CanSat 2018
Critical Design Review (CDR)
Outline
Version 1.0

Team # 3944

grizu-263

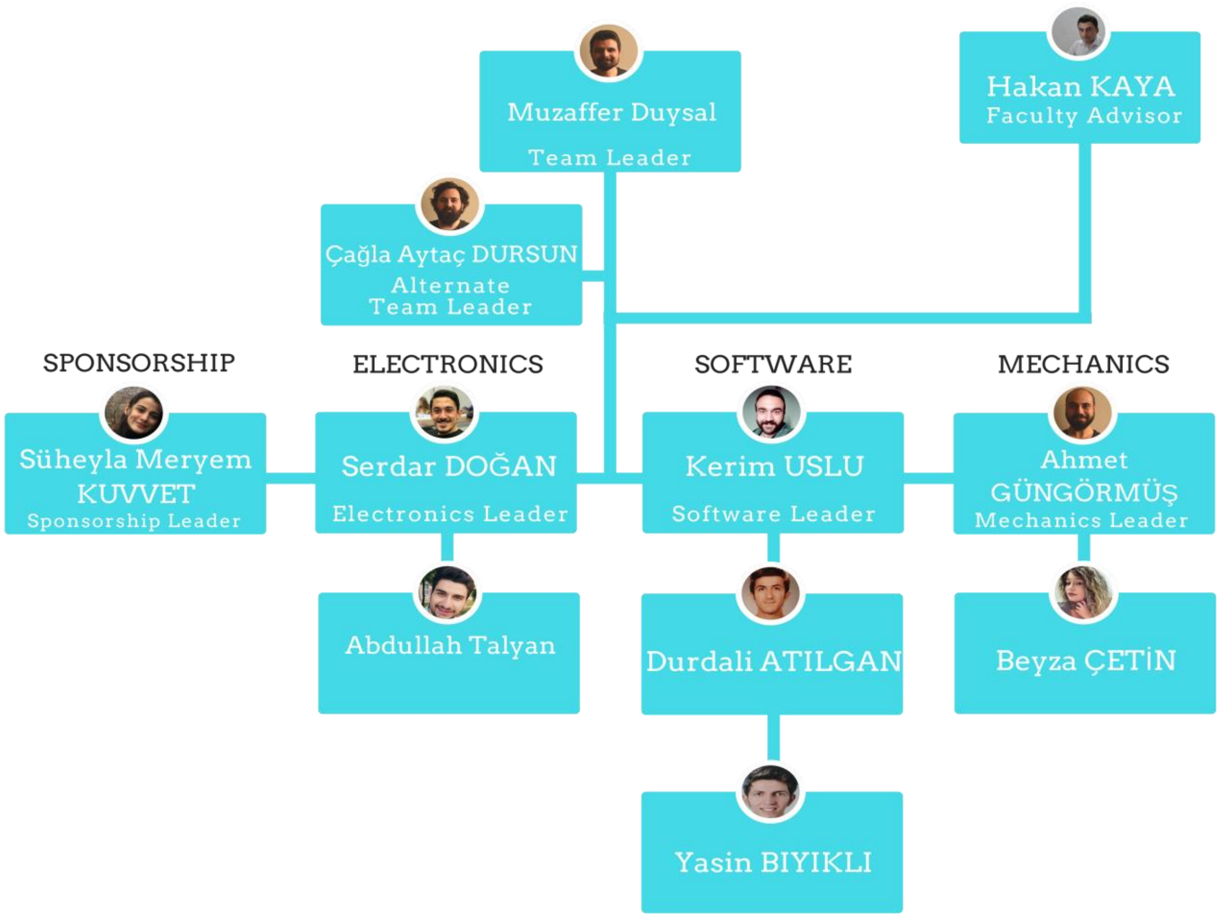
Presentation Outline

- **Systems Overview –** Muzaffer DUYSAL
- **Sensor Subsystem Design –** Beyza CETIN
- **Descent Control Design –** Ahmet GUNGORMUS
- **Mechanical Subsystem Design –** Serdar DOGAN
- **CDH Subsystem Design –** Durdali ATILGAN
- **Electrical Power Subsystem Design –** Serdar DOGAN
- **Flight Software Design –** Kerim USLU
- **Ground Control System Design –** Durdali ATILGAN
- **CanSat Integration and Test –** Abdullah TALYAN
- **Mission Operations and Analysis –** Yasin BIYIKLI
- **Requirements Compliance –** Yasin BIYIKLI
- **Management –** Süheyla Meryem KUVVET

Team Organization

Name	Year	Department
Muzaffer DUYSAL	Senior	Electrical-Electronics Engineering
Çağla Aytaç DURSUN	Senior	Metallurgical and Materials Engineering
Ahmet GÜNGÖRMÜŞ	Senior	Mechanical Engineering
Serdar DOĞAN	Senior	Mechanical Engineering
Durdali ATILGAN	Sophomore	Electrical-Electronics Engineering
Kerim USLU	Junior	Electrical-Electronics Engineering
Abdullah TALYAN	Senior	Electrical-Electronics Engineering
Beyza ÇETİN	Sophomore	Mechanical Engineering
Yasin BIYIKLI	Junior	Electrical-Electronics Engineering
Süheyla Meryem Kuvvet	Freshman	Civil Engineering

Team Organization



Acronyms (1 of 3)

- **A –** Analysis
- **ABS –** Acrylonitrile butadiene styrene
- **CDH –** Communication and Data Handling
- **D –** Demonstration
- **DCS –** Descent Control System
- **EPS –** Electrical Power Subsystem
- **EPSR-**Electrical Power Subsystem Requirement
- **FSW –** Flight Software
- **GCS –** Ground Control System
- **GS –** Ground station
- **I –** Inspection
- **PCB –** Print Circuit Board
- **T –** Test
- **VM –** Verification Method
- **RTC –** Real Time Clock
- **SPI –** Serial Peripheral Interface
- **GPS** – Global Positioning System
- **REQ** – Requirement
- **SS –** Sensor Subsystem
- **SSR-** Sensor Subsystem Requirement
- **CONOPS** – Concept of Operations
- **EEPROM** – Electrically Erasable Programmable Read Only Memory
- **I2C** – Inter – Integrated Circuit
- **MCU** – Microcontroller Unit

Acronyms (2 of 3)

- **PC –** Personal Computer
- **RAM –** Random Access Memory
- **USB –** Universal Serial Bus
- **GUI –** Graphical User Interface
- **LED –** Light Emitting Diode
- **LDR –** Light Dependent Resistor
- **RN –** Requirement Number
- **SRN –** Subsystem Requirement Number
- **ADC –** Analogue to Digital Converter
- **DC –** Direct Current
- **IMU** – Inertial Measurement Unit
- **g**- Gram
- **V**- Voltage
- **hPa**- Hectopascal
- **FPS**- Frame Per Second
- **VGA**- Video Graphics Array
- **UXGA**- Ultra eXtended Graphics Array

Acronyms (3 of 3)

- **SD -** Secure Digital
- **UART -** Universal Asynchronous Receiver/ Transmitter
- **Hz** - Hertz
- **PWN -** Power On
- **R -** Revision
- **GPIO -** General Purpose Input Output
- **SOIC -** Small Outline Integrated Circuit
- **IDE** Integrated Development Environment
- **RP-SMA -** Reverse Polarity SubMiniature version A
- **.CSV -** comma-separated values
- **GPL -** General Public License
- **ABHS –** Aero Breaking Head Shield
- **ASCII-** American Standard Code for Information Interchange
- **Pro -** Professional
- **I/O –** Input/Output
- **XCTU -** Next Generation Configuration Platform for XBee/RF Solutions
- **Id - -**Identification

The purpose of this section is to introduce the reviewer to the overall requirements and configuration of the CanSat. This provides a basis for the details presented in the subsystem sections.

Systems Overview

Muzaffer DUYSAL

Mission Summary

Mission

The CanSat shall consist of the probe containing the electronics and egg and a detachable heat shield.

Mission Objectives

- CanSat is composed of two parts: A heat shield and a probe.
- Heat shield protects the probe, which performs the desired mission.
- The launched CanSat will leave the rocket when the rocket arrives at 670 meters between 725 meters.
- The heat shield will be opened after the CanSat leaves the rocket
- Cansat (Heat shield and Probe) will fall push toward ground rapidly 10-30 m/s
- Heat shield must open towards the direction of descent. Tumble is not allowed.
- Stability will be verified with a tilt sensor.
- Probe and Heat shield will be separated at 300 meters.
- Probe descent rate of 5 meters/sec with parachute.
- Probe will fall with the egg.
- Probe will collect air pressure and external temperature data.
- Battery voltage, GPS position and a tilt sensor for stability verification during descent.
- While the probe is landing, the audio beacon will start singing**.**

Bonus Objective

- A camera with a minimum resolution of 640x480 should be used to take photos of the ground.
- Add a color video camera to capture the release of the heat shield and the ground during the last 300 meters of descent.
- The camera must be activated at 300 meters.

External Objective

- We have our own website(www.grizu-263.space)
- We have social media accounts such as instagram, facebook, twitter, linkedin, and patreon.
- This year our goal is to rank among the top five.

Summary of Changes Since PDR

Mechanical

- Heat shield and Probe structural material have been changed with fiberglass instead of carbonfiber.
- Heat shield recovery design was made.

Electrical and Software

- Minor changes were made fixes on algorithm has been updated.
- Changed to Voltage regulator
- Changed to GCS hand antenna and probe antenna

System Requirement Summary (1 of 4)

Requirement Number	Requirement	Rationale	Priority	VM			
				A	I	T	D
RN#1	Total mass of the CanSat (probe) shall be 500 grams +/- 10 grams.	Competition Requirement	HIGH	√	√		√
RN#2	The aero-braking heat shield shall be used to protect the probe while in the rocket only and when deployed from the rocket. It shall envelope/shield the whole sides of the probe when in the stowed configuration in the rocket. The rear end of the probe can be opened.	Competition Requirement	HIGH	√	√		√
RN#3	The heat shield must not have any openings.	Competition Requirement	MEDIUM	√	√		√
RN#4	The probe must maintain its heat shield orientation in the direction of descent.	Competition Requirement	HIGH	√	√	√	
RN#5	The probe shall not tumble during any portion of descent. Tumbling is rotating end-over-end.	Competition Requirement	HIGH	√	√	√	
RN#6	The probe with the aero-braking heat shield 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	√	√		√

System Requirement Summary (2 of 4)

Requirement Number	Requirement	Rationale	Priority	VM			
				A	I	T	D
RN#7	The probe shall hold a large hen's egg and protect it from damage from launch until landing.	Competition Requirement	HIGH	√	√	√	√
RN#8	The probe shall accommodate a large hen's egg with a mass ranging from 54 grams to 68 grams and a diameter of up to 50mm and length up to 70mm.	Competition Requirement	MEDIUM	√	√	√	√
RN#9	The aero-braking heat shield shall not have any sharp edges to cause it to get stuck in the rocket payload section which is made of cardboard.	Competition Requirement	MEDIUM	√	√		
RN#10	The aero-braking heat shield shall be a florescent color; pink or orange.	Competition Requirement	MEDIUM	√	√		
RN#11	The rocket airframe shall not be used to restrain any deployable parts of the CanSat.	Competition Requirement	MEDIUM	√	√		
RN#12	The rocket airframe shall not be used as part of the CanSat operations.	Competition Requirement	LOW	√	√		
RN#13	The CanSat, probe with heat shield attached shall deploy from the rocket payload section.	Competition Requirement	MEDIUM	√	√		

System Requirement Summary (3 of 4)

Requirement Number	Requirement	Rationale	Priority	VM			
				A	I	T	D
RN#21	All electronics shall be hard mounted using proper mounts such as standoffs, screws, or high performance adhesives.	Competition Requirement	HIGH	√	√		
RN#25	During descent, the probe shall collect air pressure, outside air temperature, GPS position and battery voltage once per second and time tag the data with mission time.	Competition Requirement	HIGH	√	√	√	√
RN#27	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#28	XBEE radios shall be used for telemetry. 2.4 GHz Series 1 and 2 radios are allowed. 900 MHz XBEE Pro radios are also allowed.	Competition Requirement	MEDIUM		√	√	√
RN#29	Cost of the CanSat shall be under $1000. Ground support and analysis tools are not included in the cost.	Competition Requirement	HIGH	√	√		√

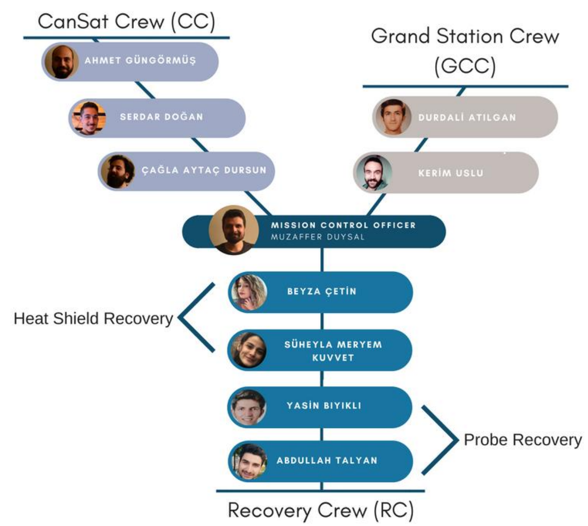
System Requirement Summary (4 of 4)

Requirement Number	Requirement	Rationale	Priority	VM			
				A	I	T	D
RN#32	Each team shall develop their own ground station.	Competition Requirement	MEDIUM		√	√	√
RN#35	Teams shall plot each telemetry data field in real time during flight.	Competition Requirement	HIGH	√	√	√	
RN#36	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#38	Both the heat shield and probe shall be labeled with team contact information including email address.	Competition Requirement	HIGH	√	√		√
RN#43	The descent rate of the probe with the heat shield deployed shall be between 10 and 30 meters/second.	Competition Requirement	HIGH	√	√		√
RN#44	The descent rate of the probe with the heat shield released and parachute deployed shall be 5 meters/second.	Competition Requirement	HIGH	√	√		√
RN#49	A tilt sensor shall be used to verify the stability of the probe during descent with the heat shield deployed and be part of the telemetry.	Competition Requirement	HIGH	√	√		

Pre-Launch Activities
Arrival at the launch site
Cansat assemble
Set up ground station

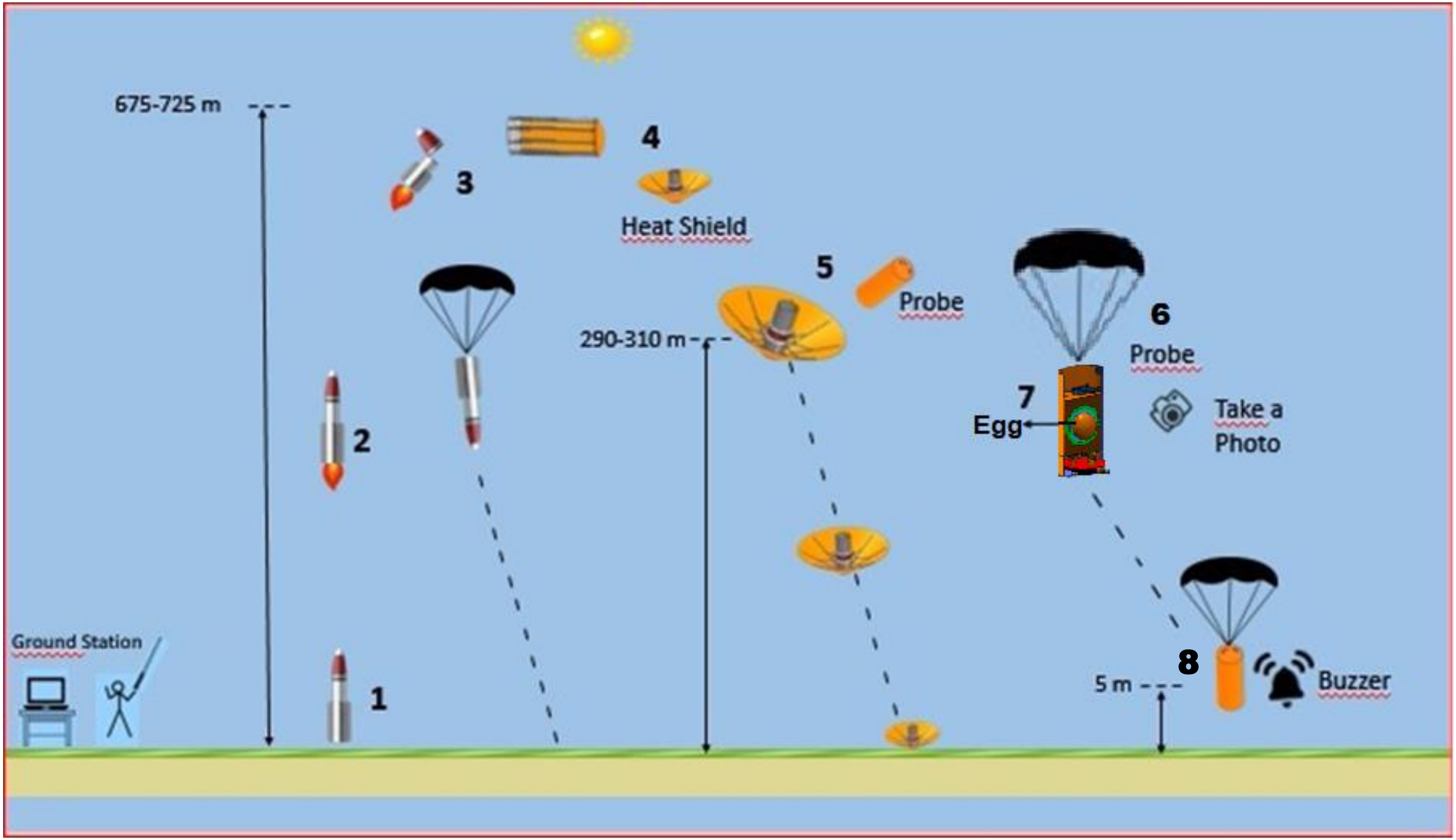
Launch day Activities
The Drop test
Verify communications with the Payload
Mechanisms will be reviewed
CanSats will be inspected for safety
All CanSats must pass the envelop test
Weight and fit check test
Placement of The CanSat into the rocket
Communication test with the CanSat
Place the rocket into the assigned launch pad
The team mission control officer execute launches flight procedures
After the flight, the SD card will be delivered to the judge

Team member roles and responsibilities



Mission Control Officer : Informs flight coordinator when the team and cansat are ready for the flight
Ground Station Crew : Those are responsible for monitoring the ground station for telemetry reception and sending commands to CanSat
Recovery Crew : People who are looking for Cansat in the competition area
CanSat Crew : Those who are preparing Cansat

System Concept of Operations



System Concept of Operations

- **Pre-Launch Test**

Egg protection and electronic systems enclose in probe → Mechanical system integrity checks → The software will be checked → Sensors will be tested.

