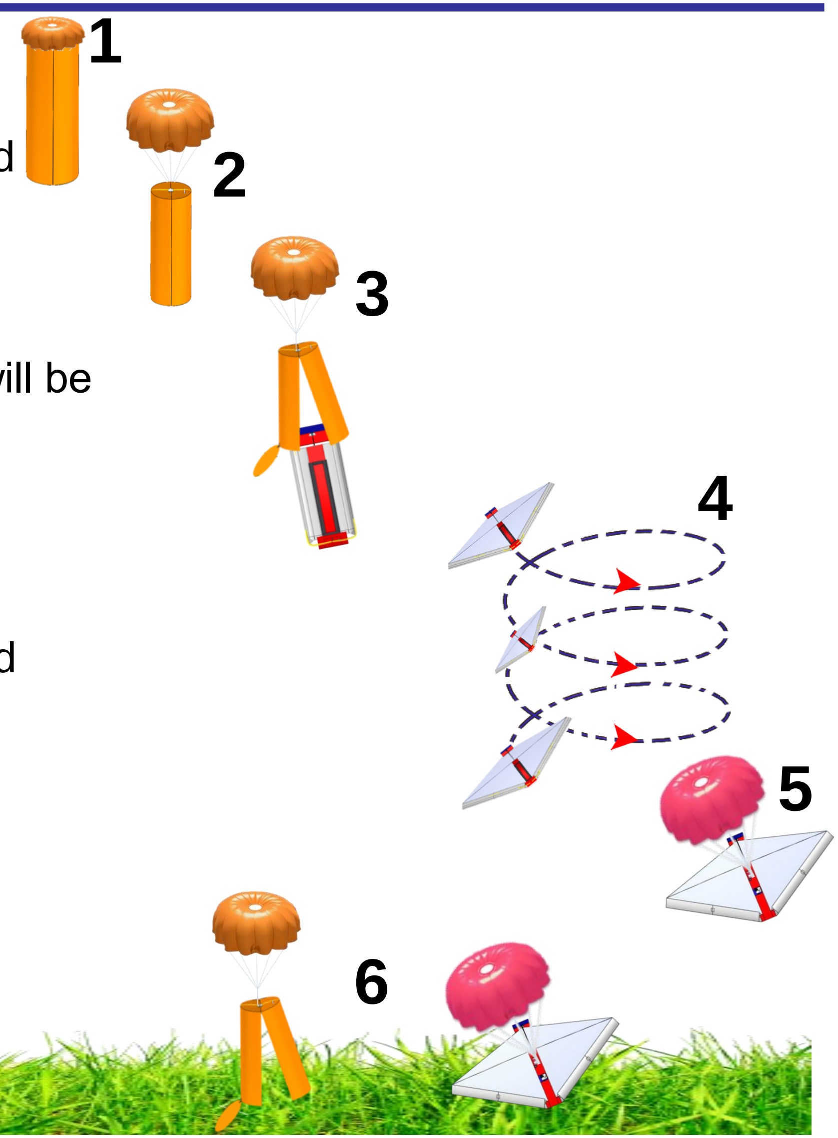
Communications test image from last year

Integrated Level Functional Test Plan (3 of 6)

Mechanisms

- The container opening mechanism will be tested using melt of fishline.
- The opening of the payload's delta wing with a folding mechanism will be tested.
- The payload's parachute opening mechanism will be tested using melt of fishline.

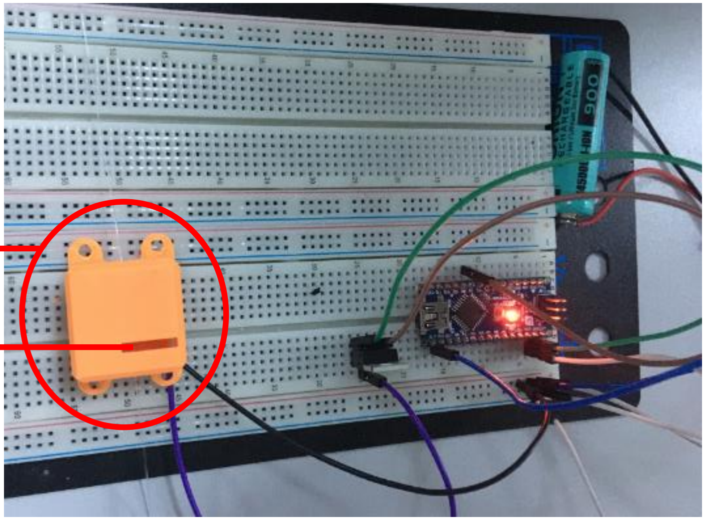
1. CanSat
2. Container parachute will be opened.
3. Container will be opened via melt of fishline and payload will be separated from the container.
4. Payload shall glide in a circular pattern with a radius of 250 meters for one minute.
5. Payload's parachute will be opened via melt of fishline.
6. CanSat mission will be completed.

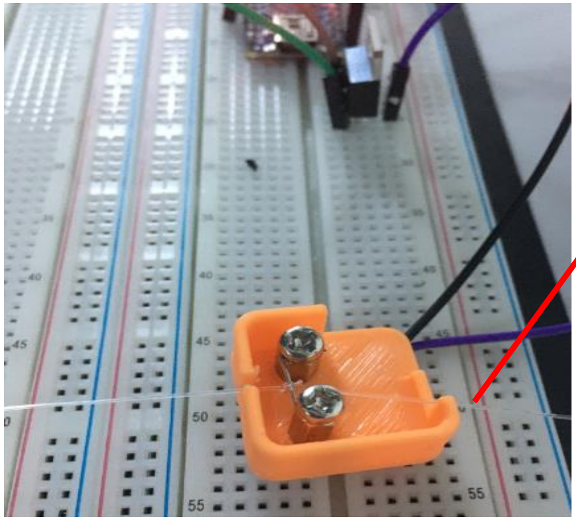


Integrated Level Functional Test Plan (4 of 6)

Release Mechanism Test

- The container opening mechanism tested using melt of fishline method.
- The payload’s parachute opening mechanism tested using melt of fishline method.
- Sufficient power supplied to the fishline for the process.
- **The fishline placed in a melt stop box inside the CanSat.**
- The power of the fishline cut off automatically just after opening by the use of a switch.
- The fishline operated for a very short period of time and will not be heated at full power.

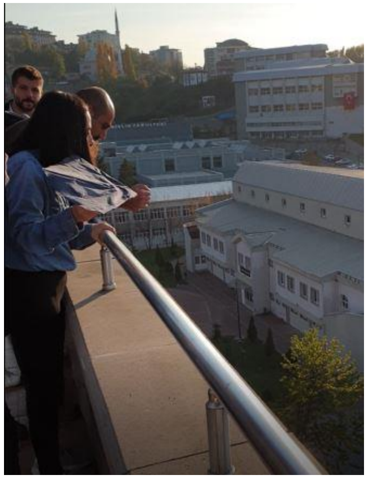
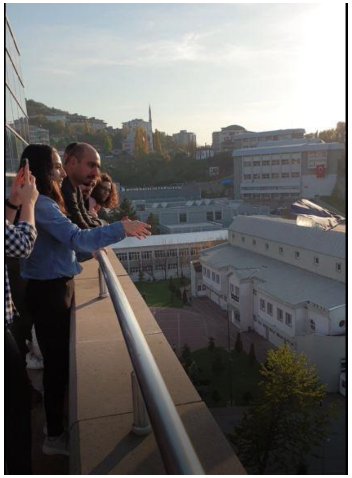




The test method is the melt of fishline.

Descent Test (Payload)

- We mounted different types (simple, diamond, etc.) of delta wings to the payload.
- Each tested wings assessed in terms of gliding requirements (the gliding in a circular pattern for one minute with a radius of 250 meters).
- Delta wing will be integrated into the payload and re-tested on different altitudes, after completing all of the payload mechanisms.


We released the pre-prepared payload prototype from 25 meters.

Descent Test (Container)

- Firstly, the diameter of the parachute is calculated according to the desired descent rate (20 m/s).
- The parachute was then released from an altitude of 25 meters and checked for descent rate at the desired speed.
- If the desired speed could not be achieved during the descent, the parachute diameter calculation and parachute modification will be done again.

Container and Parachute

Drop Test

- The CanSat will be released from a height of 2 meters after being tied up with 61 cm rope.
- The release mechanism will be tested to verify the durability of the container and the payload in it.
- It will be checked whether CanSat is still operational.
- CanSat will be checked for any mechanical damage.
- It will be confirmed that CanSat is still receiving telemetry.

Drop test image from last year

Thermal Test

- CanSat will be powered on and then placed in the thermal chamber.
- The temperature of the thermal chamber will be adjusted to 60°C.
- The thermal test duration will be 2 hours.
- The operational conditions of entire mechanisms and the communications at the end of the test will be checked.

Environmental Test Plan (2 of 2)

Vibration Test

- The vibration test will be realized to verify the mounting integrity of all components, mounting connections, structural integrity and battery connections.
- The CanSat will be placed on the orbit sander and the vibration test will be conducted with a vibration ratio of 20-29 Gs for 5 minutes by exposing it to 0-233 Hz vibration.
- Any mechanical and electrical damage will be checked after the test.

Vibration test image from last year

Fit Check

- In order to control CanSat's dimensions, a 125 mm diameter hole is cut from a steel plate.
- The accuracy of the diameter of the generated circle will be controlled by a micrometer caliper.
- The accuracy of CanSat's diameter will be tested with the formed hole.

Steel plate and formed hole

Fit check image from last year

Mission Operations & Analysis

Uğurcan SORUÇ

Overview of Mission Sequence of Events (1 of 3)

ARRIVAL
• Arrive to the launch location. • Set up ground system. (GSC) • Check the CanSat. (Whole Team)
PRE-LAUNCH
• Software calibration command transmission to the payload from the ground station. (GSC) • Check the size and weight of the CanSat. (MCO) • Check communication. (GSC) • Check delta wing, rudder and elevator. (CC) • Check parachutes. (CC) • Check separation mechanisms. (CC - GSC) • Perform drop test. (MCO - GSC - CC) • Check safety requirements. (MCO) **Ground System Setup (GSC)** • Test batteries for 2 hours. • Check power bank. **Antenna Constructions (GSC)** • A single part antenna will be used. Check the antenna for consistency. • The antenna will be directly connected to the XBee. Check communication. • The XBee is connected to the ground station computer via serial port. Check data flow. **Assembly (CC)** • The delta wing will be stowed with the help of a folding mechanism. • The payload will be stowed into the container. • Then parachute will be folded and placed on the top of the container.

Overview of Mission Sequence of Events (2 of 3)

LAUNCH

- Place the CanSat into the rocket
- Start data transmission by electronic system
- Liftoff the rocket
- Release of CanSat from the rocket (between 670-725 meters).
- The CanSat's parachute opens
- Descent of CanSat up to 450 m with a speed of 20 m/s (±5 m/s).
- Separation of the payload from the container at 450 m (±10 m).
- Actively control of the delta wing via the payload
- Glide of the payload in a circular pattern with 250 m radius for one minute
- The parachute of the payload opens at above 100 meters
- The payload descent with a speed of 10 m/s (±5 m/s).
- The buzzer activates and the telemetry tranmission stops at the end of the flight

FLIGHT RECOVERY

- The container will descent by the parachute. Find the container via the fluorescent color of its parachute and the audio beacon. (CRC)
- Find the payload via GPS telemetry, audio beacon and with the fluorescent color of its parachute. (PRC)
- Retrieve and back up telemetry data from payload‘s SD card. (GSC)

Overview of Mission Sequence of Events (3 of 3)

DATA ANALYSIS
• Check camera data. (GSC - MCO) • Analyze telemetry data. (GSC - MCO) • Check real-time graphics. (GSC - MCO)
POST FLIGHT REVIEW
• Prepare PFR file. (Whole Team)

Mission Operations Manual Development Plan (1 of 2)

MISSION OPERATION MANUEL

- **Configure the ground station**
  - Communication test
  - Check antenna
- **Preparing the CanSat**
  - Assemble the CanSat
  - Release mechanism control
  - Mass and size control
  - Drop test
  - Delta wing, rudder and elevator control
- **Integrating the CanSat into the rocket**
  - Fit check
  - Check stowed the CanSat's parachute
- **The launch preparation procedures**
  - Launch procedure
  - Removal procedure

Mission Operations Manual Development Plan (2 of 2)

CONFIGURE GROUND STATION

- The necessary equipment (antenna, laptop, etc.) will be controlled by GSC.
- The communication systems will be tested and installed by GSC.

PREPARING CANSAT

- Calibration of sensors and the CanSat's final check will be done by CC.
- Delta wing, rudder and elevator will be controlled by CC.
- The release mechanism will be checked by CC.

INTEGRATING CANSAT

- The CanSat crew will make the CanSat fully assembled and ready for launch.
- Care should be taken to ensure that all parts are properly mounted when this will be done.

- After we will be completed all the tests, MCO will deliver the CanSat to the staff for launch.

CanSat Location and Recovery (1 of 2)

How can find the container?
• The container recovery crew will be found the container via buzzer and container's fluorescent orange color parachute.

Which color is the container and the parachute?
• The container color is orange.
• The container's parachute color is fluorescent orange.

The container return address
• The necessary contact information will be written on the container.
Zonguldak Bülent Ecevit University Space Team grizu-263 **#Team 7840** **grizu263@beun.edu.tr**

The container's fluorescent orange color parachute

CanSat Location and Recovery (2 of 2)

How can find the payload?

- The payload recovery crew will be found the payload via buzzer, GPS telemetry and the payload's fluorescent pink color parachute.

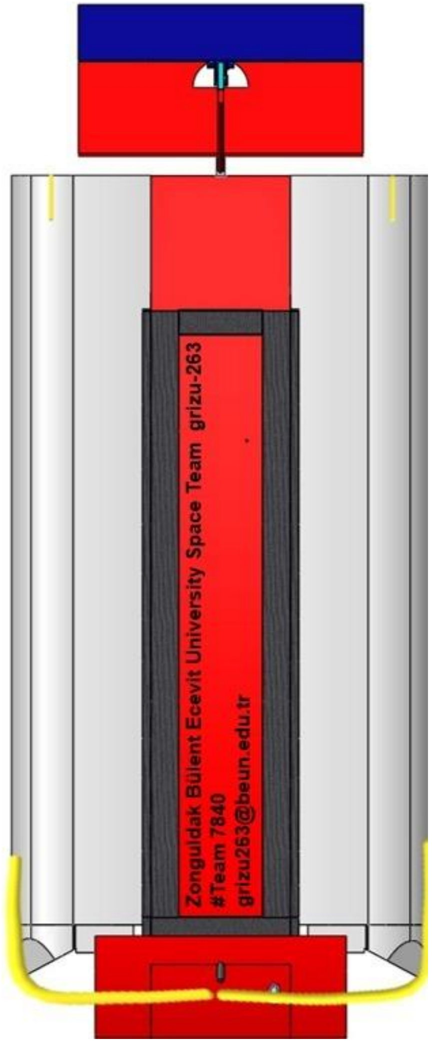
Which color is the payload and the parachute?

- The payload color is red and the delta wings colors are grey.
- The payload's parachute color is fluorescent pink.

The payload return address

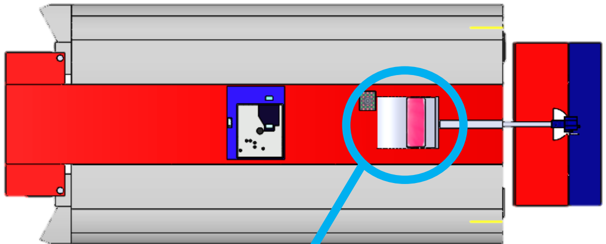
- The necessary contact information will be written on the payload.

Zonguldak Bülent Ecevit University
Space Team grizu-263
#Team 7840
grizu263@beun.edu.tr



Top view of the payload

Bottom view of the payload



The payload's fluorescent pink color parachute

View of the payload in the last 100 meters

Requirements Compliance

Uğurcan SORUÇ

Requirements Compliance Overview

- The design was prepared according to the CanSat 2020 mission.
- There is not any requirement that does not comply with our design.
- Environmental tests (drop, thermal, vibration, fit check) are planned in accordance with the requirements.

Mechanical Team

- Theoretically, the total mass was calculated to be 600 (± 10) grams according to requirements.
- The payload and container descent speeds were calculated according to requirements.
- The glide of the payload was calculated to be within a radius of about 250 meters for a minute at above 100 meters.
- Different types of delta wings were tested (simple delta, diamond delta etc.).

Electrical and Software Team

- The selected sensors and the required data was collected.
- Camera tests required for bonus mission were performed.
- Interface design was done by GCS.
- The antenna and XBee radio selection were completed.
- The communication test between the XBee's was performed.
- The algorithm for flight software that meets the requirements was completed by FSW team.

Requirements Compliance (1 of 7)

RN#	Requirement	Comply / No Comply / Partial	X-Ref Slide(s) Demonstrating Compliance	Team Comments or Notes
1	Total mass of the CanSat (science payload and container) shall be 600 grams +/- 10 grams.	**Comply**	100,170,188	OK
2	CanSat shall fit in a cylindrical envelope of 125 mm diameter x 310 mm length. Tolerances are to be included to facilitate container deployment from the rocket fairing.	**Comply**	27,37,38,178	OK
3	The container shall not have any sharp edges to cause it to get stuck in the rocket payload section which is made of cardboard.	**Comply**	37,178	OK
4	The container shall be a fluorescent color; pink, red or orange.	**Comply**	57,185,186	OK
5	The container shall be solid and fully enclose the science payload. Small holes to allow access to turn on the science payload is allowed. The end of the container where the payload deploys may be open.	**Comply**	38,83,84,90,91,178	OK
6	The rocket airframe shall not be used to restrain any deployable parts of the CanSat.	**Comply**	37,38,178	OK
7	The rocket airframe shall not be used as part of the CanSat operations.	**Comply**	37	OK

Requirements Compliance (2 of 7)