- **Launch**

1. Cansat placed into the Rocket
2. Rocket Launch
3. Telemetry is starts to take data
4. Rocket and heat shield are leave at 700 meters
5. Sensors start to collect data
6. 700 to 300 meters drop to 10-30 m/s velocity
7. Heat shield and probe are leave at 300 meters
8. The probe drops down 300 meters at 5 m/s velocity. And parachute opens at 300 meters.
9. The ground station continues to receive data until the system lands on
10. The system will go down without tumble.
11. Telemetry stops and Audio beacon becomes activated.
12. The system will be found and the egg will be checked.

System Concept of Operations

- **Post-Launch**

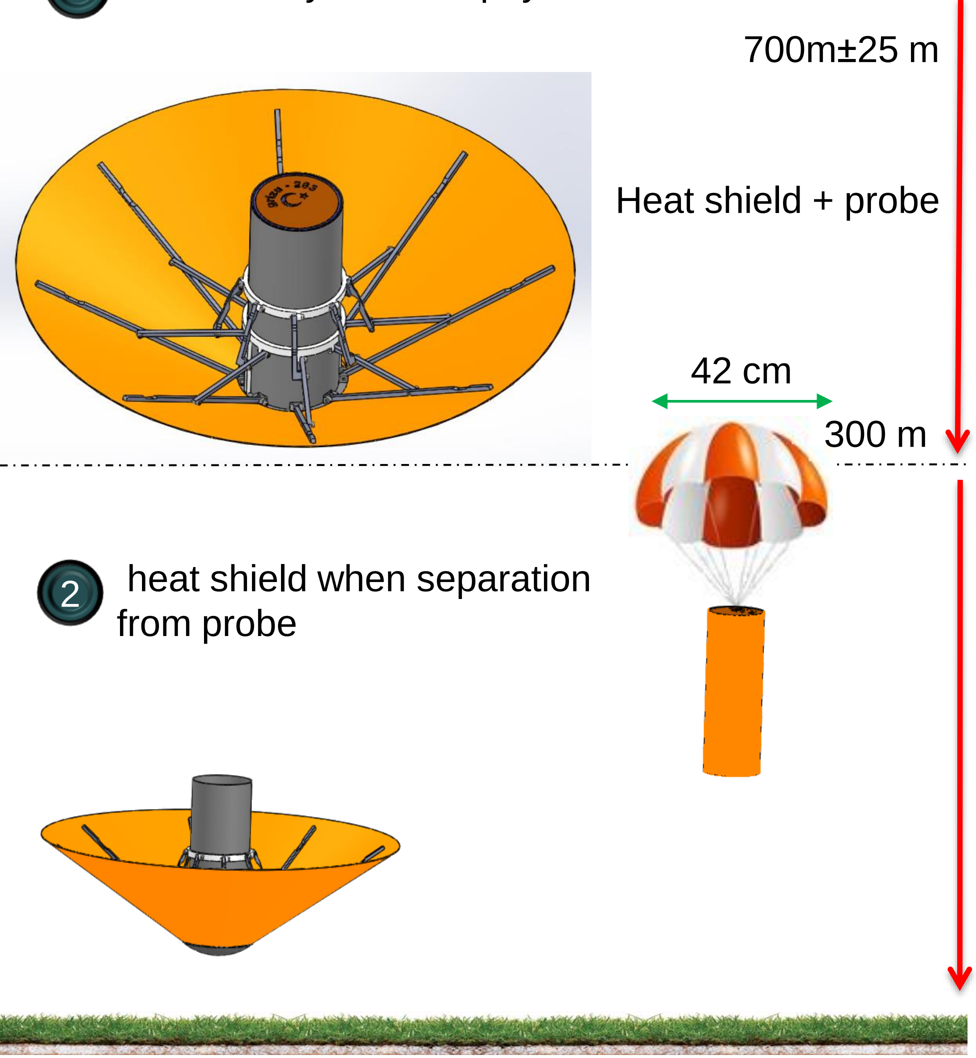
Analyzing received Data → Checking the Pictures → Preparation of PFR

Requirements for the Operation

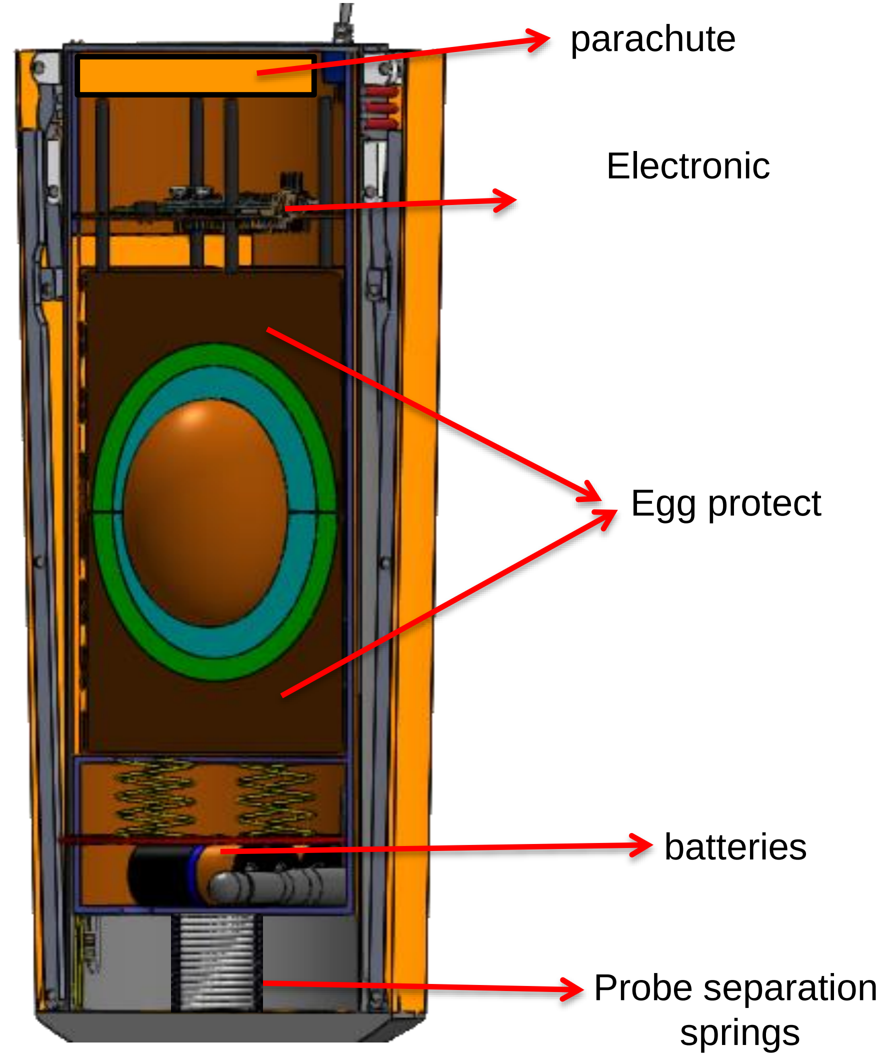
- Heat shield will leave the rocket and will be opened at 700 meters.
- It will drop from 700 to 300 meters at 10-30 m/s velocity.
- Heat shield and probe are leaving at 300 meters
- The probe will drop down 300 meters at 5 m/s velocity.
- And parachute will be opened at 300 meters.
- The system must go down without tumbling.
- Egg should not break
- All the sensors must be working throughout the flight.

Physical Layout

1 Immediately after the payload leaves of the rocket.

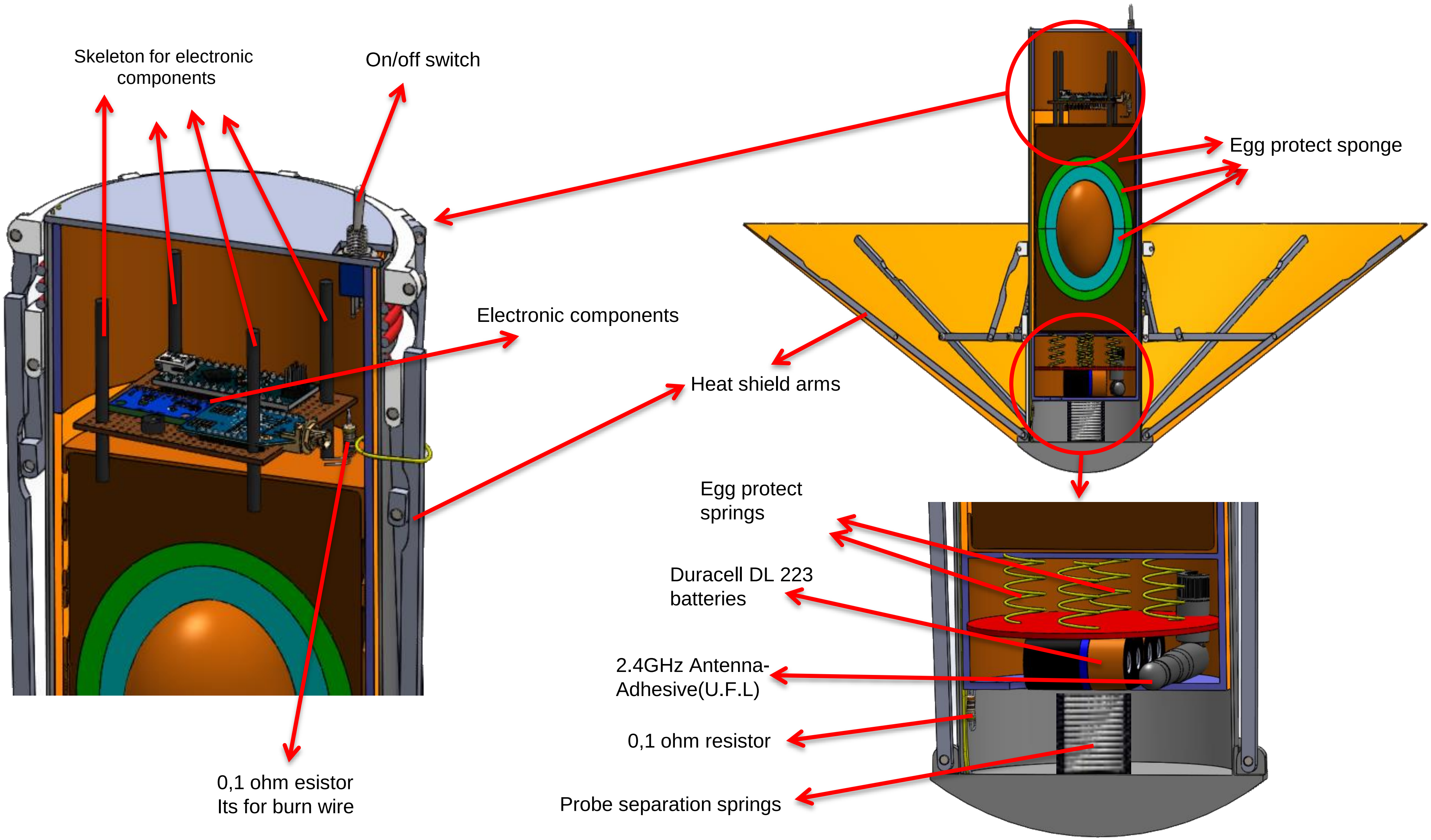


2 heat shield when separation from probe



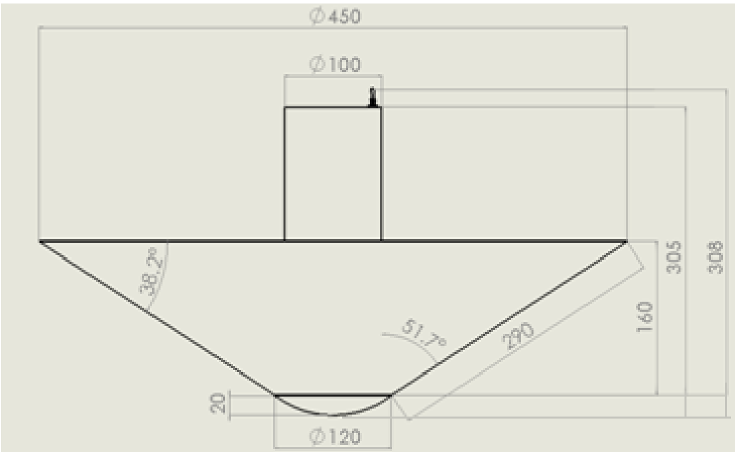
Heat shield + Probe

Physical Layout

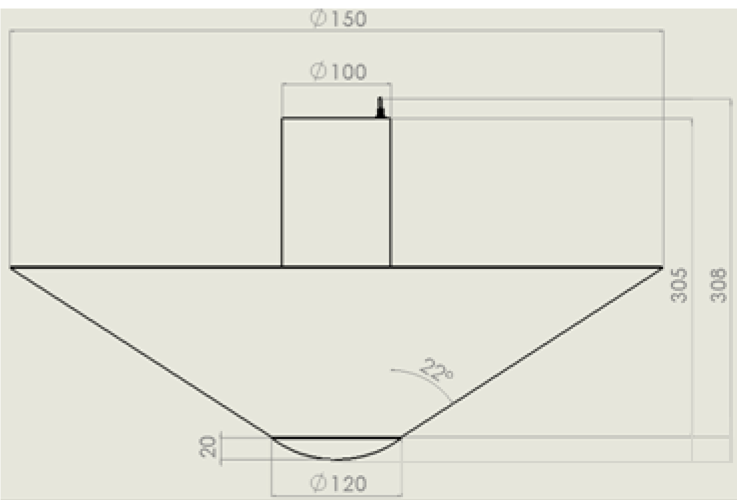


Physical Layout

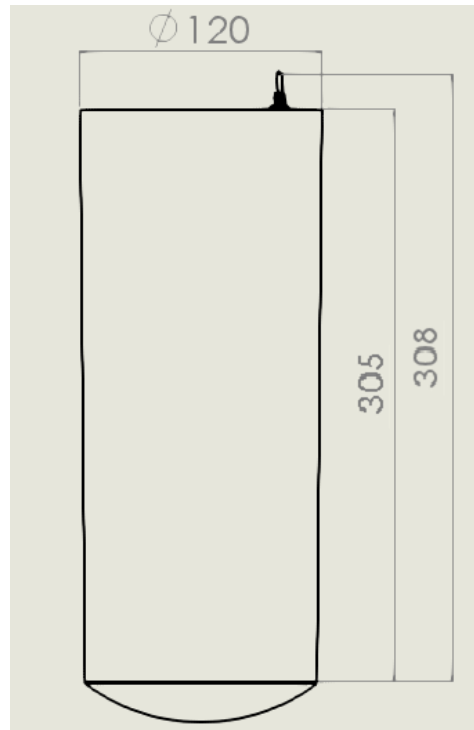
This for 10 m/s



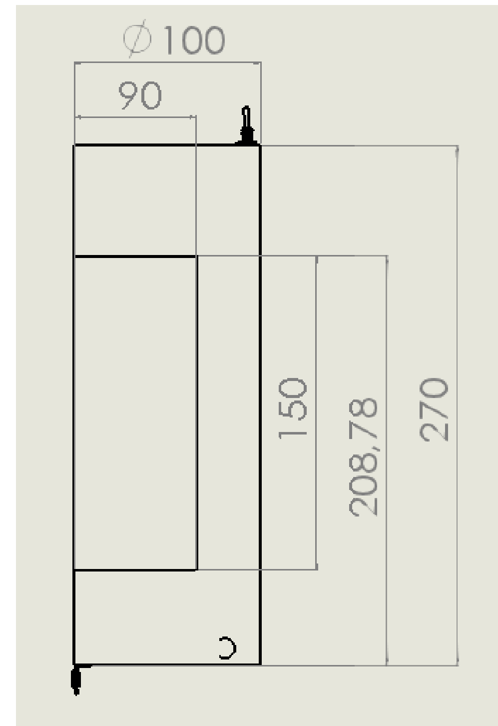
This for 30 m/s



- Pictures have been drawn with CAD program
- All measures are in millimeters
- All angles are in degree



Heat shield dimensions
(Arms are close)



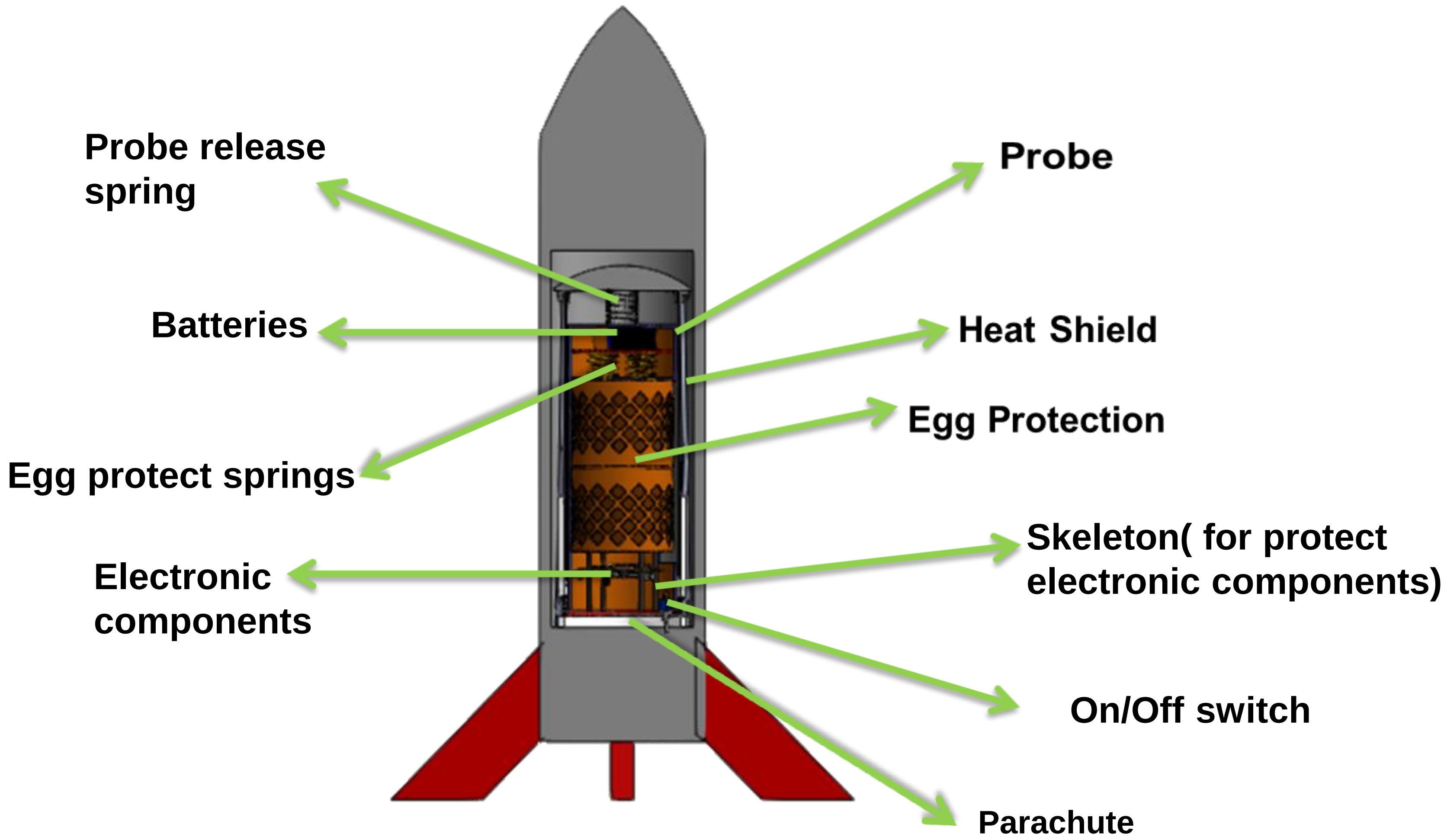
Probe’s dimensions

Launch Vehicle Compatibility

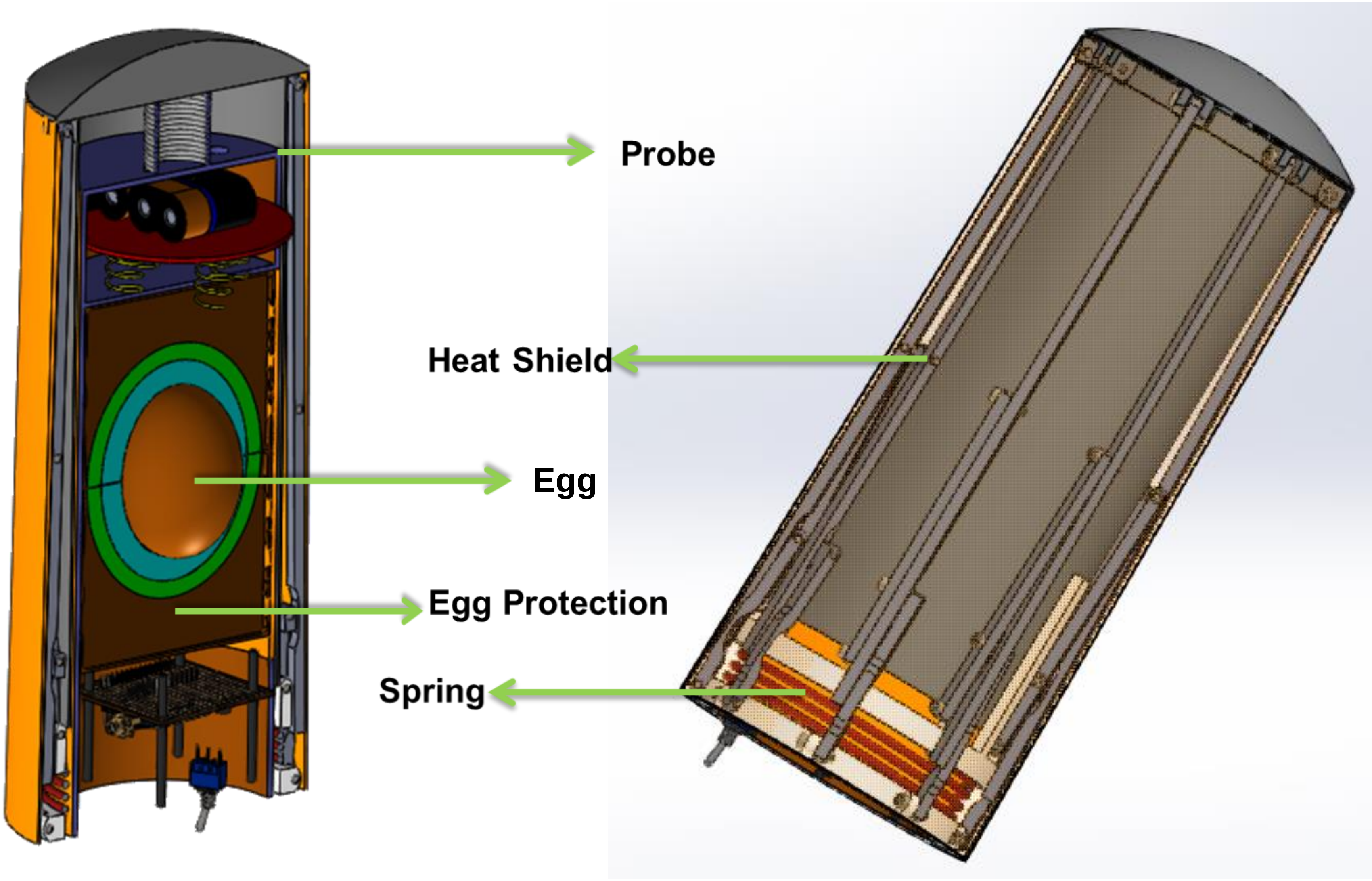
- Probe has heat shield, electronics system, egg, egg protect container and mechanical system.
- The electronic circuits are placed in the probe’s body.
- Margins of 2 mm is given for width and 2 mm for height.

Dimensions[mm]	Height (mm)	Diameter (mm)
Section		
Heat Shield & Probe	308	123
Rocket Payload	310	125

Launch Vehicle Compatibility

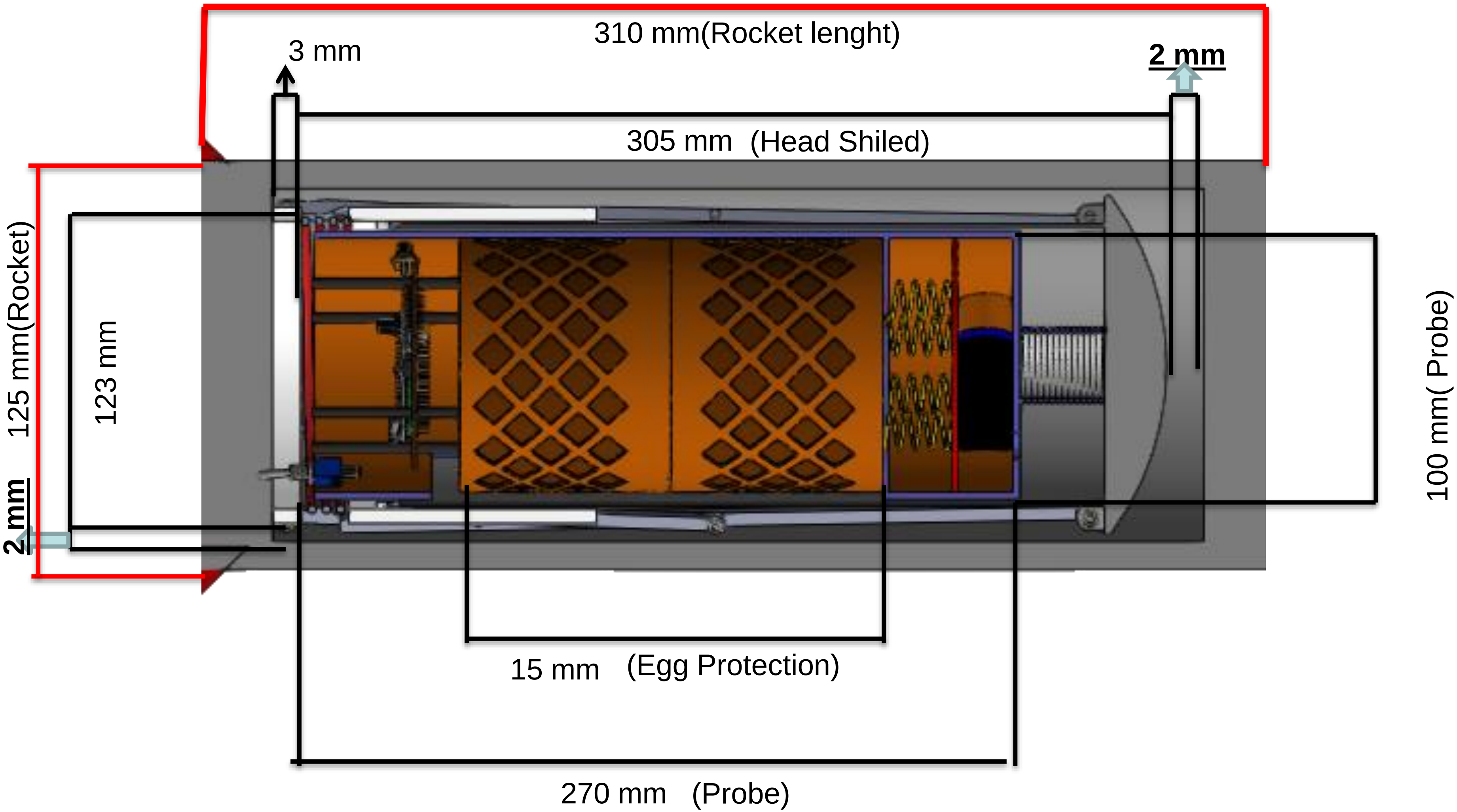


Launch Vehicle Compatibility



Launch Vehicle Compatibility

We leave 2mm margins in vertical and 2mm margins in the horizontal



Sensor Subsystem Design

Beyza CETIN

Sensor Subsystem Overview

No	Sensor	Model	Function	Purpose
1	Air pressure	10-DOF IMU (BMP 280 MPU 9255)	We will use many sensors on a board. BMP280 sensor measure to temperature, pressure and altitude.	To measure air pressure, air temperature, altitude and tilt
2	Air temperature	10-DOF IMU (BMP 280 MPU 9255)		
3	GPS	MT3329	MT3329 use to measure longitude, latitude and altitude. MT3329 update rate higher and power consumption more less than other GPS sensor	To measure position, altitude and descen speed
4	Power Voltage	Voltage Divider	This solution is more simple, light and small than opponent.	To measure of battery voltage
5	Tilt Sensor	MPU-9255	MPU-9255 used to measure tilt with inclinometer and magnetometer	To measure tilt.
6	Camera	Y2000	Y2000 camera have some advantage, photo capture speed, small and light dimension and use more less pins on MCU than other solution.	To take picture

Sensor Changes Since PDR

- No changes have been made to the sensors since PDR.

Sensor Subsystem Requirements

Number	Requirement	Rationale	Priority	VM			
				A	I	T	D
RN#18	All electronic components shall be enclosed and shielded from the environment with the exception of sensors.	Competition requirement	HIGH	✓	✓		
RN#19	All structures shall be built to survive 15 Gs of launch acceleration.	Competition requirement	HIGH	✓	✓		
RN#20	All structures shall be built to survive 30 Gs of shock.	Competition requirement	HIGH	✓	✓		
RN#21	All electronics shall be hard mounted using proper mounts such as standoffs, screws, or high performance adhesives.	Competition requirement	HIGH	✓	✓		

Sensor Subsystem Requirements

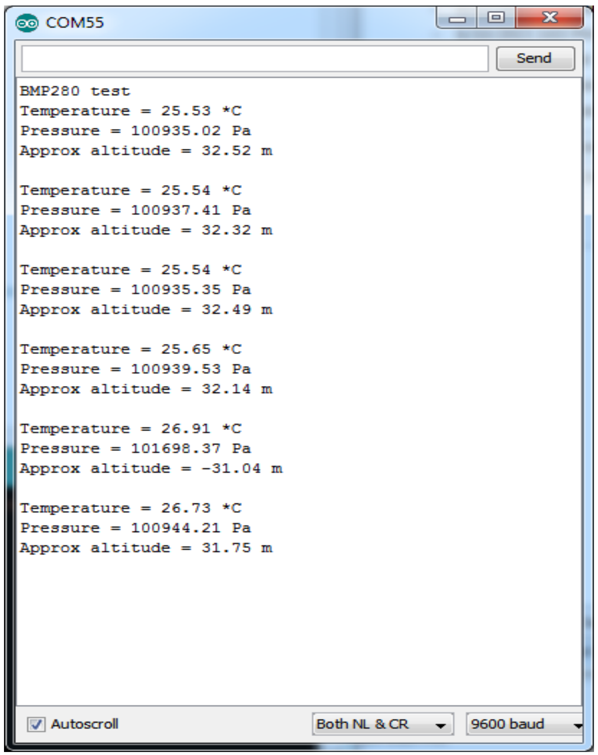
Number	Requirement	Rationale	Priority	VM			
				A	I	T	D
RN#25	During descent, the probe shall collect air pressure, outside air temperature, GPS position and battery voltage once per second and time tag the data with mission time.	Competition requirement	HIGH	✓	✓	✓	✓
RN#26	During descent, the probe shall transmit all telemetry. Telemetry can be transmitted continuously or in bursts	Competition requirement	HIGH	✓	✓	✓	✓
RN#27	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#28	XBEE radios shall be used for telemetry. 2.4 GHz Series 1 and 2 radios are allowed. 900 MHz XBEE Pro radios are also allowed.	Competition requirement	MEDIUM		✓	✓	✓

Sensor Subsystem Requirements

Number	Requirement	Rationale	Priority	VM			
				A	I	T	D
RN#49	A tilt sensor shall be used to verify the stability of the probe during descent with the heat shield deployed and be part of the telemetry.	Competition requirement	HIGH	√	√		
RN#40	No lasers allowed.	Competition requirement	HIGH	√	√		
SSR#1	Camera of resolution 640 x 480 is used to capture images.	To fulfill bonus objective	HIGH	√	√	√	
SSR#2	Use of 10-DOF IMU	To provide space for the pins of the processor	HIGH	√	√	√	
SSR#3	Sensor selected compatible with CPU	Health Measuring	HIGH	√	√	√	

Probe Air Pressure Sensor Summary

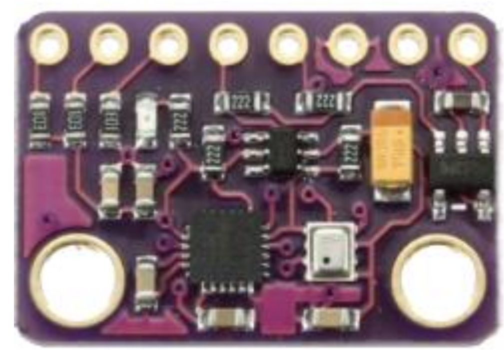
Device Name	Interface	Operating Pressure	Size	Accuracy	Supply Voltage
BMP 280	I2C, SPI	300 -1100 hPa	2.0 x 2.5 x 0.95 mm³	±1.0	1.71 - 3.6 V



We choose this sensor, because:

- Low noise in measurements
- High altitude accuracy
- Includes temperature and humidity sensor
- Located on the 10DOF sensor board

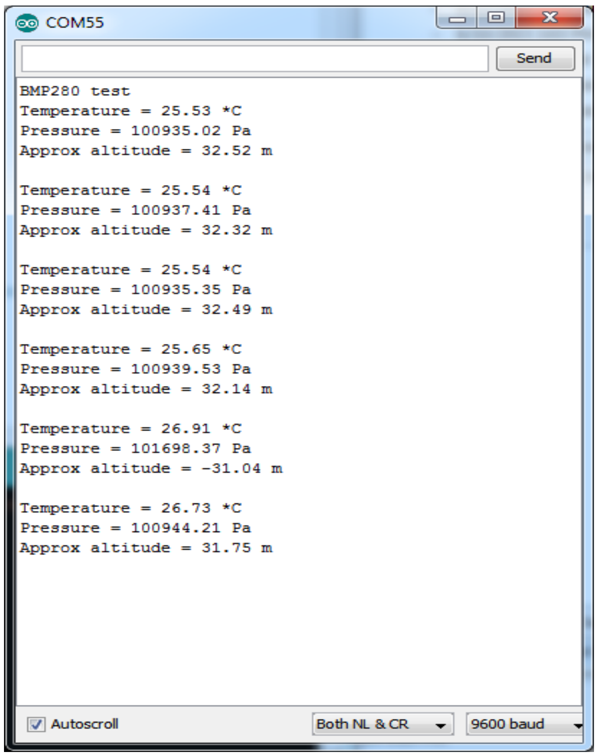
$$p_0 = \frac{p}{\left(1 - \frac{altitude}{44330}\right)^{5.255}}$$



P: Measured Pressure (hPa)
Po: Pressure at sea level (hPa)

Probe Air Temperature Sensor Summary

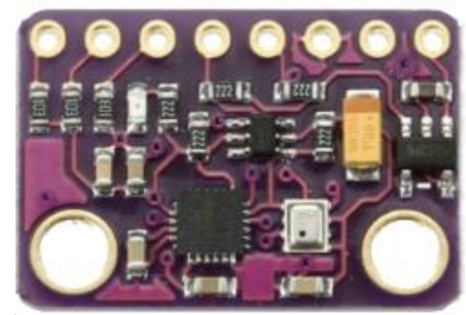
Device Name	Interface	Operating Temperature	Size	Accuracy	Supply Voltage
BMP 280	I2C, SPI	-40 +85	2.0 x 2.5 x 0.95 mm^3	±1.0(°C)	1.71 - 3.6 V



We choose this sensor, beacuse:

- Measures both the temperature and the pressure
- Easy to code and use
- Located on the 10DOF sensor board

Correction Method



Temperature sensor will be calibrated by comparing taken data with the known temperature on ground station before the launch.