RN#	Requirement	Comply / No Comply / Partial	X-Ref Slide(s) Demonstrating Compliance	Team Comments or Notes
8	The container parachute shall not be enclosed in the container structure. It shall be external and attached to the container so that it opens immediately when deployed from the rocket.	**Comply**	58,91	OK
9	The descent rate of the CanSat (container and science payload) shall be 20 meters/second +/- 5m/s.	**Comply**	14,35,36,53,54,65, 96,176,181	OK
10	The container shall release the payload at 450 meters +/- 10 meters.	**Comply**	14,34,35,36,53,54, 60,94,171,181	OK
11	The science payload shall glide in a circular pattern with a 250 m radius for one minute and stay above 100 meters after release from the container.	**Comply**	14,35,36,153,170, 171,173,175,181	OK
12	The science payload shall be a delta wing glider.	**Comply**	22,27,60,72,163, 175,180,181,211	OK
13	After one minute of gliding, the science payload shall release a parachute to drop the science payload to the ground at 10 meters/second, +/- 5 m/s.	**Comply**	14,35,36,53,60,65	OK
14	All descent control device attachment components shall survive 30 Gs of shock.	**Partial Comply**	**178**	Tested with prototypes. Need actual design test.
15	All electronic components shall be enclosed and shielded from the environment with the exception of sensors.	**Comply**	34,37	OK

Requirements Compliance (3 of 7)

RN#	Requirement	Comply / No Comply / Partial	X-Ref Slide(s) Demonstrating Compliance	Team Comments or Notes
16	All structures shall be built to survive 15 Gs of launch acceleration.	**Partial Comply**	**178**	Tested with prototypes. Need actual design test.
17	All structures shall be built to survive 30 Gs of shock.	**Partial Comply**	**178**	Tested with prototypes. Need actual design test.
18	All electronics shall be hard mounted using proper mounts such as standoffs, screws, or high performance adhesives.	**Comply**	97	OK
19	All mechanisms shall be capable of maintaining their configuration or states under all forces.	**Comply**	97,178	OK
20	Mechanisms shall not use pyrotechnics or chemicals.	**Comply**	98,99,100	OK
21	Mechanisms that use heat (e.g., nichrome wire) shall not be exposed to the outside environment to reduce potential risk of setting vegetation on fire.	**Comply**	79,91,95	OK
22	The science payload shall measure altitude using an air pressure sensor.	**Comply**	42	OK
23	The science payload shall provide position using GPS.	**Comply**	44	OK

Requirements Compliance (4 of 7)

RN#	Requirement	Comply / No Comply / Partial	X-Ref Slide(s) Demonstrating Compliance	Team Comments or Notes
24	The science payload shall measure its battery voltage.	**Comply**	45	OK
25	The science payload shall measure outside temperature.	**Comply**	43	OK
26	The science payload shall measure particulates in the air as it glides.	**Comply**	47,48	OK
27	The science payload shall measure air speed.	**Comply**	46	OK
28	The science payload shall transmit all sensor data in the telemetry.	**Comply**	136,138,149	OK
29	Telemetry shall be updated once per second.	**Comply**	110,142	OK
30	The Parachutes shall be fluorescent Pink or Orange.	**Comply**	54,57	OK
31	The ground system shall command the science vehicle to start transmitting telemetry prior to launch.	**Comply**	35,137,155	OK
32	The ground station shall generate a csv file of all sensor data as specified in the telemetry section.	**Comply**	112,155	OK
33	Telemetry shall include mission time with one second or better resolution. Mission time shall be maintained in the event of a processor reset during the launch and mission.	**Comply**	142,143	OK

Requirements Compliance (5 of 7)

RN#	Requirement	Comply / No Comply / Partial	X-Ref Slide(s) Demonstrating Compliance	Team Comments or Notes
34	Configuration states such as if commanded to transmit telemetry shall be maintained in the event of a processor reset during launch and mission.	**Comply**	143,145	OK
35	XBEE radios shall be used for telemetry. 2.4 GHz Series radios are allowed. 900 MHz XBEE Pro radios are also allowed.	**Comply**	110	OK
36	XBEE radios shall have their NETID/PANID set to their team number.	**Comply**	110	OK
37	XBEE radios shall not use broadcast mode.	**Comply**	110	OK
38	Cost of the CanSat shall be under $1000. Ground support and analysis tools are not included in the cost.	**Comply**	199	OK
39	Each team shall develop their own ground station.	**Comply**	149,153,180	OK
40	All telemetry shall be displayed in real time during descent.	**Comply**	137,156,157	OK
41	All telemetry shall be displayed in engineering units (meters, meters/sec, Celsius, etc.).	**Comply**	156	OK
42	Teams shall plot each telemetry data field in real time during flight.	**Comply**	156,157	OK

Requirements Compliance (6 of 7)

RN#	Requirement	Comply / No Comply / Partial	X-Ref Slide(s) Demonstrating Compliance	Team Comments or Notes
44	The ground station shall include one laptop computer with a minimum of two hours of battery operation, XBEE radio and a hand-held antenna.	**Comply**	149,152,153	OK
45	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**	35,152,153,180	OK
46	Both the container and probe shall be labeled with team contact information including email address.	**Comply**	185,186	OK
47	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**	143,145	OK
48	No lasers allowed.	**Comply**	37,76	OK
49	The probe must include an easily accessible power switch that can be accessed without disassembling the cansat and in the stowed configuration.	**Comply**	32,33,34	OK
50	The probe must include a power indicator such as an LED or sound generating device that can be easily seen without disassembling the CANSAT and in the stowed state.	**Comply**	32,33	OK

Requirements Compliance (7 of 7)

RN#	Requirement	Comply / No Comply / Partial	X-Ref Slide(s) Demonstrating Compliance	Team Comments or Notes
51	An audio beacon is required for the probe. It may be powered after landing or operate continuously.	**Comply**	142,144,185,186	OK
52	The audio beacon must have a minimum sound pressure level of 92 dB, unobstructed.	**Comply**	118,120	OK
53	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.	**Comply**	118,120,125,132	OK
54	An easily accessible battery compartment must be included allowing batteries to be installed or removed in less than a minute and not require a total disassembly of the CanSat.	**Comply**	97	OK
55	Spring contacts shall not be used for making electrical connections to batteries. Shock forces can cause momentary disconnects.	**Comply**	124,127,131,133	OK
56	The CANSAT must operate during the environmental tests laid out in Section 3.5.	**Comply**	177,178	OK
57	Payload/Container shall operate for a minimum of two hours when integrated into rocket.	**Comply**	130,134	OK

Management

Nevin Maside TÜT

CanSat Budget – Hardware (1 of 3)

ELECTRONICS HARDWARE					
	Components	Quantity	Unit Price ($)	Total Price ($)	Considerations
PAYLOAD	Microcontroller (TEENSY 3.6)	1	29.25	29.25	Actual
	10-DOF IMU (MPU-9255+BMP280)	1	10	10	Actual
	Optical Dust Sensor (SHARP GP2Y10)	1	7.01	7.01	Actual
	Air Speed Sensor Kit (APM 2.6 MPXV7002DP)	1	45.43	45.43	Actual
	Camera (SQ11)	1	12.05	12.05	Actual
	Servo Motor (Feetech FS5106R)	2	17.70	35.4	Actual
	GPS Sensor (NEO-7M)	1	17.4	17.4	Actual
	Buzzer (KSTG951AP RS PRO)	1	1.7	1.7	Actual
	Antenna (TP-LINK TL-ANT2405CL)	1	5	5	Actual
	XBee Radio (XBEE PRO S2C)	1	57.3	57.3	Actual
	Battery (SONY VTC6)	2	5.5	11	Actual
	Coin Cell (CR2032 3V)	1	0.54	0.54	Actual
	Switch (KTS102)	1	0.48	0.48	Actual
	DC-DC 5V Regulator (S7V7F5)	1	1.9	1.9	Actual
	DC-DC 3.3V Regulator (AMS-1117)	1	0.5	0.5	Actual
	SD Card (Sandisk Ultra)	2	4.56	9.12	Actual
CONTAINER	Air Pressure Sensor (BMP280)	1	3.48	3.48	Actual
	Microcontroller (Arduino Nano)	1	22	22	Actual
	Battery (Orion 14500 AA)	1	4	4	Actual
	Buzzer (KSTG951AP RS PRO)	1	1.7	1.7	Actual
	Switch (KTS102)	1	0.48	0.48	Actual
	DC-DC 5V Regulator (S7V7F5)	1	1,9	1.9	Actual
	SD Card (Sandisk Ultra)	1	4.56	4.56	Actual
	SD Card Module	1	0.71	0.71	Actual

We bought again all components in this year.