$$T = \frac{p}{R \times \rho}$$

$\rho = \text{Density of dry air} \left(\frac{\text{kg}}{m^3}\right)$

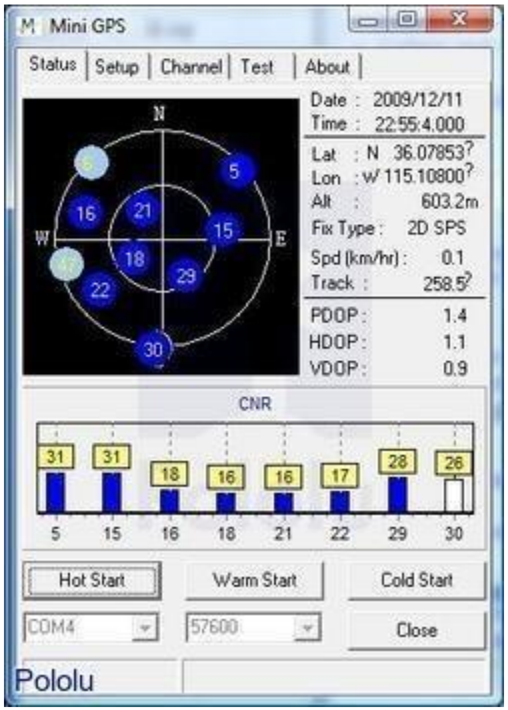
$p = air\ pressure\ (Pa)$

$R = Specific\ gas\ constant\ dry\ air, 287.05 \frac{J}{kg.K}$

$T = Temperature(°K)$

GPS Sensor Summary

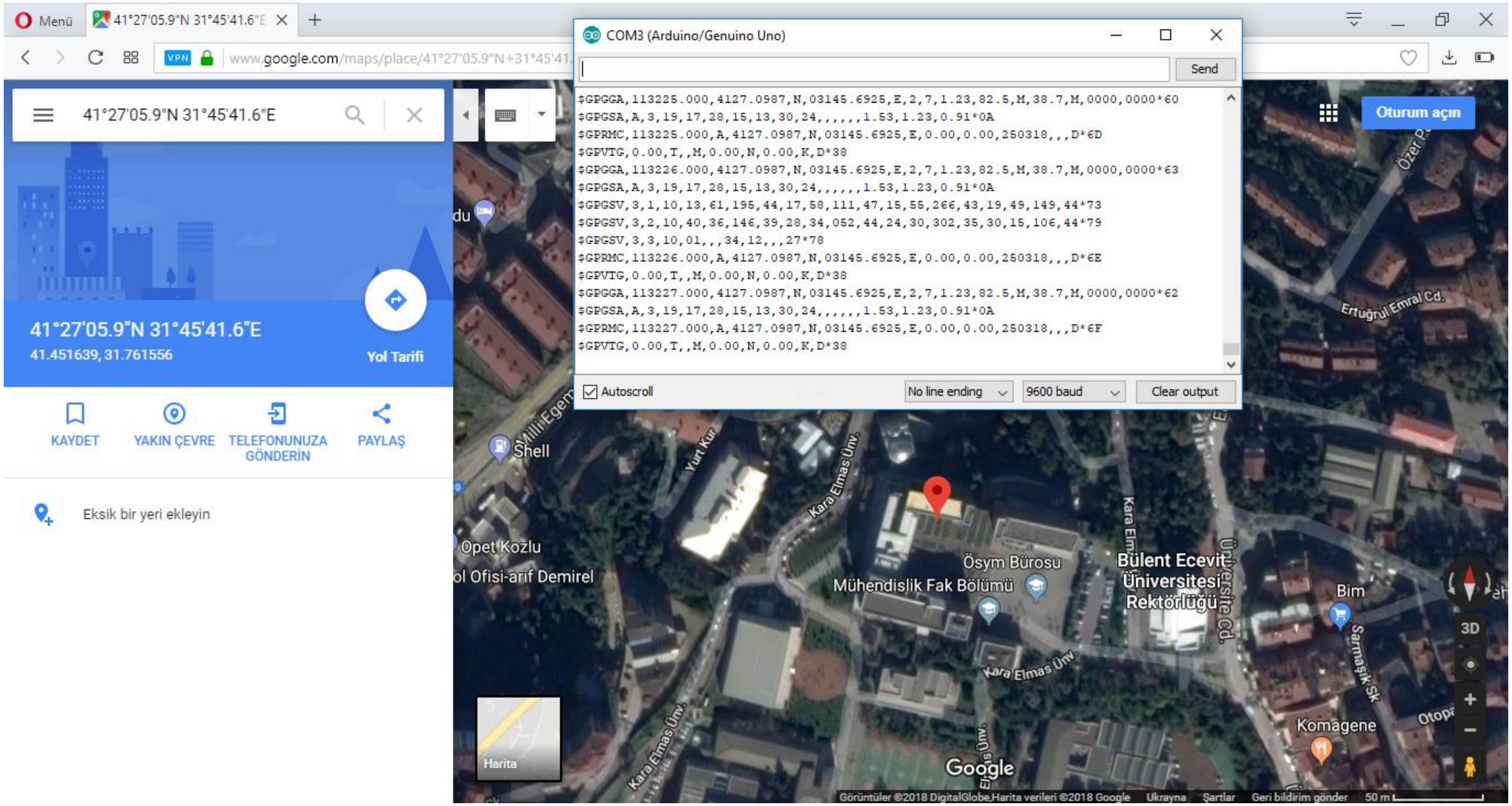
Device Name	Interface	Operating Voltage (V)	Max Update Rate (Hz)	Horizontal Accuracy (m)	Channels
MT3329	UART	3.2-5.0	10	2.5	66



We choose this sensor, because:

- GPS update rate high
- Power consumption is very low during tracking
- Supports 66-channel GPS
- Up to 10Hz update rate

The GPSFox (1MB zip) Windows application from Locosys displays the serial GPS data in a fancy format, but, unlike the the Mini GPS application, it can’t configure the LS20031 GPS receiver module.



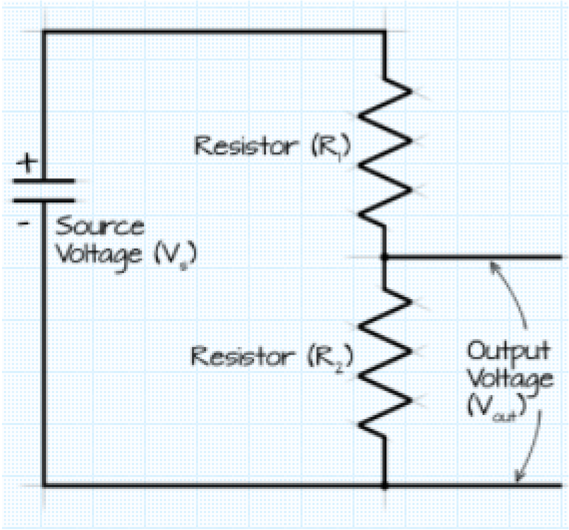
Coordinate calculations of GPS, are in degrees and decimal minutes (DMM). We entered this unit on Google Maps and found that our location is correct. When we look at the search part of Google Maps in the picture, we enter the Degrees and Decimal minutes (DMM) and the data itself is converted to Degrees, Minutes and Seconds (DMS). So the numbers on that search box and the coordinate data from the GPS look different. Actually, they indicate the same place in two but their units are different.

Probe Voltage Sensor Summary

Device Name	Interface	Measurement Voltage (V)	Accuracy (%)
Voltage Divider	Analog	0-25	±0.1

$$V_{out} = \frac{V_s \times R_2}{R_1 + R_2}$$

V_S:Voltage Source
V_{OUT}:Output Voltage
R_1:Resistance 1
R_2:Resistance 2



A voltage divider circuit is a very common circuit that takes a higher voltage and converts it to a lower one by using a pair of resistors. The formula for calculating the output voltage is based on Ohm's Law

Tilt Sensor Summary

Device Name	Interface	Operating Voltage(V)	Range
MPU9255	12C	2.4 – 3.6	±4800μT

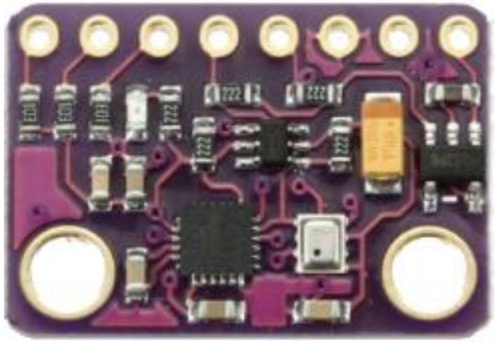
We choose this sensor, because:

- Tri-axis compass with a full scale range of ±4800μT
- 400kHz Fast Mode I2C serial host interface
- Located on the 10DOF sensor board
- Output: Built-in 16-bit AD converter, 16-bit data output

$$(B_P - V)^T (B_P - V) = B^2$$

X Magnetometer Data : 2 Bytes
Y Magnetometer Data : 2 Bytes
Z Magnetometer Data : 2 Bytes

The sensor data registers contain the latest gyroscope, accelerometer, magnetometer, auxiliary sensor, and temperature measurement data. They are read-only registers, and are accessed via the serial interface.
Data from these registers may be read anytime.



Bonus Objective Camera Summary

Device Name	Interface	Operating Voltage(V)	Megapixels	Resolution
Y2000	Digital	5 V	0.3	640x480

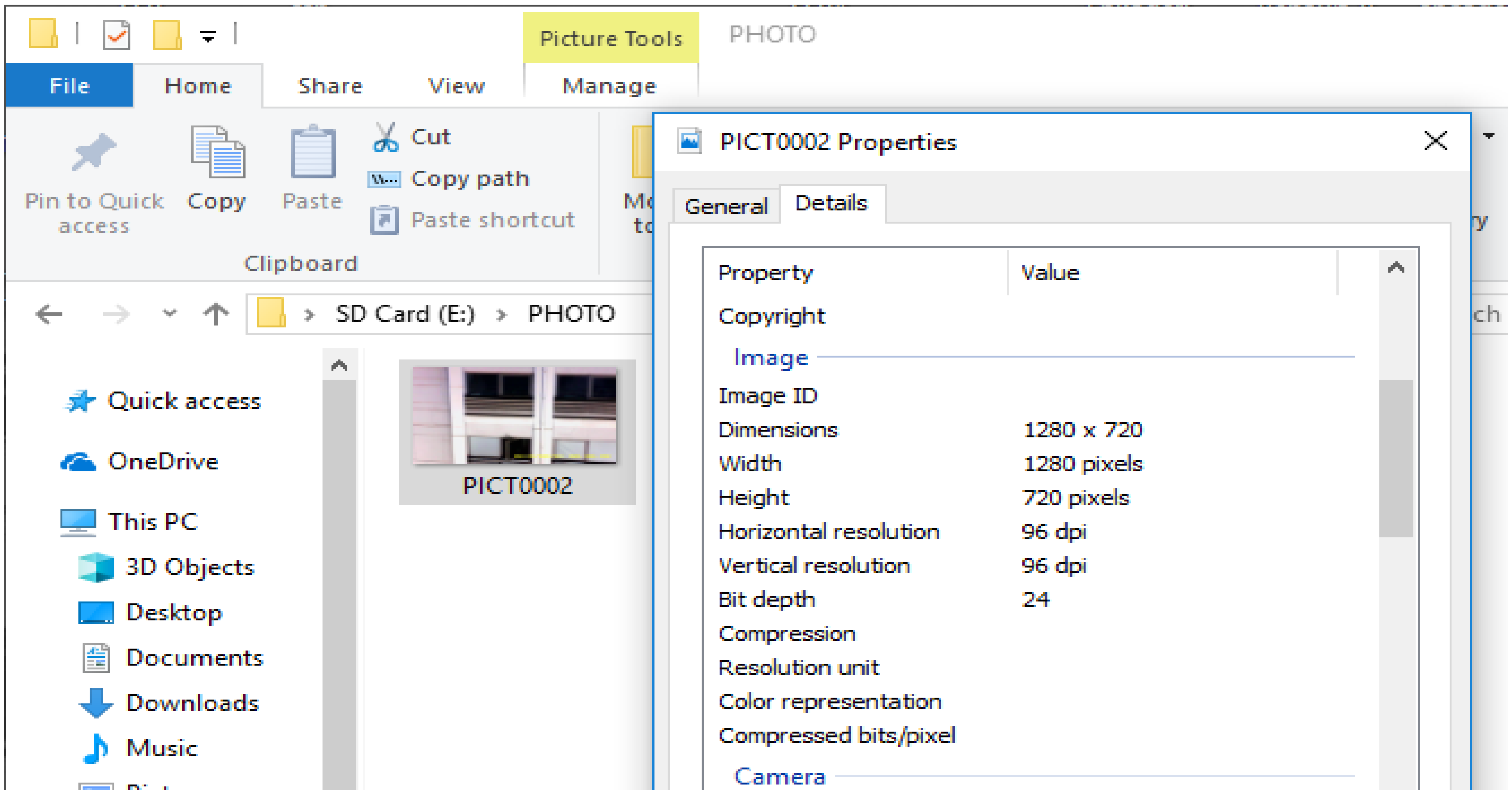
We choose this sensor are:

- High sensitivity in low light
- Image support: JPG
- 30FPS video capture capability
- Easy to communicate with MCU

The camera will be controlled via switching by transistor circuit from by microcontoller. The camera itself has an internal SD card.

This image taken from Y2000

Bonus Objective Camera Summary



This photo contains resolution information of the camera

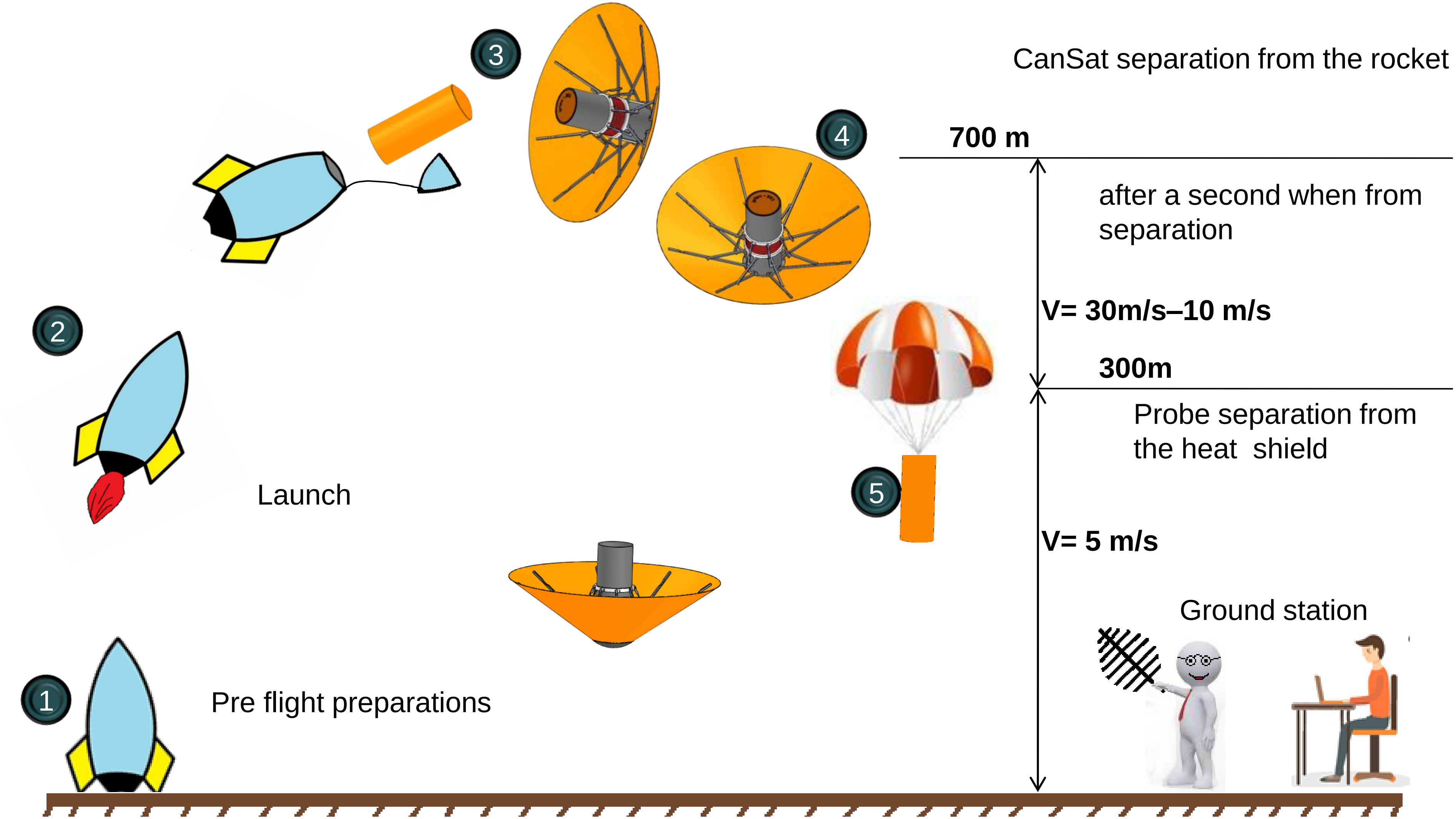
Bonus Objective Wind Sensor

- **We will not do this bonus mission**

Descent Control Design

Serdar DOGAN

Descent Control Overview



Descent Control Changes Since PDR

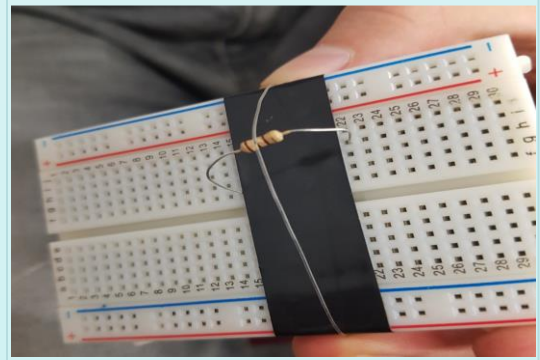
- **No change in descent control. Because everything was calculated in the PDR**

Prototype testing:

Test Name	Procedure	Picture	Pass/Fail
Parachute descent test	The system(parachute + probe) was released to 30 meters and Completed landing at a speed of close to 5 m/s		Passed
Egg protect system test (Parachuteless test)	The system was released from 5 meters and the egg remained intact		Passed

Descent Control Changes Since PDR

Prototype testing:

Test Name	Procedure	Picture	Pass/Fail
Opening mechanism test (Burn wire melted using resistors method)	The wire pulls a current of 1.4A . The wire breaks in one second		Passed
Heat shield descent test	Descent direction and tumbling problem solved with the position of the center of gravity		Passed

Descent Control Requirements

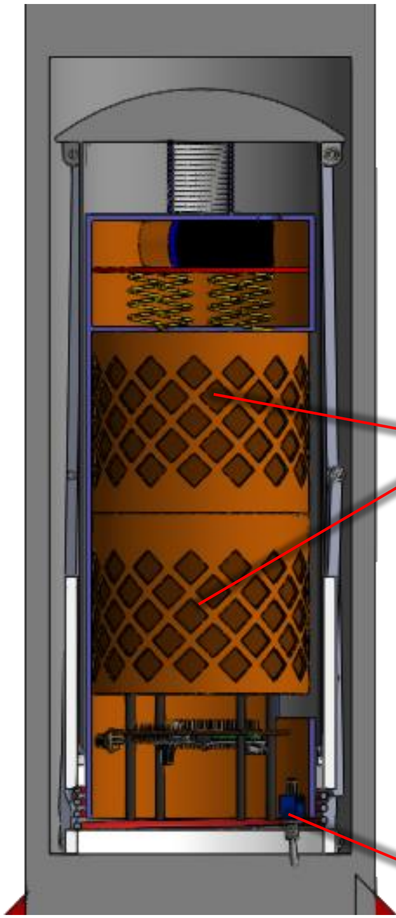
ANNUAL CANSAT COMPETITION

Number	Description	Rationale	Priority	VM			
				A	I	T	D
RN #3	The heat shield must not have any openings.	Competition requirement.	MEDIUM	√	√		√
RN#4	The probe must maintain its heat shield orientation in the direction of descent.	Competition requirement.	HIGH	√	√	√	
RN#5	The probe shall not tumble during any portion of descent. Tumbling is rotating end-over-end.	Competition requirement.	HIGH	√	√	√	
RN #10	The aero-braking heat shield shall be a florescent color; pink or orange.	Competition requirement. Easy to spot heat shield	MEDIUM	√	√		
RN #13	The CanSat, probe with heat shield attached shall deploy from the rocket payload section.	Competition requirement.	HIGH	√	√		

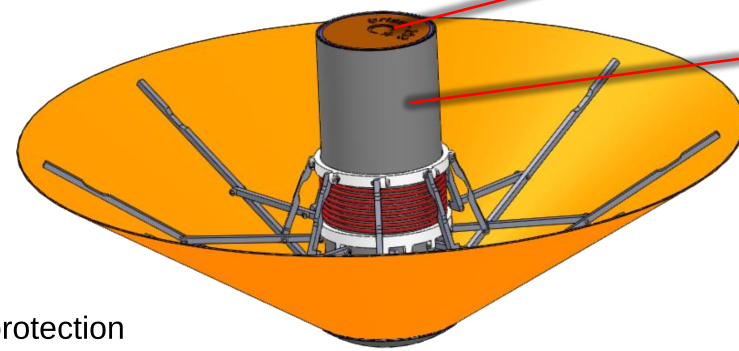
Descent Control Requirements

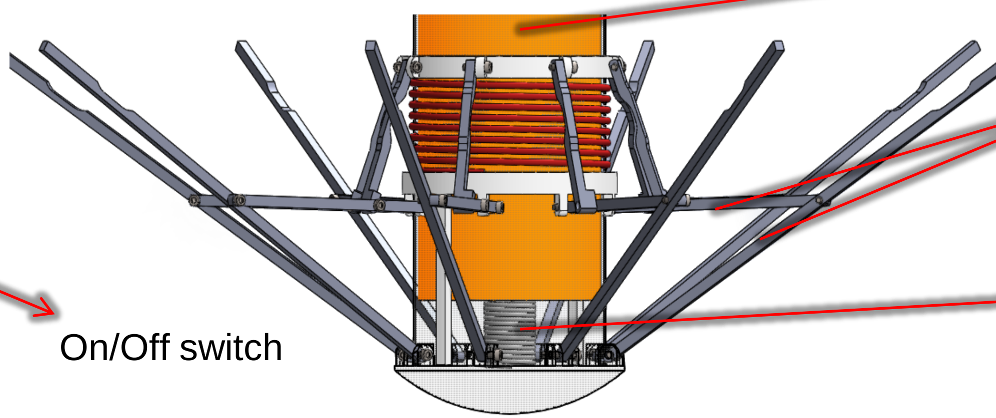
Number	Description	Rationale	Priority	VM			
				A	I	T	D
RN #14	The aero-braking heat shield shall be released from the probe at 300 meters.	Competition requirement.	HIGH	√	√		
RN#15	The probe shall deploy a parachute at 300 meters.	Competition requirement.	HIGH	√	√		
RN#16	All descent control device attachment components (aero-braking heat shield and parachute) shall survive 30 Gs of shock.	Competition requirement.	HIGH	√	√		
RN #43	The descent rate of the probe with the heat shield deployed shall be between 10 and 30 meters/second.	Competition requirement.	HIGH	√	√		√
RN#44	The descent rate of the probe with the heat shield released and parachute deployed shall be 5 meters/second.	Competition requirement.	HIGH	√	√		√

Payload Descent Control Hardware Summary

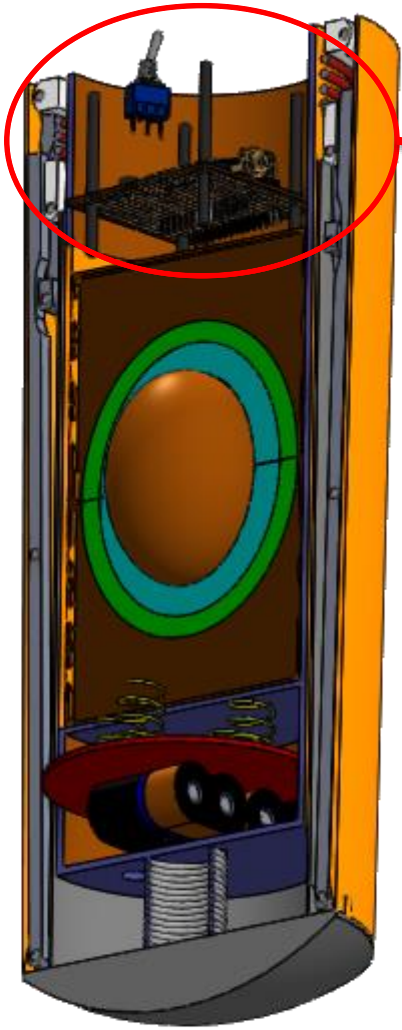


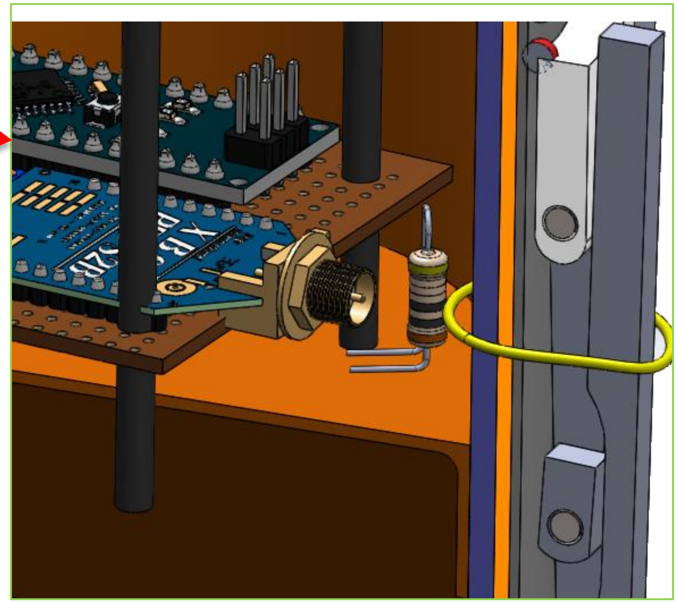
(Payload in rocket)





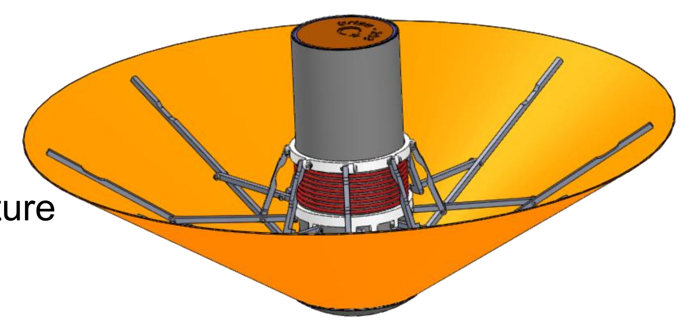
Payload Descent Control Hardware Summary





The heat shield opening system is triggered by the burn wire melted using resistors method and the heat shield arms are opened by the spring and sliding joint mechanism

Deployed configuration is like right piçture



Payload Descent Control Hardware Summary

Passive control for heat shield

- **Component sizing:**

❖ This part is detailed in Mechanical Subsystem Overview

- **Key design considerations:**

❖ The gravity center will be deployed at the bottom of the heat shield (in the direction of landing) to prevent the load from rolling and yawning.

❖ Heavy parts such as batteries and eggs were mounted as close to the nose as possible to attract the center of gravity to the nose

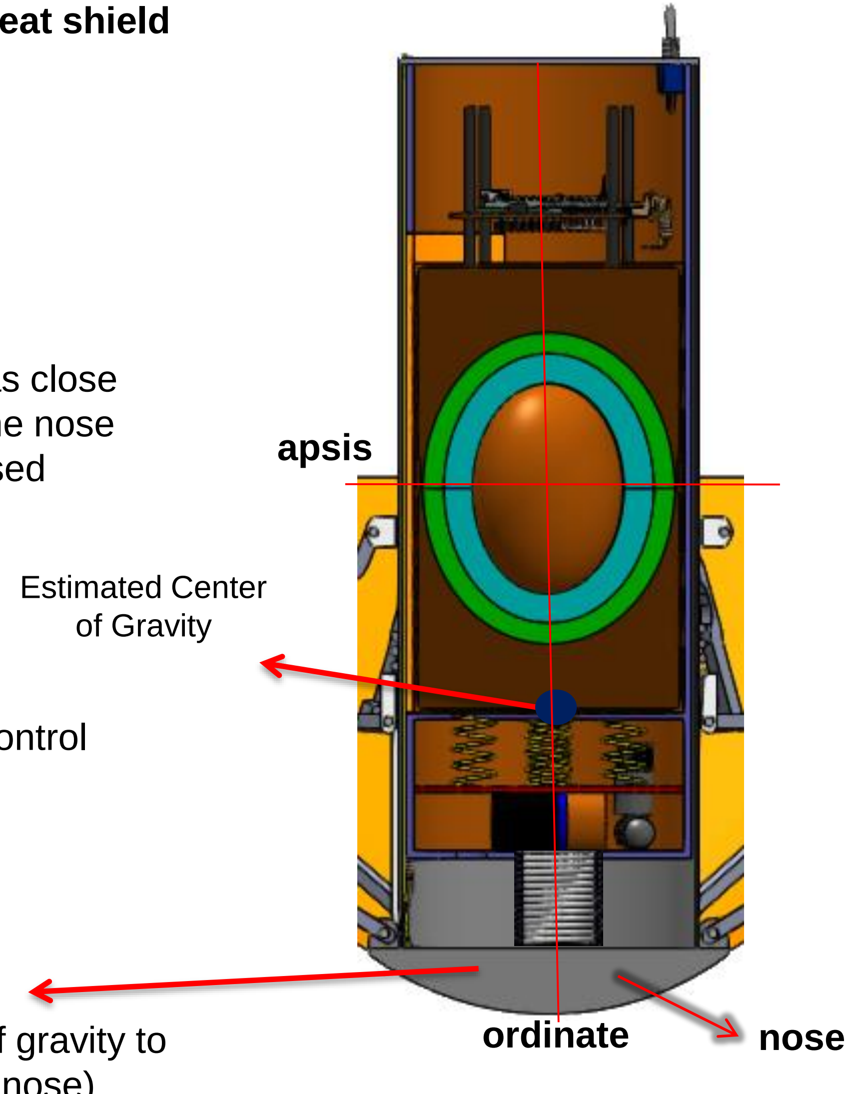
❖ Center of gravity positioning as passive control will be used

- **Color selection(s)**

❖ Heat shield color is orange

- **For active components**

❖ No active components are used in heat shield descent control



Payload Descent Control Hardware Summary

Passive control for probe

- **Component sizing:**

❖ Parachute radius is 210 mm (Detailed calculation are provided in the following slides.)
❖ Spill hole radius is 10 mm

- **Key design considerations:**

❖ Used parachutes for passive control of the probe.
❖ Our parachute is like an umbrella, it is large and round.
❖ Made from Silnylon 30D Nylon 66.
❖ There is a small hole in the middle. A part of the air will go out through this hole. If all the air stays in the parachute, the probe goes sideways rather than downward.

- **Color selection(s)**

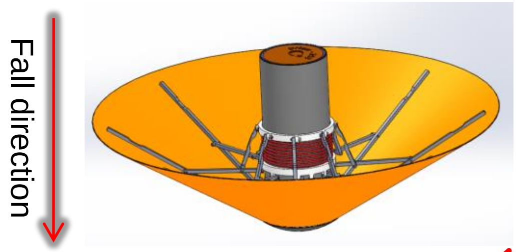
❖ Parachute color is orange. Because it can see easily in the sky.

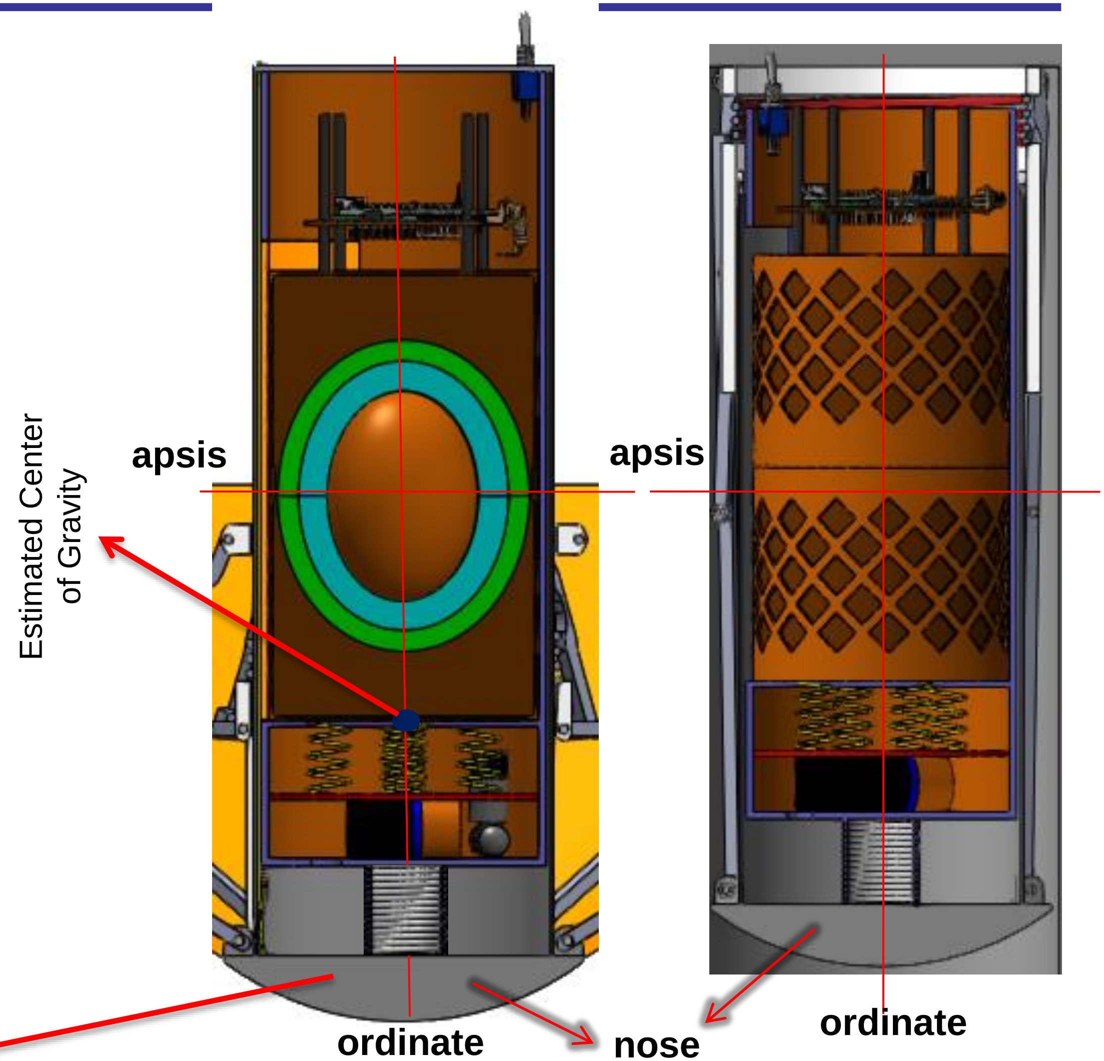
- **For active components**

❖ No active components are used in probe descent control.

Descent Stability Control Design

- In order to stabilize the descent speed between 10 and 30 m/s, the landing stability will be ensured by the angle at which the arms are positioned after the heat shield is turned on. these angled arms will be used as passive controls
- The gravity center will be deployed at the bottom of the heat shield (in the direction of landing) to prevent the load from rolling and yawning, and the arms will be opened symmetrically to prevent yawing and skidding. Center of gravity positioning as passive control will be used.
- Heavy parts such as batteries and eggs were mounted as close to the nose as possible to attract the center of gravity to the nose





Carbon rigid part (heavy to pull the center of gravity to the side of the heat shield nose)

Descent Rate Estimates

- **Probe's parachute landing calculation**
- The parachute will be used to control the speed of the probe's descent.

$$R = \sqrt{\frac{2F_{Drag}}{\pi\rho V^2 C_d}}$$

$$R = \sqrt{\frac{2mg}{\pi\rho V^2 C_d}}$$

$$R = \sqrt{\frac{2(0.3kg)(9.81\,m/s^2)}{\pi(1.225k\,g/m^3)(5\,m/s)^2(1.5)}}$$

$$R = \sqrt{\frac{5.887}{144.317}} = \sqrt{0.040785}$$

$$R = 0.2019535m = (20.19535cm)$$

V = Landing speed (m/s)

F_{drag} = mg (Frictional force) (N)

π = 3,14159265359

C_d = 1.5 (Drift coefficient)

R = Radius (m)

ρ = Air density at +15 ° C from sea level (1,225 kg/m3)

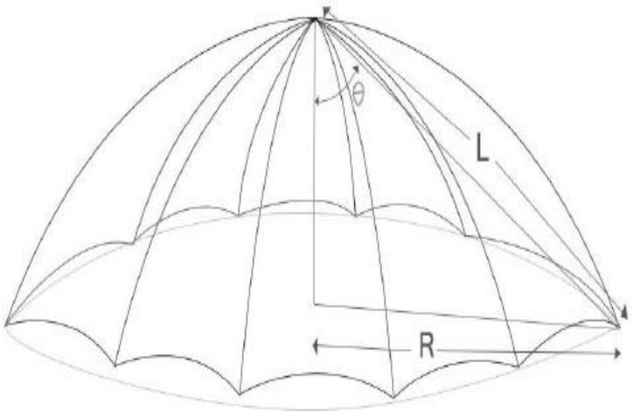
m=300 grams(Probe's weight)

The radius is calculated according to the gave speed(5m/s).
R is the radius value of the surface affected by the friction force.
When the hole radius is 1 cm. The general parachute radius will be 21 cm.

Descent Rate Estimates

$$R = 0.2019535m \qquad L = 0.25m$$

$$R = L x \sin\theta = \sqrt{\frac{2mg}{\pi \rho V^2 C_d}}$$



$$0.25 x \sin\theta = \sqrt{\frac{2(0.3kg)(9.81\, m/s^2)}{\pi(1.225k\, g/m^3)(5\, m/s)^2(1.5)}}$$

$$\sin\theta = \frac{0.2019535}{0.25} \qquad \theta = \sin^{-1}(\frac{R}{L})s$$

$$\underline{\theta = 53.88\text{degree}}$$

Descent Rate Estimates

- **PROBE SPEED CALCULATION**

$$D = \frac{1}{2} x C_d x \rho x \Delta A x V_\infty^2$$

R_{total} = 21 cm

R_{hole} = 1 cm

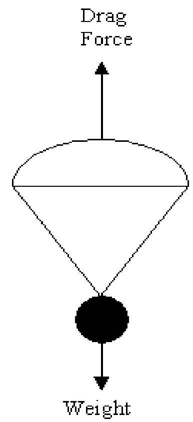
$$\Delta A = \pi x (R_{total} - R_{hole})^2$$

$$\Delta A = \pi x (21 - 1)^2 = 0.12566\, m^2$$

$$G = mxg$$

Base Rule :

$$V_\infty = \sqrt{\frac{2xmxg}{C_d x \Delta A x \rho}}$$



Weight (W) acts downward, through the center of mass. The resistance of the ambient air creates a drag force (D). These forces are balanced once terminal velocity is reached.

$$V = \sqrt{\frac{2x0.3(kg)x9.81(\frac{m}{s^2})}{1.5x0.12566x1.225(\frac{kg}{m^3})}}$$

Landing Way $\underline{V = 5.000001498\, m/s}$

- **HEAT SHIELD + PROBE SPEED CALCULATION**

$$R = \sqrt{\frac{2F_{Drag}}{\pi\rho V^2 C_d}} \Rightarrow R = \sqrt{\frac{2mg}{\pi\rho V^2 C_d}}$$

V = Landing speed (m/s)
F_{drag} = mg (Frictional force) (N)
π = 3,14159265359
C_d = 0.5(Drift coefficient)
R = Radius (m)
ρ = Air density at +15 ° C from sea level (1,225 kg/m3)
m=500 grams(payloads weight).
V=10 m/s – 30 m/s

$$R_{max} = \sqrt{\frac{2x0.5(kg)x9.8(\frac{m}{s^2})}{\pi x1.225\left(\frac{kg}{m^3}\right)x10^2(\frac{m^2}{s^2})x0.5}} = 0.226 \text{ m}$$

$$R_{min} = \sqrt{\frac{2x0.5(kg)x9.8(\frac{m}{s^2})}{\pi x1.225\left(\frac{kg}{m^3}\right)x30^2(\frac{m^2}{s^2})x0.5}} = 0.0752 \text{ m}$$

Descent Rate Estimates

- **HEAT SHIELD SPEED CALCULATION**

$$V_\infty = \sqrt{\frac{2xmxg}{C_d x \Delta A x \rho}}$$

$$R_{max} = 0.226 \text{ m}$$

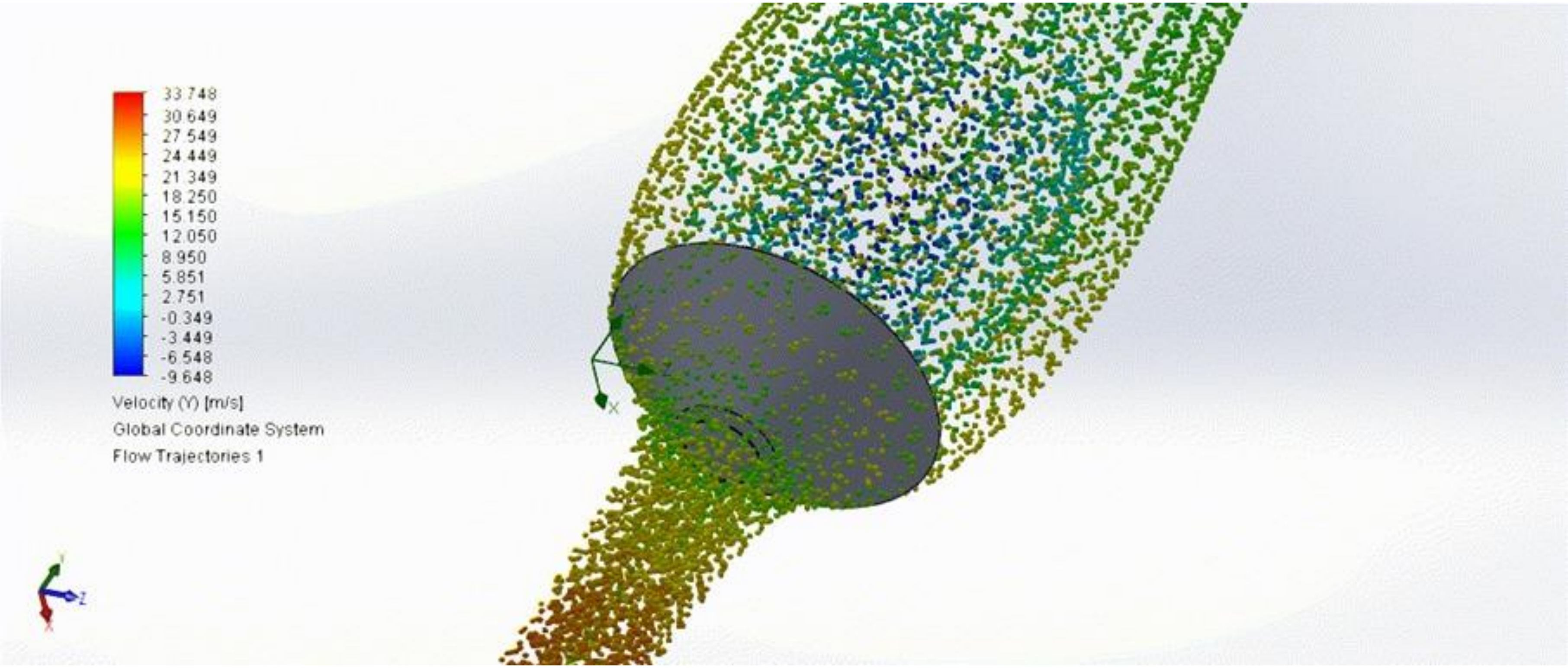
$$A_{max} = \pi \text{x} R_{max}{}^2 = 0.1605 m^2$$

V = Landing speed (m/s)
π = 3,14159265359
C_d = 0.5(Drift coefficient)
R = Radius (m)
ρ = Air density at +15 ° C from sea level (1,225 kg/m3)
m=200 grams(heat shield weight).

$$V = \sqrt{\frac{2x0.2(kg)x9.81(\frac{m}{s^2})}{0.5x0.1605(m^2)x1.225(\frac{kg}{m^3})}} = 6.315\left(\frac{m}{s}\right)$$

The R_{max} value is used to falling the heat shield at minimum speed.

Descent Rate Estimates



Heat shield flow simulation in fall time. The wind speed is shown in the simulation according to the colors.

Mechanical Subsystem Design

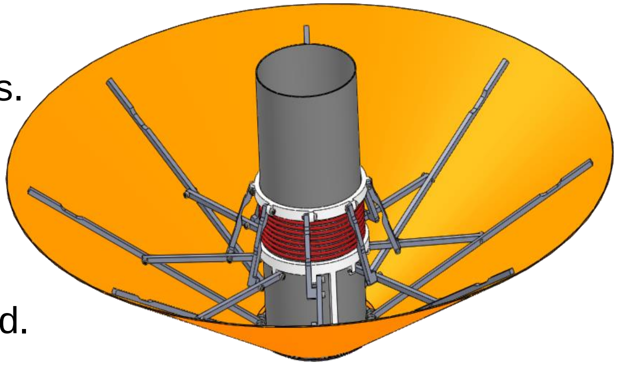
Ahmet GUNGORMUS

Mechanical Subsystem Overview

- Total mass is 500 g. (Heat shield, probe and all electrical components)

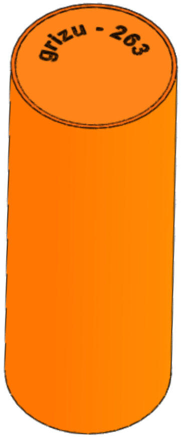
Heat shield

- Heat shield material is Fiberglass.
- We use carbon fiber for arms.
- Heat shield dimension is less than 310 mm lenght and 125 mm radius.
- Heat shield's fall speed is 30 m/s between 10 m/s.
- The open position of the heat shield's arms is 51.07 degrees.
- Heat shield opening mechanism is completely mechanical.
- With the help of spring and slider joint opening mechanism is provided.



Probe

- Probe materials is Fiberglass.
- We use carbon fiber stick inside the probe.
- Probe dimension is 270 mm lenght and 100 mm Radius.
- Probe's fall speed is 5 m/s.
- Parachute material is Silnylon 30D Nylon 66 and shape is Round spill hole.
- Consists of a hemispherical parachute of radius 21 cm with a spill hole at its center so the velocity will become 5 m/s.



Mechanical Subsystem Changes Since PDR

Part	Changes	Rationals
Heat shield body structural material	Fiberglass is chosen instead of carbonfiber	Fiberglass is cheaper than carbon fiber and can provide sufficient strength for design. so changed
Probe structural material	Fiberglass is chosen instead of carbonfiber	Fiberglass is cheaper than carbon fiber and can provide sufficient strength for design. so changed

Mechanical Sub-System Requirements

Number	Description	Rationale	Priority	VM			
				A	I	T	D
RN #1	Total mass of the CanSat (probe) shall be 500 grams +/- 10 grams.	Competition requirement.	HIGH	√	√		√
RN #2	The aero-braking heat shield shall be used to protect the probe while in the rocket only and when deployed from the rocket. It shall envelope/shield the whole sides of the probe when in the stowed configuration in the rocket. The rear end of the probe can be open.	Competition requirement.	HIGH	√	√		√
RN #3	The heat shield must not have any openings.	Competition requirement.	MEDIUM	√	√		√
RN#9	The aero-braking heat shield shall not have any sharp edges to cause it to get stuck in the rocket payload section which is made of cardboard.	Competition requirement.	MEDIUM	√	√		
RN #11	The rocket airframe shall not be used to restrain any deployable parts of the CanSat.	Competition requirement.	MEDIUM	√	√		
RN #12	The rocket airframe shall not be used as part of the CanSat operations.	Competition requirement.	LOW	√	√		
RN #14	The aero-braking heat shield shall be released from the probe at 300 meters.	Competition requirement.	HIGH	√	√		
RN #20	All structures shall be built to survive 30 Gs of shock.	Competition requirement.	HIGH	√	√		
RN #23	Mechanisms shall not use pyrotechnics or chemicals.	Competition requirement.	HIGH	√	√		

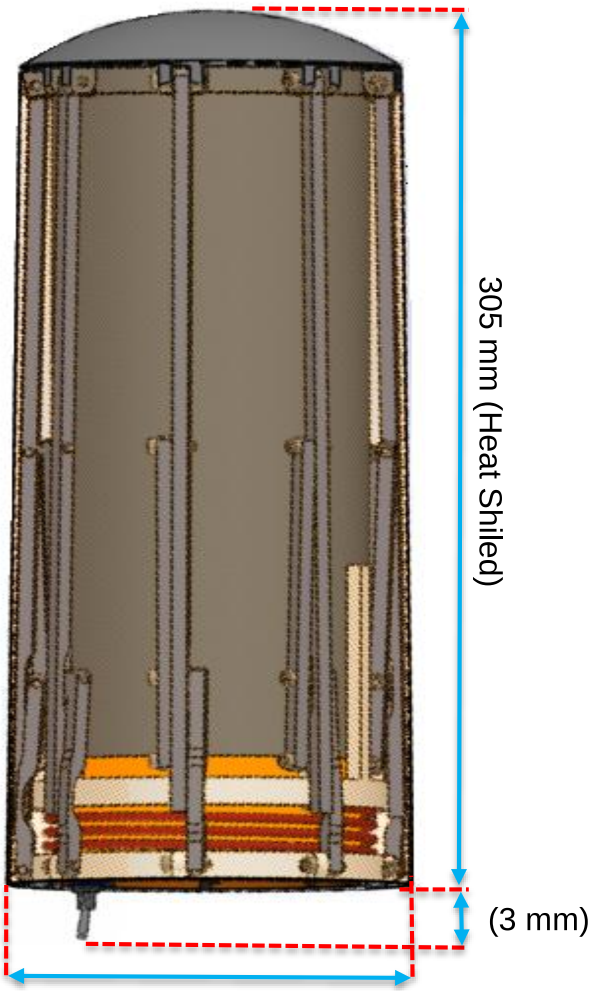
Mechanical Sub-System Requirements

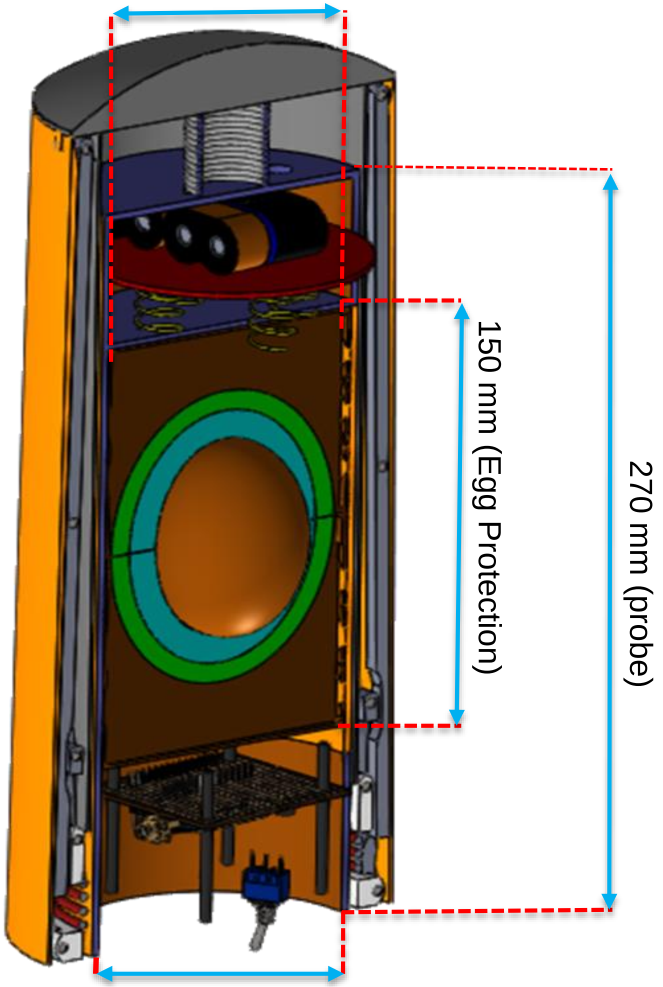
ANNUAL CANSAT COMPETITION

Number	Desciption	Rationale	Priority	VM			
				A	I	T	D
RN#4	The probe must maintain its heat shield orientation in the direction of descent.	Competition requirement.	HIGH	✓	✓	✓	
RN#6	The probe with the aero-braking heat shield 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#7	The probe shall hold a large hen's egg and protect it from damage from launch until landing.	Competition requirement.	HIGH	✓	✓	✓	✓
RN#15	The probe shall deploy a parachute at 300 meters.	Competition requirement.	HIGH	✓	✓		
RN#19	All structures shall be built to survive 15 Gs of launch acceleration.	Competition requirement.	HIGH	✓	✓		
RN#20	All structures shall be built to survive 30 Gs of shock.	Competition requirement.	HIGH	✓	✓		
RN#21	All electronics shall be hard mounted using proper mounts such as standoffs, screws, or high performance adhesives.	Competition requirement.	HIGH	✓	✓		
RN#41	The probe must include an easily accessible power switch.	Competition requirement.	HIGH	✓	✓		✓
RN#44	The descent rate of the probe with the heat shield released and parachute deployed shall be 5 meters/second.	Competition requirement.	HIGH	✓	✓		✓

Payload Mechanical Layout of Components

CAD Model Dimensions





Payload Mechanical Layout of Components

For Heat Shield

Materials	Use area	Reasons
Fiberglass	• Heat shield body	• Cheap • Durable to hit
Square carbonfiber tube	• Heat shield arms	•Lightweight •Strong
Carbonfiber sticks	• Electronics components skeleton	•Lightweight •Durability is very good
Silnylon 30D Nylon 66	• Moving shield part	•Very light •Easy to shape •More elastic
Big spiral spring	• Opening mechanism	•It provides enough tension to unfolding mechanism •Cheap
Spiral spring (thrust spring)	• Seperation mechanism	•It provides enough tension to separation mechanism
Fish line	• Opening mechanism • Seperation mechanism	•Lightweight •Cheap •Strong
Hinge	•Heat shield cover	•Strong connection