TOTAL	$282.91

CanSat Budget – Hardware (2 of 3)

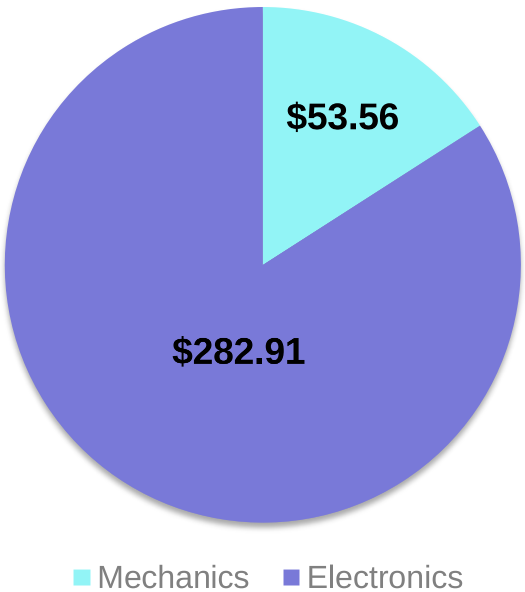
MECHANICS HARDWARE					
Components		Quantity	Unit Price ($)	Total Price ($)	Considerations
PAYLOAD	Carbon Fiber Stick	1 m	9	18	Actual
	Plastic Hinge ×2	20 mm*1 mm	0.75	1.5	Actual
	Fiberglass	1 m^2	3.53	3.53	Actual
	Silnylon 30D Nylon 66	1 m^2	12.5	12.5	Actual
CONTAINER	Fiberglass	1 m^2	3.53	3.53	Actual
	Silnylon 30D Nylon 66	1 m^2	12.5	12.5	Actual
	Stell Hinge ×2	30 mm*10 mm	1	2	Actual

TOTAL	$53.56

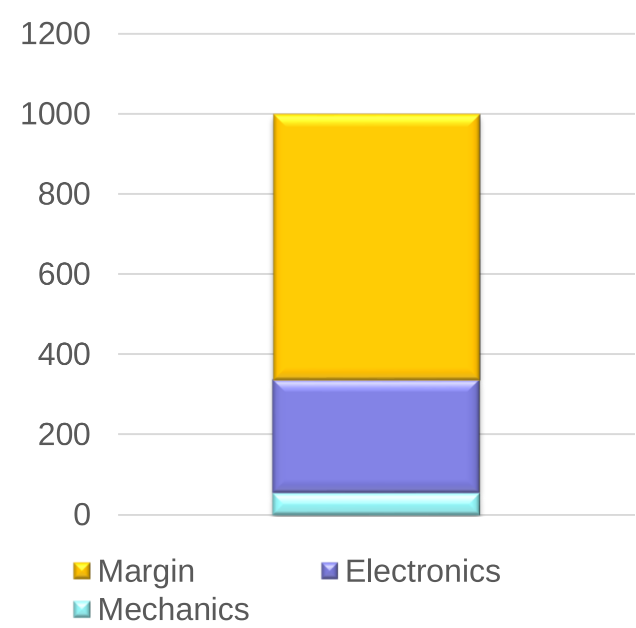
We bought again all components in this year.

CanSat Budget – Hardware (3 of 3)

Electronics / Mechanics Components



ELECTRONICS	$282.91
MECHANICS	$53.56
EXACT TOTAL	$336.47
MARGIN	$663.53



CanSat Requirement Cost – Exact Total = Margin

$1000- $336.47 = $663.53

CanSat Budget – Other Costs

OTHER

	Quantity	Total Price($)	Considerations
Prototyping		150.00	Estimate
Test facilities and equipment		University Budget	
Rental	Car*2	800.00	Estimate
Computers		Our own computers	
Travel (Flight Ticket)	8 person	4,400.00	Estimate
VISA (USA)	8 person	1,280.00	Estimate
Hotel	8 person	2,250.00	Estimate
CanSat Competition Free		200.00	Actual
Total		**9,080.00**	

GROUND STATION

Part	Model	Quantity	Price($)	Total Price($)	Considerations
Computer	-	1	Our Own Computer	-	Actual
XBEE	S2C	1	57.38	57.38	Actual
ANTENNA	Tp-link 2414A	1	64.05	64.05	Actual
Total				**121.43**	

INCOME

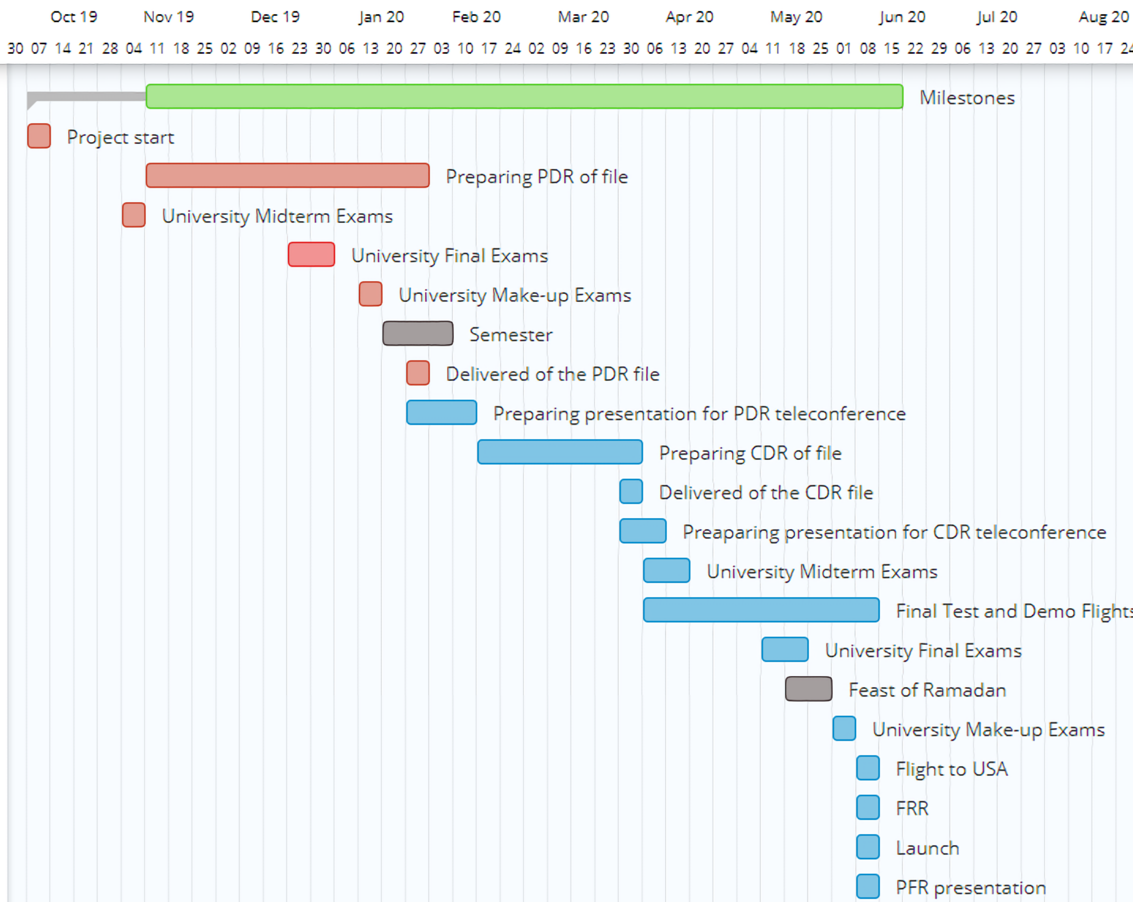
		Total Price($)
	ERDEMİR	5,600.00
Grants	Zonguldak Bülent Ecevit University	3,800.00
Total		**9,400.00**

- ✓ The money needed for producing the CanSat was granted by Zonguldak Bülent Ecevit University.
- ✓ We have completed sponsorship negotiations for travel and all other necessary expenses.
- ✓ All agreements is approved.
- ✓ ERDEMİR Company agrees to be our transportation sponsor.
- ✓ We will not have a problem in terms of the budget.

Program Schedule Overview

Milestones

	ASSIGNEE	START	DUE	
Milestones	All team	10/Oct	15/Jun	At
Project start	All team	10/Oct	10/Oct	At
Preparing PDR of file	All team	14/Nov	30/Jan	At
University Midterm Exams	All team	04/Nov	10/Nov	At
University Final Exams	All team	23/Dec	03/Jan	At
University Make-up Exams	All team	13/Jan	19/Jan	At
Semester	All team	20/Jan	03/Feb	At
Delivered of the PDR file	All team	31/Jan	31/Jan	At
Preparing presentation for PDR tel...	All team	02/Feb	15/Feb	At
Preparing CDR of file	All team	20/Feb	02/Apr	At
Delivered of the CDR file	All team	03/Apr	03/Apr	At
Preaparing presentation for CDR t...	All team	04/Apr	12/Apr	At
University Midterm Exams	All team	06/Apr	13/Apr	At
Final Test and Demo Flights	All team	12/Apr	08/Jun	At
University Final Exams	All team	11/May	22/May	At
Feast of Ramadan	All team	24/May	26/May	At
University Make-up Exams	All team	01/Jun	07/Jun	At
Flight to USA	All team	09/Jun	09/Jun	At
FRR	All team	12/Jun	12/Jun	At
Launch	All team	13/Jun	13/Jun	At
PFR presentation	All team	14/Jun	14/Jun	At



Completed Tasks

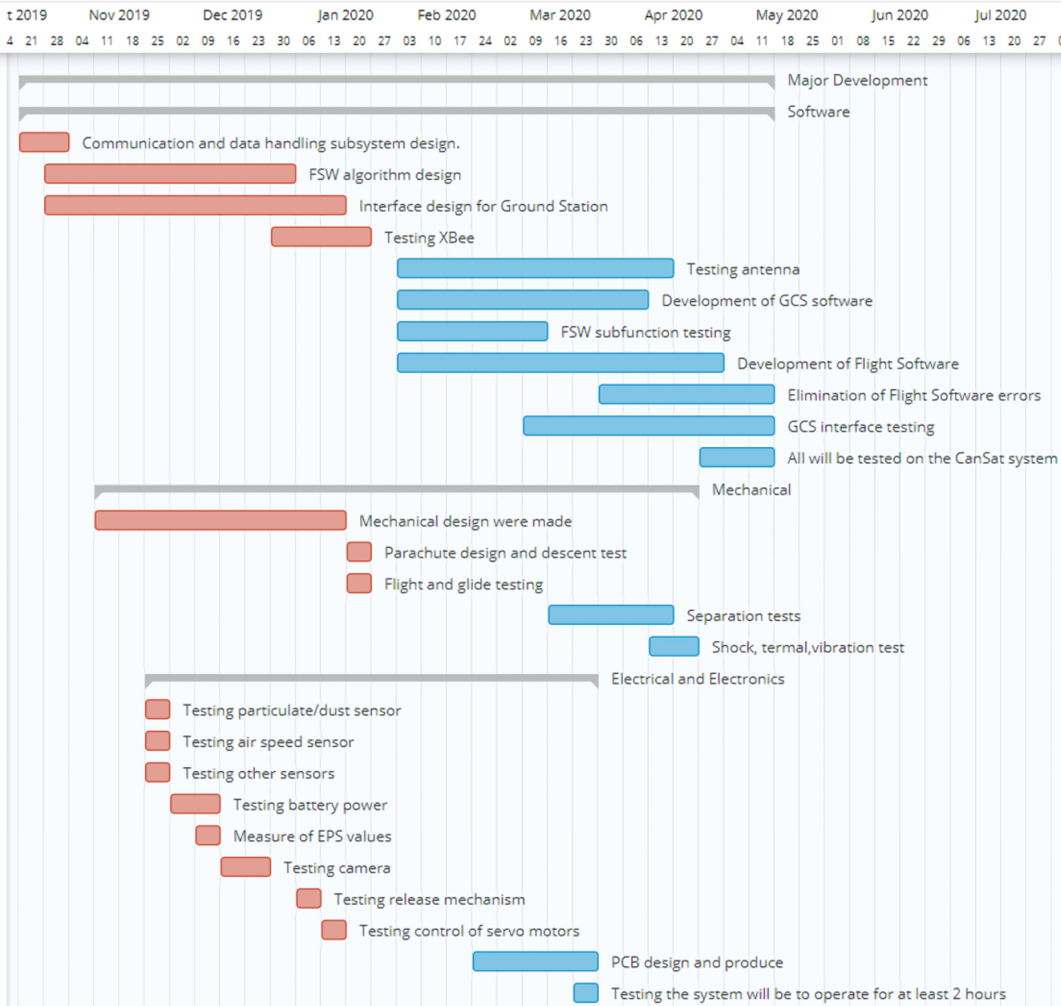
Incompleted Tasks

Holiday

We carried out competition milestones we planned before the PDR delivery on time.

Major Development

	ASSIGNEE	START	DUE	
Major Development	grizu-263	25/Oct	15/May	
Software	grizu-263	25/Oct	15/May	
Communication and data han...	software unit	25/Oct	03/Nov	su
FSW algorithm design	software unit	30/Oct	30/Dec	su
Interface design for Ground St...	software unit	01/Nov	16/Jan	su
Testing XBee	software unit	03/Jan	22/Jan	su
Testing antenna	software unit	05/Feb	14/Apr	su
Development of GCS software	software unit	03/Feb	10/Apr	su
FSW subfunction testing	software unit	03/Feb	12/Mar	su
Development of Flight Software	software unit	03/Feb	01/May	su
Elimination of Flight Software ...	software unit	30/Mar	13/May	su
GCS interface testing	software unit	13/Mar	14/May	su
All will be tested on the CanSa...	software unit	01/May	15/May	su
Mechanical	grizu-263	15/Nov	20/Apr	
Mechanical design were made	mechanical unit	15/Nov	15/Jan	mu
Parachute design and descent...	mechanical unit	21/Jan	23/Jan	mu
Flight and glide testing	mechanical unit	22/Jan	26/Jan	mu
Separation tests	mechanical unit	22/Mar	15/Apr	mu
Shock, termal,vibration test	mechanical unit	15/Apr	20/Apr	mu
Electrical and Electronics	grizu-263	25/Nov	27/Mar	
Testing particulate/dust sensor	electrical and ...	25/Nov	26/Nov	ea
Testing air speed sensor	electrical and ...	26/Nov	27/Nov	ea
Testing other sensors	electrical and ...	28/Nov	29/Nov	ea
Testing battery power	electrical and ...	07/Dec	09/Dec	ea
Measure of EPS values	electrical and ...	10/Dec	12/Dec	ea
Testing camera	electrical and ...	22/Dec	23/Dec	ea
Testing release mechanism	electrical and ...	06/Jan	07/Jan	ea
Testing control of servo motors	electrical and ...	13/Jan	15/Jan	ea
PCB design and produce	electrical and ...	01/Mar	25/Mar	ea
Testing the system will be to o...	electrical and ...	26/Mar	27/Mar	ea



Completed Tasks

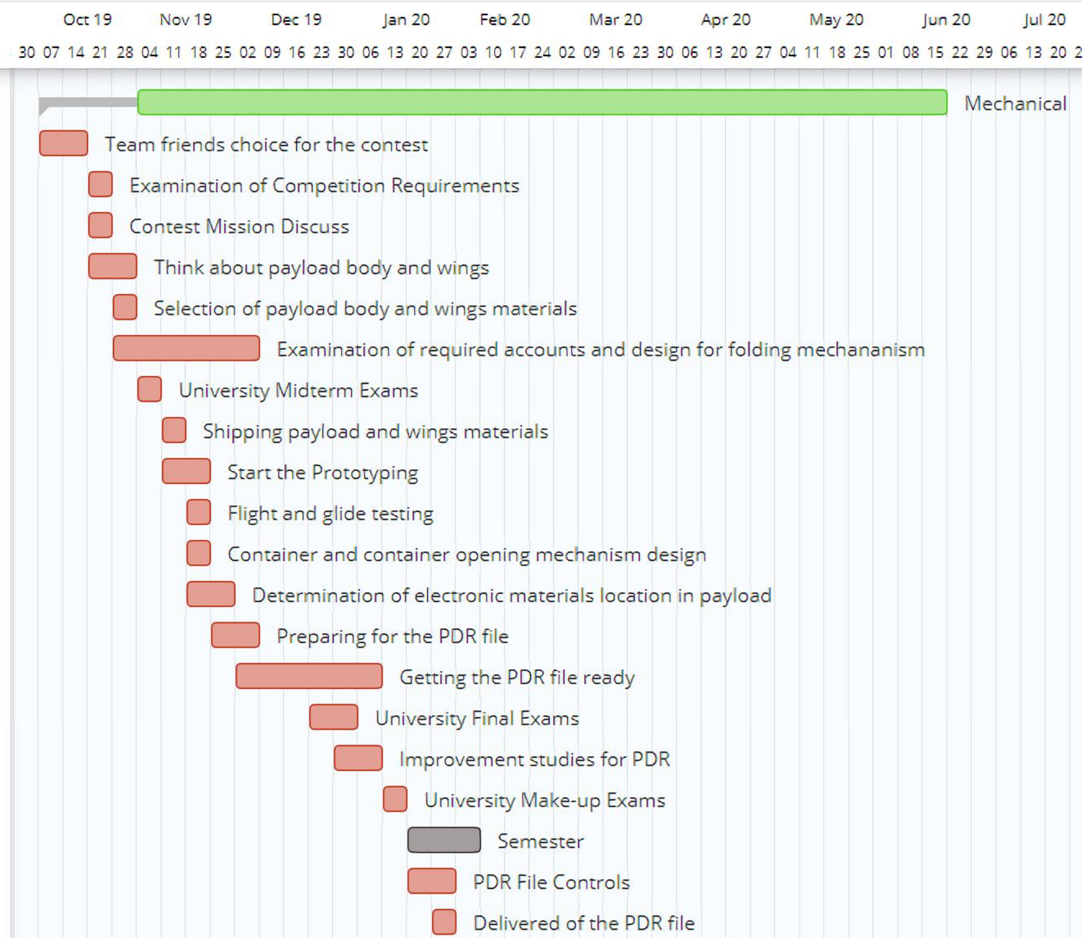
Incompleted Tasks

Holiday

Detailed Program Schedule (2 of 9)