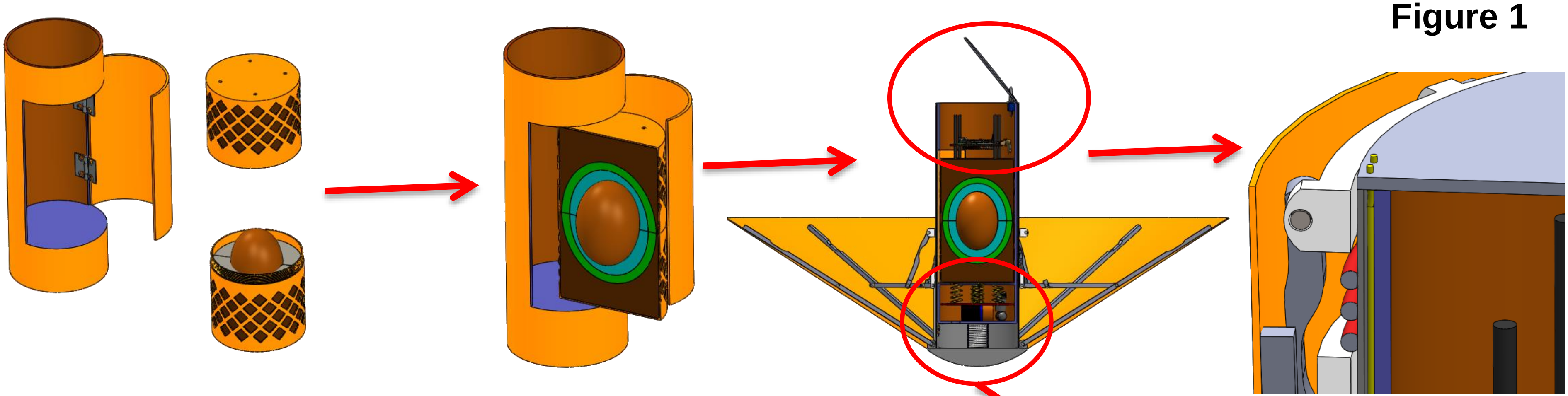
Payload Mechanical Layout of Components

For Probe

Materials	Use area	Reasons
Fiberglass	• Probe	• Cheap • Strong
3D Printer PLA Flement	• Egg protection container	• Easy to make space design
Polyethylene Tube:	• Egg protection	• It provides flexibility for the material. • Good absorption impact.
Sponge:	• Egg protection	• It is easy to move due to low weight. • The price is cheap. • Good absorption impact.
Bubble Wrap:	• Egg protection	• The material provides impact airbags. • Protect material from vibration. • Good absorption impact.
Mattress	• Egg protection	• High strength and durability. • The price is cheap. • Good absorption impact.
Small springs	• Egg protection	• Cheap • good pulse damping
Silnylon 30D Nylon 66	• Parachute	• Very light • Easy to shape • More elastic
Hinge	• Probe	• Strong connection

Payload Mechanical Layout of Components

Figure 1



• After probe placing in the heat shield, the heat shield cover will be closed and the cover will be fixed with the fishline. (As shown in figure 1 and figure 2)

• The probe will be squeezed between the heat shield and bottom spring in order to be connected the system

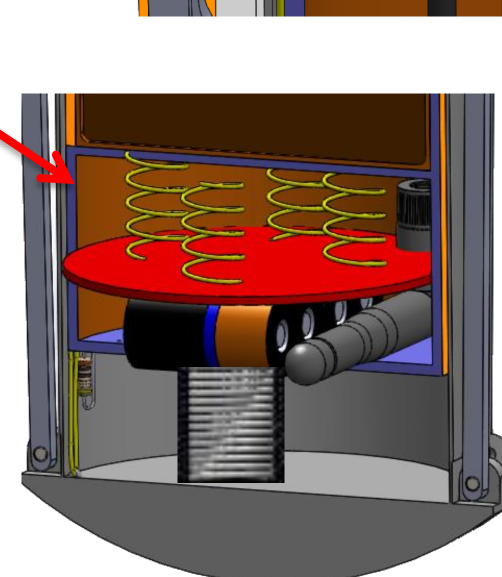
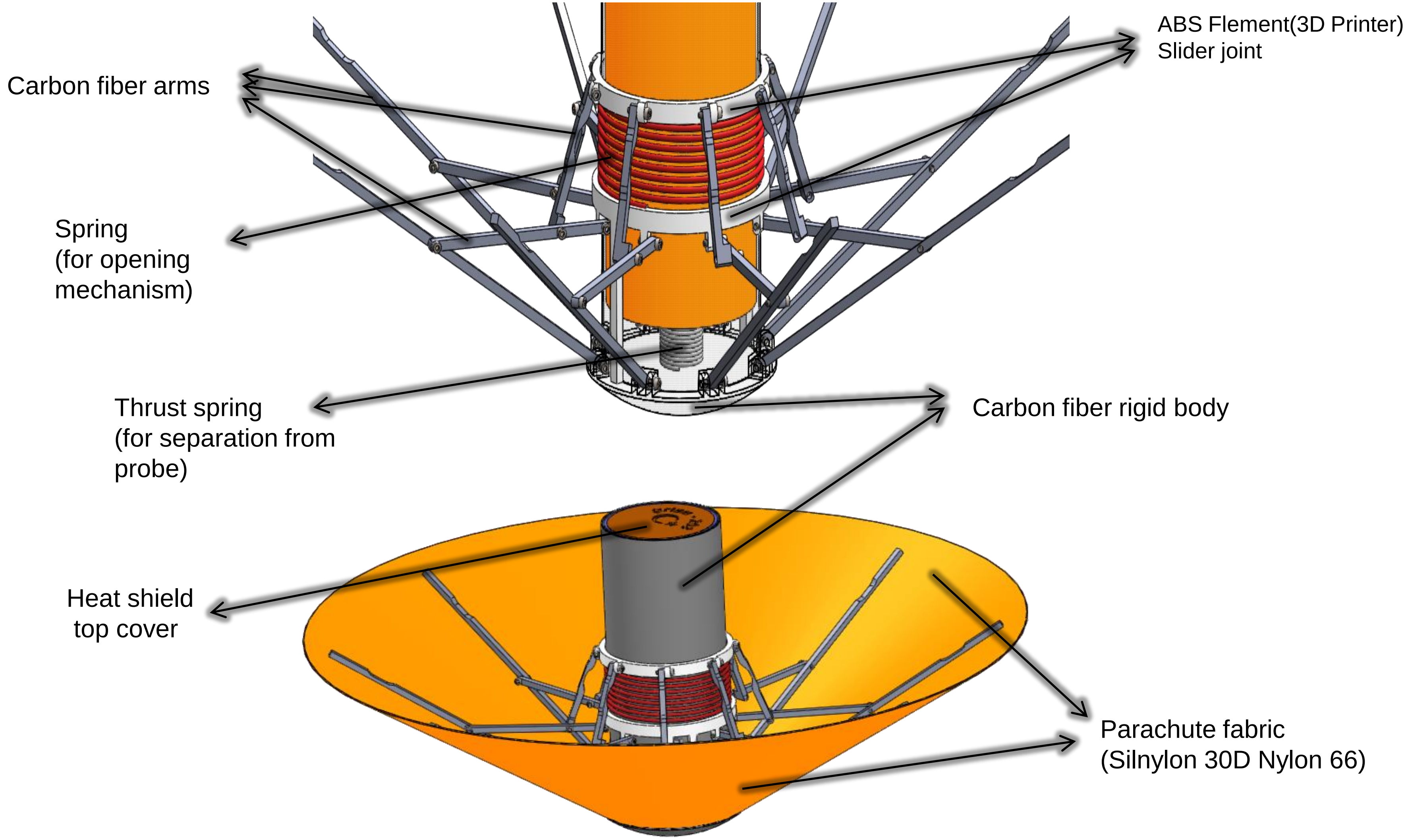


Figure 2

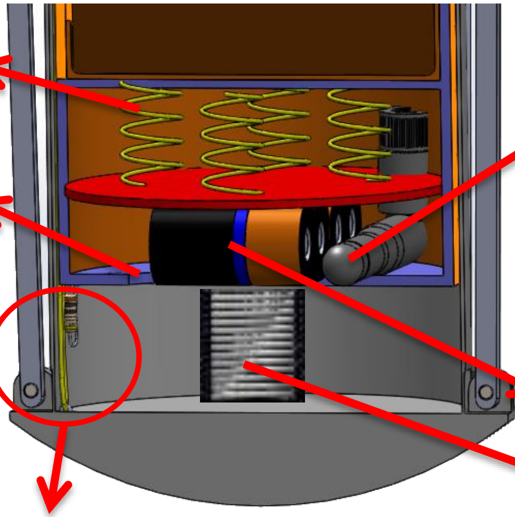
Payload Mechanical Layout of Components



Payload Mechanical Layout of Components

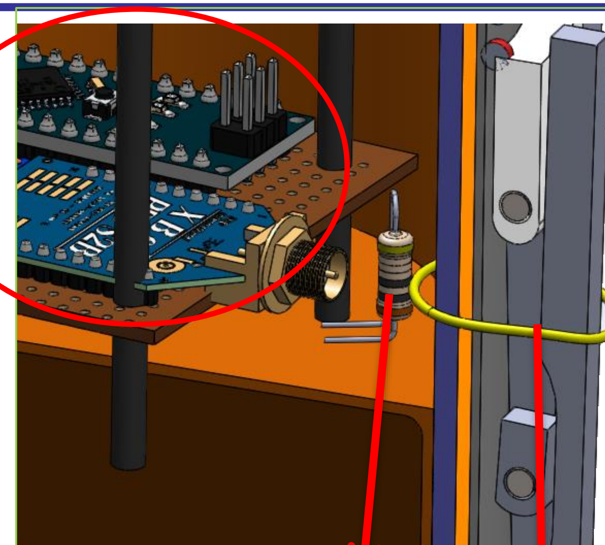
springs

Camera hole

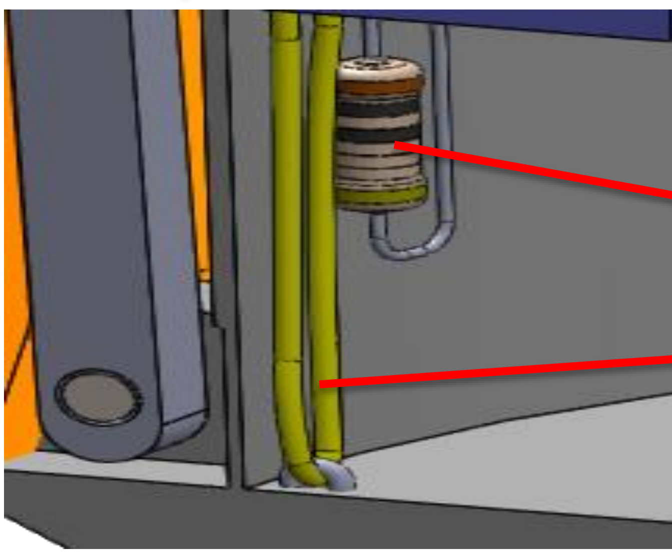


2.4GHz Antenna-Adhesive(U.F.L)

Electronic components



Duracell DL 223 batteries



Probe thrust spring

0,1 ohm resistor

fishline

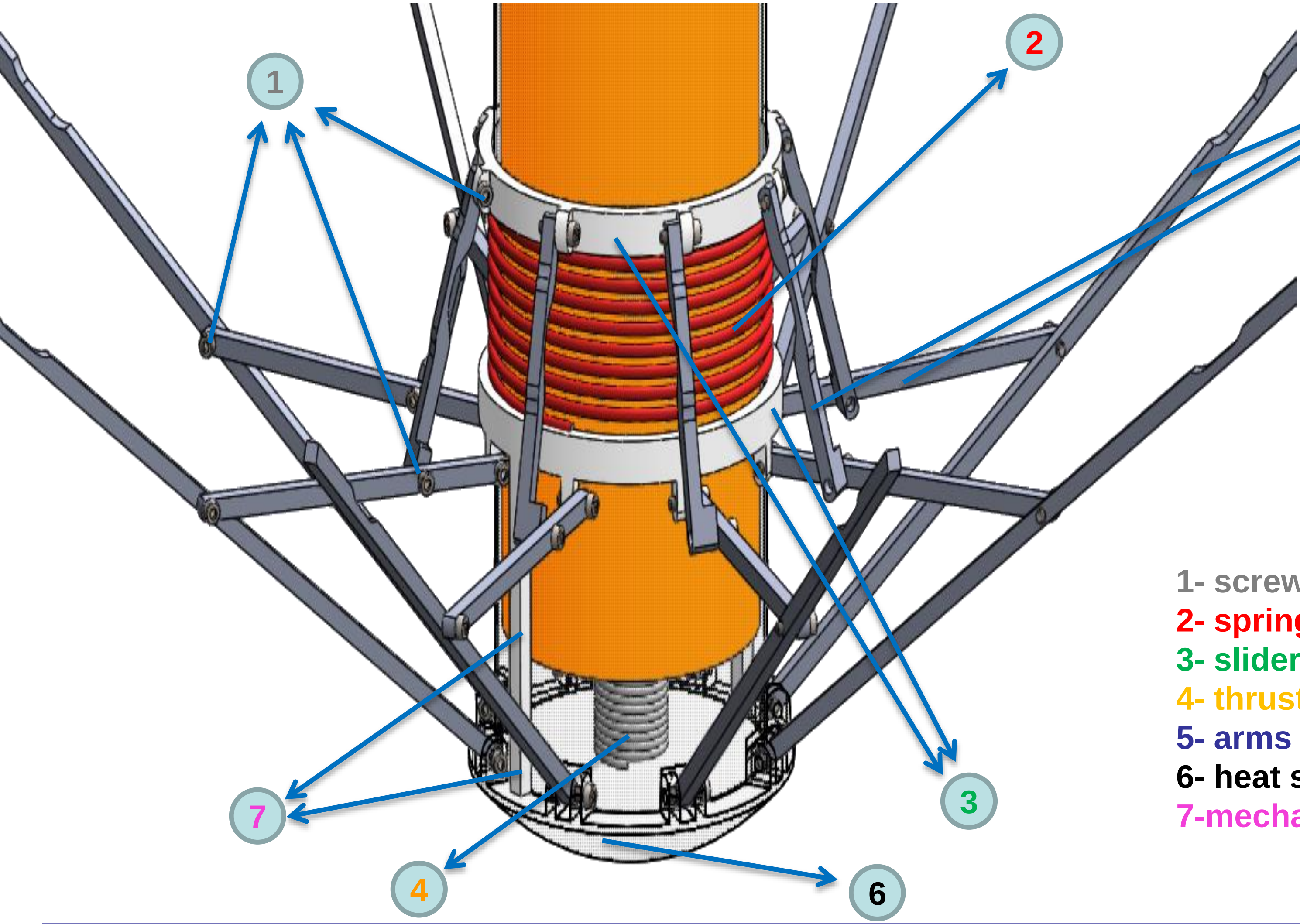
Heat shield separation mechanism from probe

0,1 ohm resistor

fishline

Heat shield opening mechansim

Payload Mechanical Layout of Components



1- screw
2- spring
3- slider joint
4- thrust spring
5- arms
6- heat shield rigid body (nose)
7-mechanism stopper