Mechanic

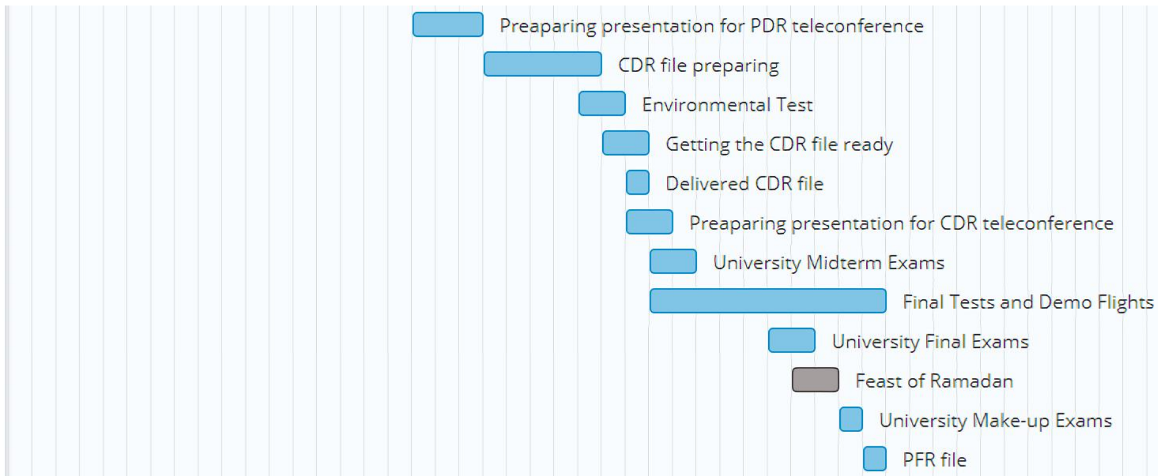
	ASSIGNEE	START	DUE	
Mechanical	mechanical unit	10/Oct	15/Jun	mu
Team friends choice for the contest	All team	10/Oct	14/Oct	At
Examination of Competition Requi...	All team	21/Oct	22/Oct	At
Contest Mission Discuss	All team	23/Oct	24/Oct	At
Think about payload body and wi...	mechanical unit	25/Oct	28/Oct	mu
Selection of payload body and win...	ömer öz	29/Oct	29/Oct	öö
Examination of required accounts ...	mechanical unit	30/Oct	02/Dec	mu
University Midterm Exams	All team	04/Nov	10/Nov	At
Shipping payload and wings mate...	turab tepebaşı	11/Nov	14/Nov	tt
Start the Prototyping	mechanical unit	15/Nov	18/Nov	mu
Flight and glide testing	mechanical unit	19/Nov	20/Nov	mu
Container and container opening ...	sedef nur altay	21/Nov	23/Nov	sn
Determination of electronic mater...	mechanical unit	24/Nov	26/Nov	mu
Preparing for the PDR file	All team	27/Nov	05/Dec	At
Getting the PDR file ready	All team	05/Dec	12/Jan	At
University Final Exams	All team	23/Dec	03/Jan	At
Improvement studies for PDR	All team	03/Jan	12/Jan	At
University Make-up Exams	All team	13/Jan	19/Jan	At
Semester	All team	20/Jan	03/Feb	At
PDR File Controls	All team	23/Jan	29/Jan	At
Delivered of the PDR file	All team	31/Jan	31/Jan	At



Completed Tasks | Incompleted Tasks | Holiday | Pre-PDR

Mechanic

Preaparing presentation for PDR t...	All team	02/Feb	15/Feb	At
CDR file preparing	All team	20/Feb	20/Mar	At
Environmental Test	mechanical unit	22/Mar	24/Mar	mu
Getting the CDR file ready	All team	25/Mar	02/Apr	At
Delivered CDR file	All team	03/Apr	03/Apr	At
Preaparing presentation for CDR t...	All team	02/Apr	12/Apr	At
University Midterm Exams	All team	06/Apr	13/Apr	At
Final Tests and Demo Flights	All team	12/Apr	08/Jun	At
University Final Exams	All team	11/May	22/May	At
Feast of Ramadan	All team	24/May	26/May	At
University Make-up Exams	All team	01/Jun	07/Jun	At
PFR file	All team	14/Jun	14/Jun	At

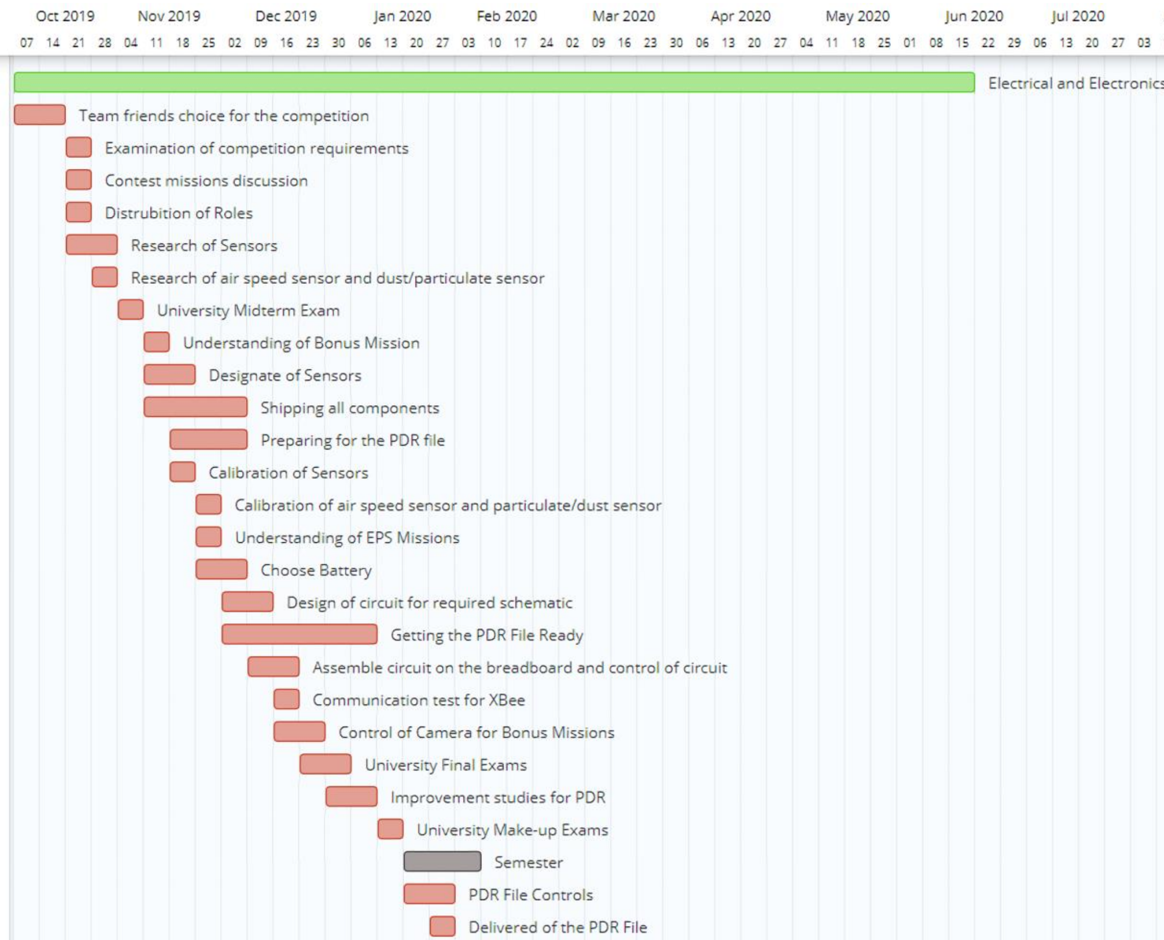


Completed Tasks   Incompleted Tasks   Holiday   Post-PDR

Detailed Program Schedule (4 of 9)

Electrical and Electronics

	ASSIGNEE	START	DUE	
Electrical and Electronics	electrical and ...	10/Oct	15/Jun	ea
Team friends choice for the comp...	All team	10/Oct	14/Oct	At
Examination of competition requir...	All team	21/Oct	22/Oct	At
Contest missions discussion	All team	23/Oct	24/Oct	At
Distrubition of Roles	electrical and ...	24/Oct	25/Oct	ea
Research of Sensors	zeynep söder	26/Oct	29/Oct	zs
Research of air speed sensor and ...	zeynep söder	30/Oct	03/Nov	zs
University Midterm Exam	All team	04/Nov	10/Nov	At
Understanding of Bonus Mission	electrical and ...	11/Nov	14/Nov	ea
Designate of Sensors	hüseyin sertka...	15/Nov	20/Nov	hs
Shipping all components	zeynep söder	15/Nov	05/Dec	zs
Preparing for the PDR file	All team	20/Nov	05/Dec	At
Calibration of Sensors	sedef özel	21/Nov	24/Nov	sö
Calibration of air speed sensor an...	zeynep söder	25/Nov	27/Nov	zs
Understanding of EPS Missions	electrical and ...	28/Nov	30/Nov	ea
Choose Battery	sedef özel	01/Dec	03/Dec	sö
Design of circuit for required sche...	electrical and ...	04/Dec	11/Dec	ea
Getting the PDR File Ready	All team	05/Dec	12/Jan	At
Assemble circuit on the breadboa...	electrical and ...	13/Dec	18/Dec	ea
Communication test for XBee	electrical and ...	17/Dec	22/Dec	ea
Control of Camera for Bonus Missi...	electrical and ...	22/Dec	23/Dec	ea
University Final Exams	All team	23/Dec	03/Jan	At
Improvement studies for PDR	All team	03/Jan	12/Jan	At
University Make-up Exams	All team	13/Jan	19/Jan	At
Semester	All team	20/Jan	03/Feb	At
PDR File Controls	All team	21/Jan	29/Jan	At
Delivered of the PDR File	All team	31/Jan	31/Jan	At

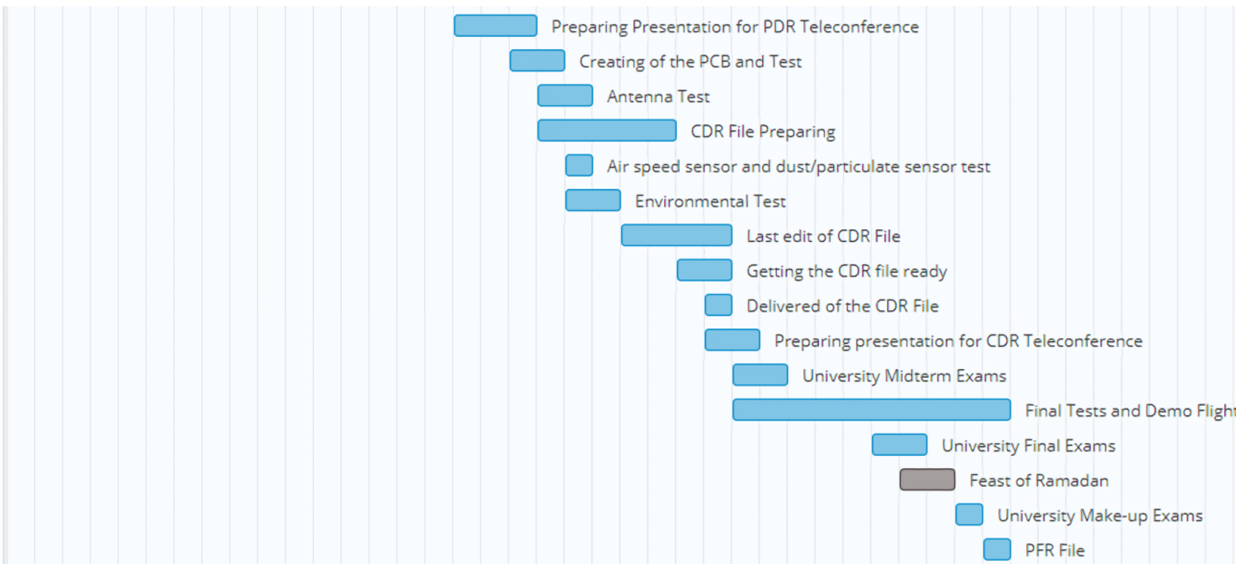


Completed Tasks   Incompleted Tasks   Holiday   Pre-PDR

Detailed Program Schedule (5 of 9)

Electrical and Electronics

Preparing Presentation for PDR Te...	All team	02/Feb	15/Feb	At
Creating of the PCB and Test	electrical and ...	10/Feb	20/Feb	ea
Antenna Test	electrical and ...	21/Feb	24/Feb	ea
CDR File Preparing	All team	20/Feb	20/Mar	At
Air speed sensor and dust/particul...	electrical and ...	26/Feb	29/Feb	ea
Environmental Test	electrical and ...	01/Mar	08/Mar	ea
Last edit of CDR File	All team	09/Mar	02/Apr	At
Getting the CDR file ready	All team	25/Mar	02/Apr	At
Delivered of the CDR File	All team	03/Apr	03/Apr	At
Preparing presentation for CDR Te...	All team	02/Apr	12/Apr	At
University Midterm Exams	All team	06/Apr	13/Apr	At
Final Tests and Demo Flights	All team	12/Apr	08/Jun	At
University Final Exams	All team	11/May	22/May	At
Feast of Ramadan	All team	24/May	26/May	At
University Make-up Exams	All team	01/Jun	07/Jun	At
PFR File	All team	14/Jun	14/Jun	At

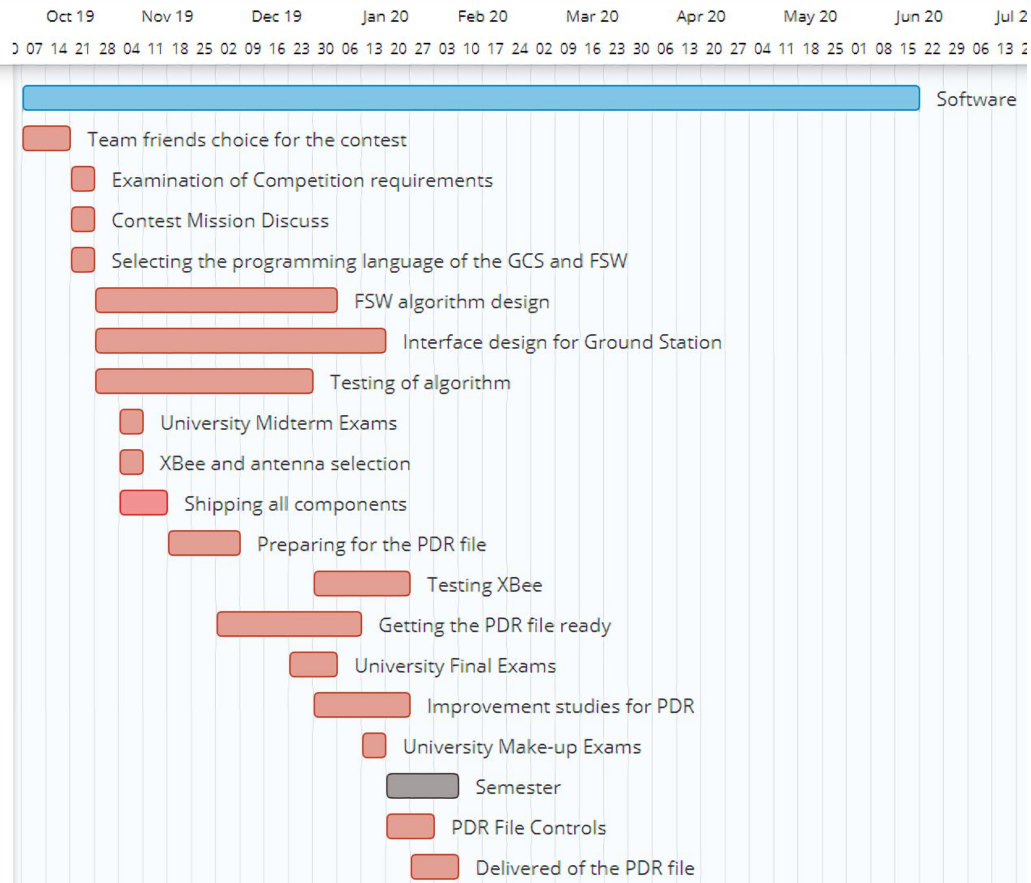


Completed Tasks Incompleted Tasks Holiday Post-PDR

Detailed Program Schedule (6 of 9)

Software

Task	ASSIGNEE	START	DUE	
Software	software unit	10/Oct	15/Jun	su
Team friends choice for the contest	All team	10/Oct	14/Oct	At
Examination of Competition requi...	All team	21/Oct	22/Oct	At
Contest Mission Discuss	All team	23/Oct	24/Oct	At
Selecting the programming langua...	süleyman ariş	25/Oct	27/Oct	sa
FSW algorithm design	osman serinkan	30/Oct	30/Dec	os
Interface design for Ground Station	süleyman ariş	01/Nov	16/Jan	sa
Testing of algorithm	software unit	01/Nov	26/Dec	su
University Midterm Exams	All team	04/Nov	10/Nov	At
XBee and antenna selection	süleyman ariş	05/Nov	10/Nov	sa
Shipping all components	osman serinkan	10/Nov	17/Nov	os
Preparing for the PDR file	All team	20/Nov	05/Dec	At
Testing XBee	software unit	03/Jan	22/Jan	su
Getting the PDR file ready	All team	05/Dec	12/Jan	At
University Final Exams	All team	23/Dec	03/Jan	At
Improvement studies for PDR	All team	03/Jan	22/Jan	At
University Make-up Exams	All team	17/Jan	17/Jan	At
Semester	All team	20/Jan	03/Feb	At
PDR File Controls	All team	23/Jan	29/Jan	At
Delivered of the PDR file	All team	31/Jan	03/Feb	At



Completed Tasks | Incompleted Tasks | Holiday | Pre-PDR

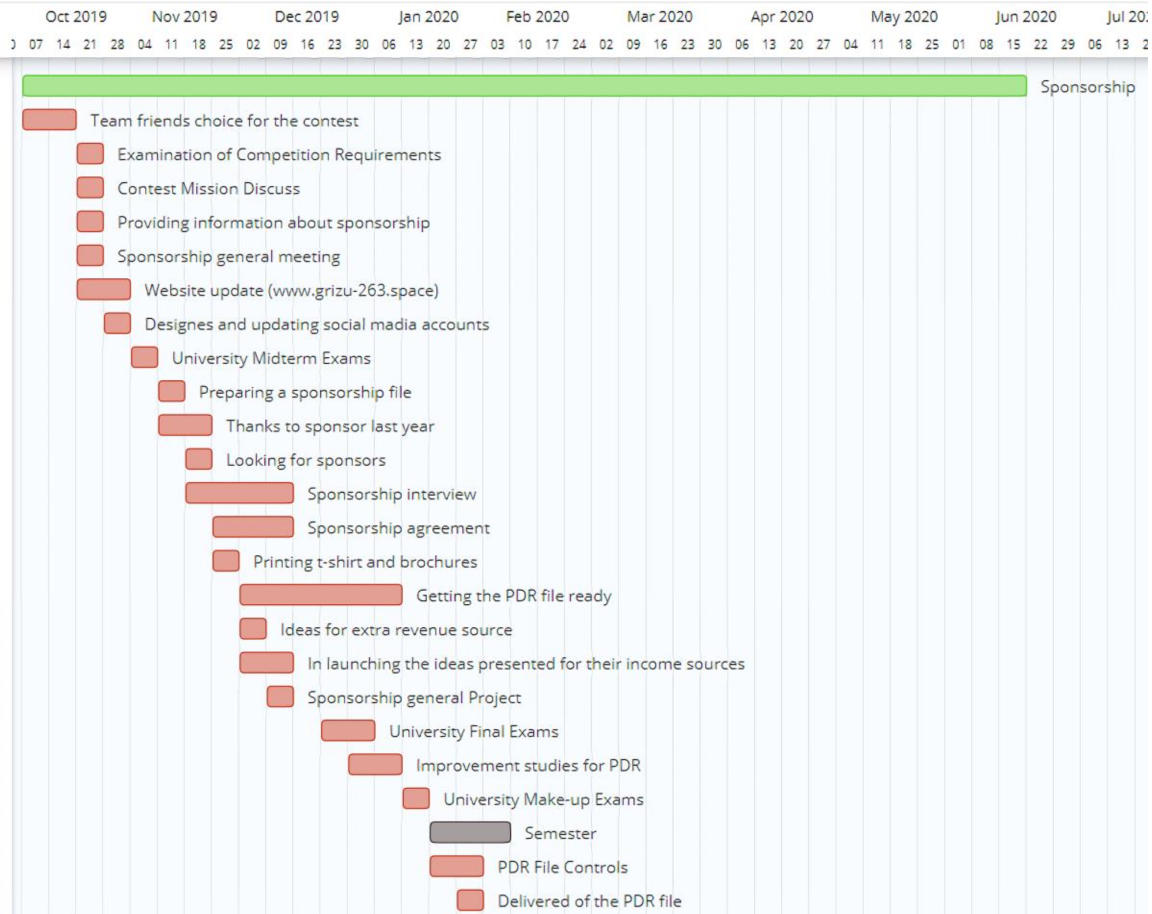
Software

Preaparing presentation for PDR t...	All team	02/Feb	15/Feb	At
Development of GCS software	osman serinkan	03/Feb	10/Apr	os
FSW subfunction testing	software unit	03/Feb	12/Mar	su
Development of Flight Software	süleyman ariş	03/Feb	01/May	sa
Testing Antennas	software unit	05/Feb	14/Apr	su
CDR file preparing	All team	20/Feb	20/Mar	At
Getting the CDR file ready	All team	25/Mar	02/Apr	At
Delivered CDR file	All team	03/Apr	03/Apr	At
Preaparing presentation for CDR t...	All team	02/Apr	12/Apr	At
University Midterm Exams	All team	06/Apr	13/Apr	At
Final Tests and Demo Flights	All team	12/Apr	08/Jun	At
Elimination of Flight Software errors	software unit	30/Mar	13/May	su
GCS interface testing	software unit	13/Mar	14/May	su
University Final Exams	All team	11/May	22/May	At
Testing the general CanSat system...	software unit	14/May	20/May	su
General CanSat system testing for...	software unit	22/May	24/May	su
Feast of Ramadan	All team	24/May	26/May	At
University Make-up Exams	All team	01/Jun	07/Jun	At
PFR file	All team	14/Jun	14/Jun	At

Completed Tasks | Incompleted Tasks | Holiday | Post-PDR

Sponsorship

	ASSIGNEE	START	DUE	
Sponsorship	sponsorship u...	10/Oct	15/Jun	su
Team friends choice for the contest	All team	10/Oct	14/Oct	At
Examination of Competition Requi...	All team	21/Oct	22/Oct	At
Contest Mission Discuss	All team	23/Oct	24/Oct	At
Providing information about spon...	sponsorship u...	25/Oct	26/Oct	su
Sponsorship general meeting	sponsorship u...	26/Oct	26/Oct	su
Website update (www.grizu-263.s...	nevin maside tüt	27/Oct	29/Oct	nm
Designes and updating social mad...	nevin maside tüt	30/Oct	02/Nov	nm
University Midterm Exams	All team	04/Nov	10/Nov	At
Preparing a sponsorship file	nevin maside tüt	11/Nov	16/Nov	nm
Thanks to sponsor last year	sponsorship u...	17/Nov	19/Nov	su
Looking for sponsors	sponsorship u...	19/Nov	21/Nov	su
Sponsorship interview	sponsorship u...	22/Nov	10/Dec	su
Sponsorship agreement	sponsorship u...	25/Nov	10/Dec	su
Printing t-shirt and brochures	sponsorship u...	26/Nov	28/Nov	su
Getting the PDR file ready	All team	05/Dec	12/Jan	At
Ideas for extra revenue source	sponsorship u...	06/Dec	07/Dec	su
In launching the ideas presented f...	sponsorship u...	08/Dec	10/Dec	su
Sponsorship general Project	sponsorship u...	11/Dec	11/Dec	su
University Final Exams	All team	23/Dec	03/Jan	At
Improvement studies for PDR	All team	03/Jan	12/Jan	At
University Make-up Exams	All team	13/Jan	19/Jan	At
Semester	All team	20/Jan	03/Feb	At
PDR File Controls	All team	23/Jan	29/Jan	At
Delivered of the PDR file	All team	31/Jan	31/Jan	At

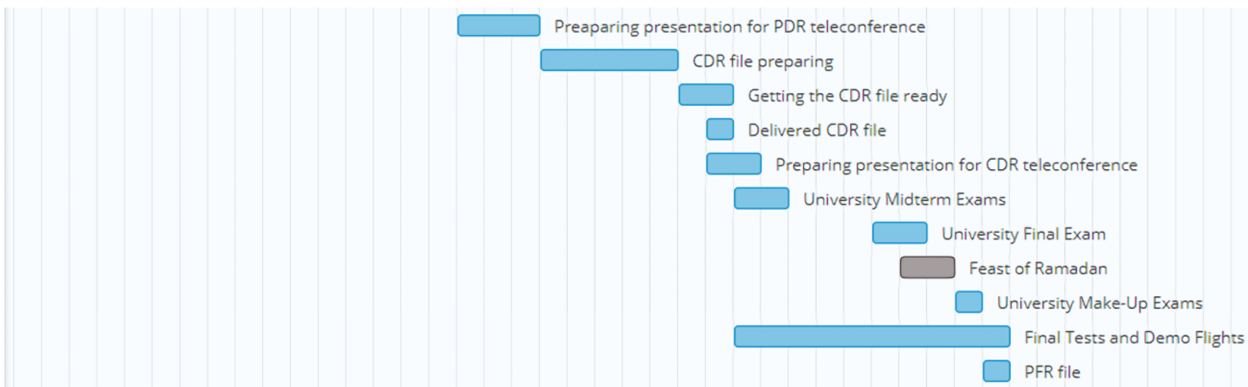


Completed Tasks | Incompleted Tasks | Holiday | Pre-PDR

Detailed Program Schedule (9 of 9)

Sponsorship

Preaparing presentation for PDR t...	All team	02/Feb	15/Feb	At
CDR file preparing	All team	20/Feb	20/Mar	At
Getting the CDR file ready	All team	25/Mar	02/Apr	At
Delivered CDR file	All team	03/Apr	03/Apr	At
Preparing presentation for CDR te...	All team	02/Apr	12/Apr	At
University Midterm Exams	All team	06/Apr	13/Apr	At
University Final Exam	All team	11/May	22/May	At
Feast of Ramadan	All team	24/May	26/May	At
University Make-Up Exams	All team	01/Jun	07/Jun	At
Final Tests and Demo Flights	All team	12/Apr	08/Jun	At
PFR file	All team	14/Jun	14/Jun	At



Completed Tasks Incompleted Tasks Holiday Post-PDR

Conclusions (1 of 3)

ACCOMPLISHMENTS:

- Different delta wing types were tested.
- Mechanical design was completed.
- Descent control calculations were done.
- Material selection was made.
- The parachute speed test of the container and payload was performed.
- All sensors including dust/particulate and air speed sensors determined, procured and tested.
- The interface design was completed for the ground station.
- Flight software algorithm was completed.
- XBee and antenna were selected.
- XBee communication test was completed.
- The rudder and elevator servo motors were tested.
- The voltages of the selected batteries were checked.

UNFINISHED WORKS:

- The container and payload separation mechanism will be tested.
- The selected antenna will be tested.
- The GCS software will be developed.
- The flight software will be developed.
- The FSW and GCS software errors will be detected and fixed.
- The PCB circuit will be designed.

Conclusions (2 of 3)

Why you are ready to proceed to next stage of development?

•The Preliminary Design Phase is completed for mechanical, software, and electronic systems.

•We have carried out all the tasks in a planned way according to the requirements of the competition.

•We have already planned the environmental tests.

•We have already planned and tested all system components of the CanSat.

•The CanSat's production, our transportation and accommodation expenses are ready to be covered by the sponsors (such as ERDEMİR Company) and Zonguldak Bülent Ecevit University.

•We are confident in transforming the prototype into a product with the experience we gained from the past years.

We carried out all the tasks and competition milestones we planned before the PDR file delivery on time.

Conclusions (3 of 3)