Payload Mechanical Layout of Components

Heat shield top cover

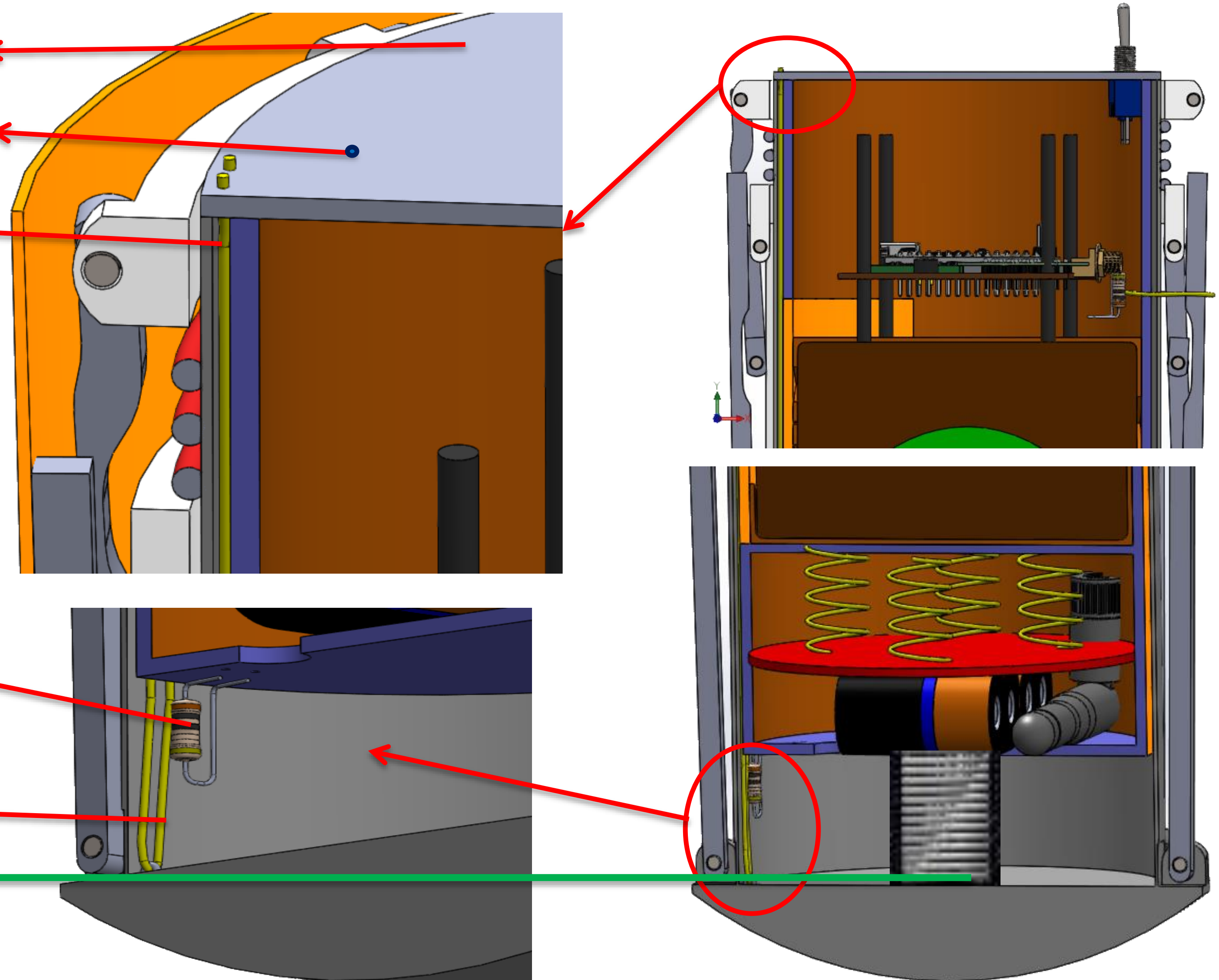
LDR sensor

fishline

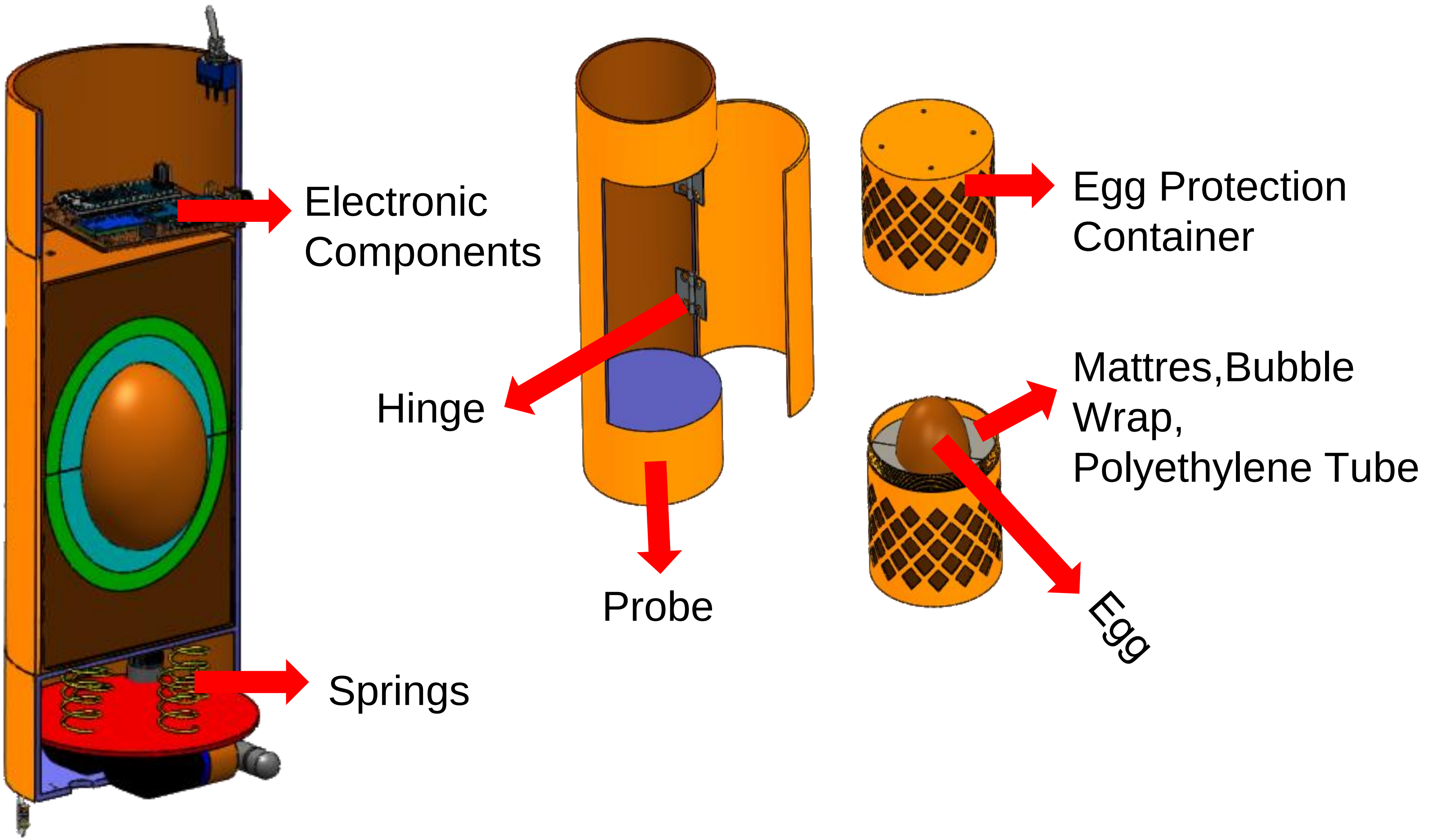
Heat shield attachment points

0,1 ohm resistor

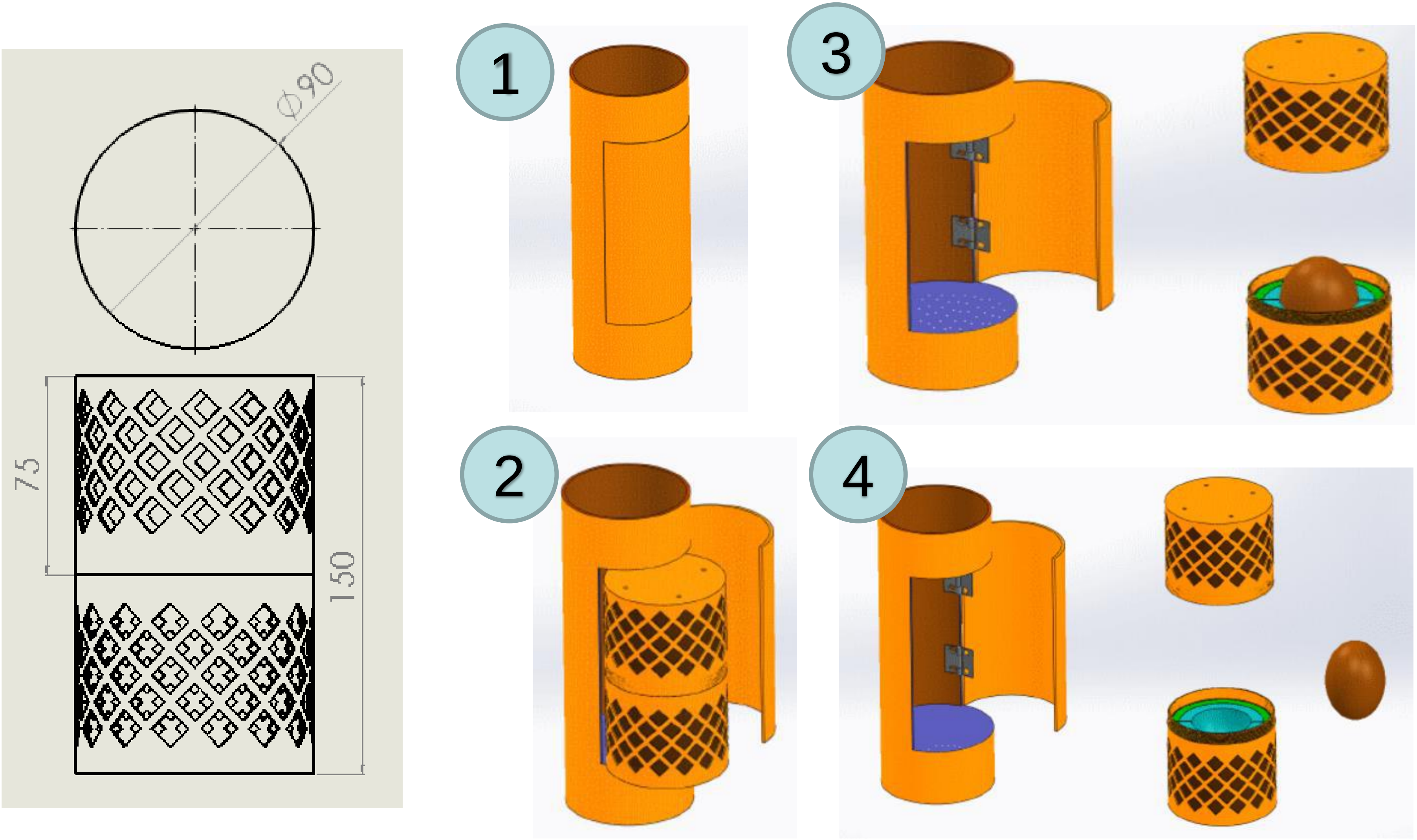
fishline



Egg Protection Mechanical Layout of Components



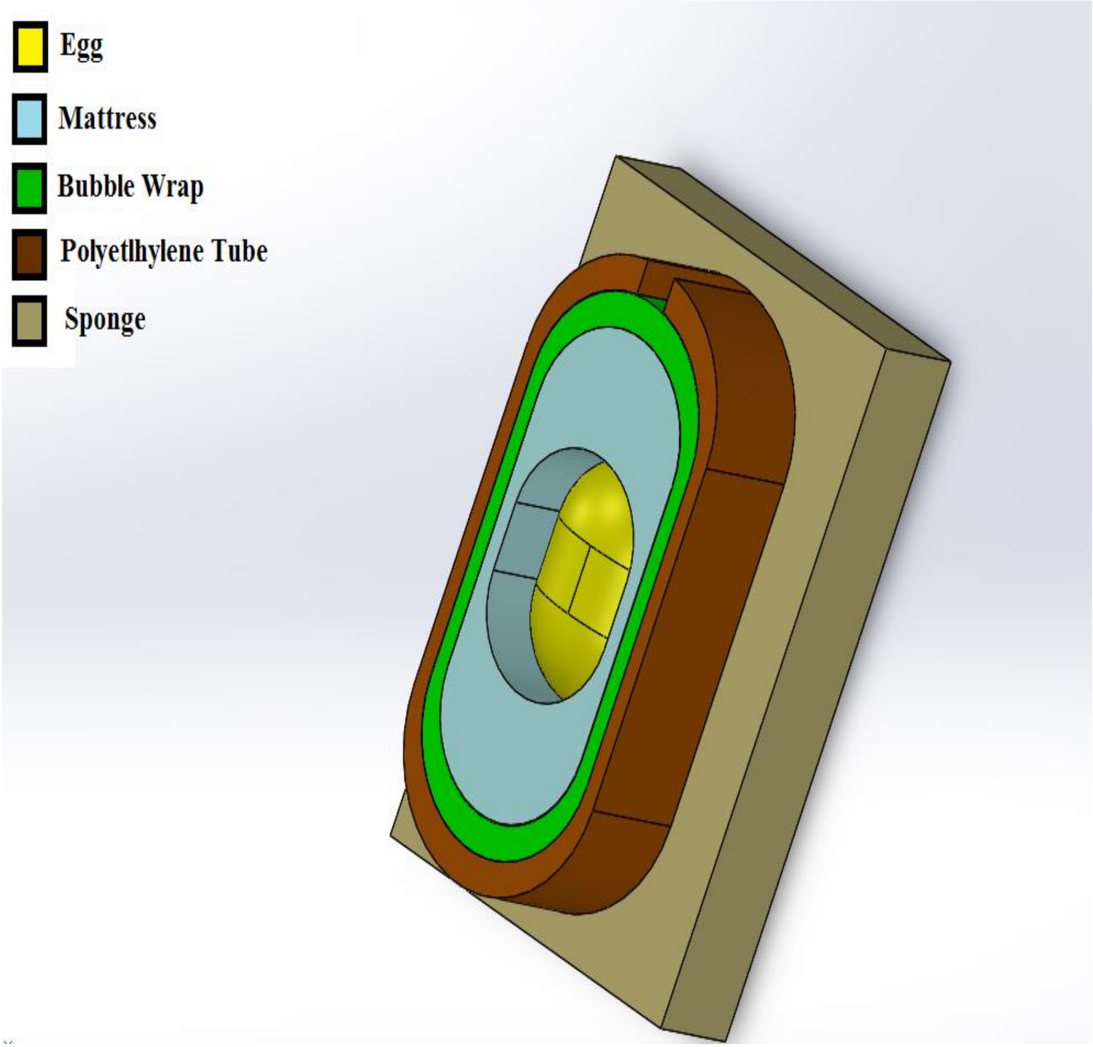
Egg Protection Mechanical Layout of Components



Egg Protection Mechanical Layout of Components

- The selection & trades for the concepts on egg protection are done in the Sytems Overview section
- Egg weight is 60 grams.
- Egg length is 70 mm. Egg width is 50 mm.
- Further discussions on the Egg Protection design

PROS	CONS
• Low weight • The best balance • High endurance for eggs • The best absorption • Take up little space	We must make a protective container for our system



Egg Protection Mechanical Layout of Components

- **Polyethylene Tube:**

  It provides flexibility for the material. Good absorption impact.

- **Sponge:**

  It is easy to move due to low weight**.** The price is cheap. Good absorption impact.

- **Bubble Wrap:**

The material provides impact airbags. Protect material from vibration. Good absorption impact.

- **Mattress:**

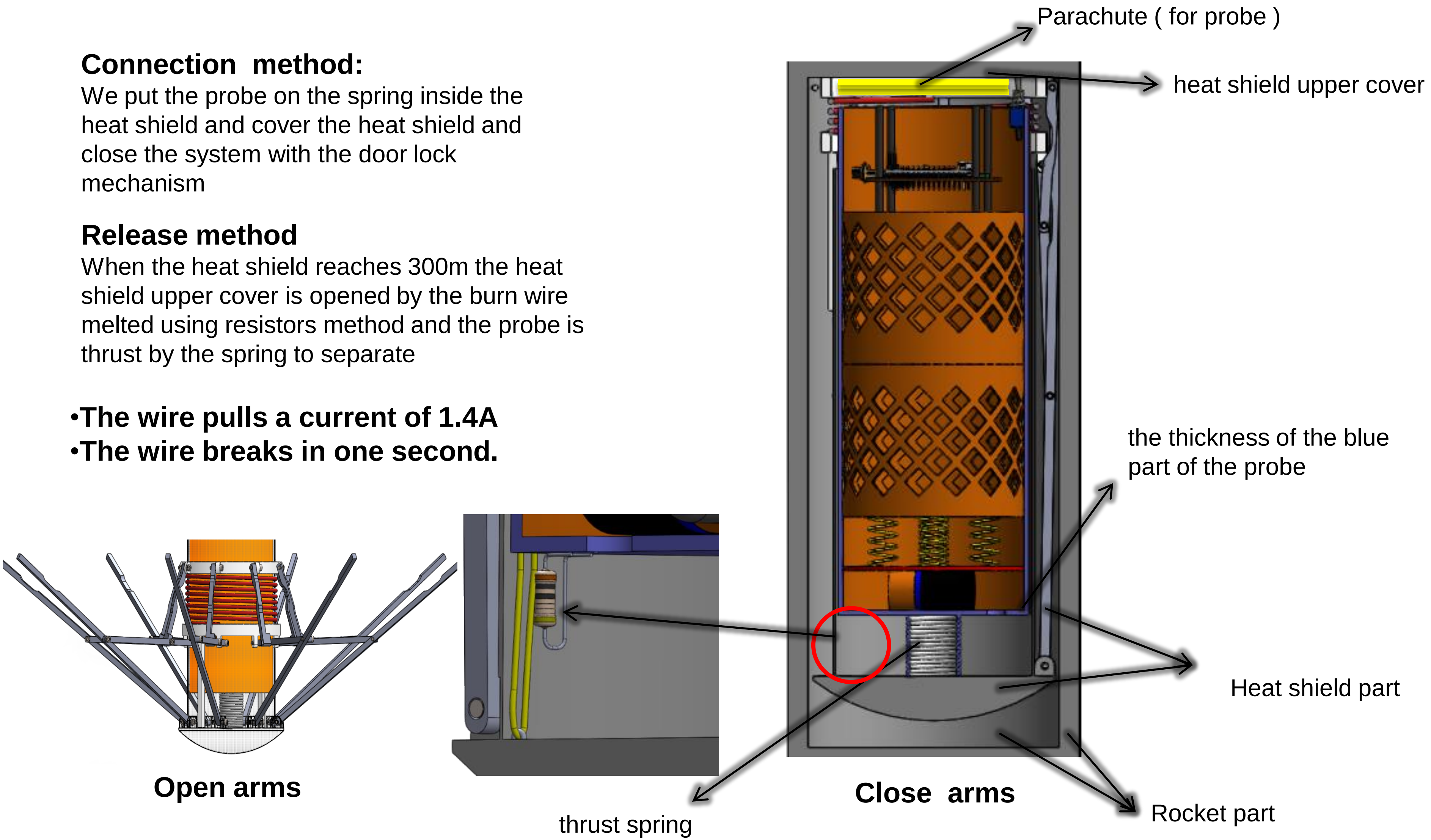
High strength and durability**.** The price is cheap. Good absorption impact.

Heat shield Release Mechanism

Connection method:
We put the probe on the spring inside the heat shield and cover the heat shield and close the system with the door lock mechanism

Release method
When the heat shield reaches 300m the heat shield upper cover is opened by the burn wire melted using resistors method and the probe is thrust by the spring to separate

- **The wire pulls a current of 1.4A**
- **The wire breaks in one second.**



Probe Parachute Release Mechanism

First step (ground station)

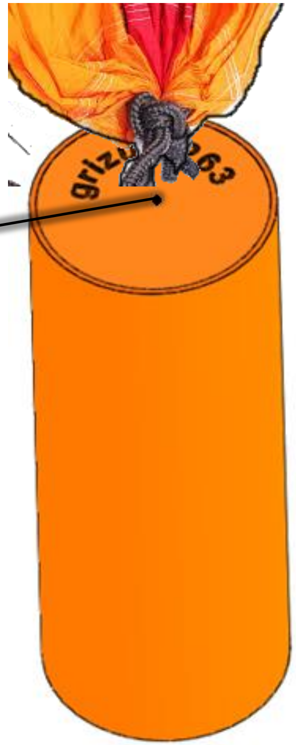
The stranded strands will be threaded through an opening in the top of the strand and knotted. After the probe is placed in the heat shield, the parachute is folded over and placed on the probe. The heat shield will remain in the space between the cover and the probe when the top cover of the heat shield is closed.

Second step (at 300 m)

A spring will be between the lower part of the probe and the heat shield. When the heat shield goes down to 300 m, the top cover of the heat shield will be opened and the probe will be thrown out with the help of the spring and the parachute will have to open when the encountering the air resistance

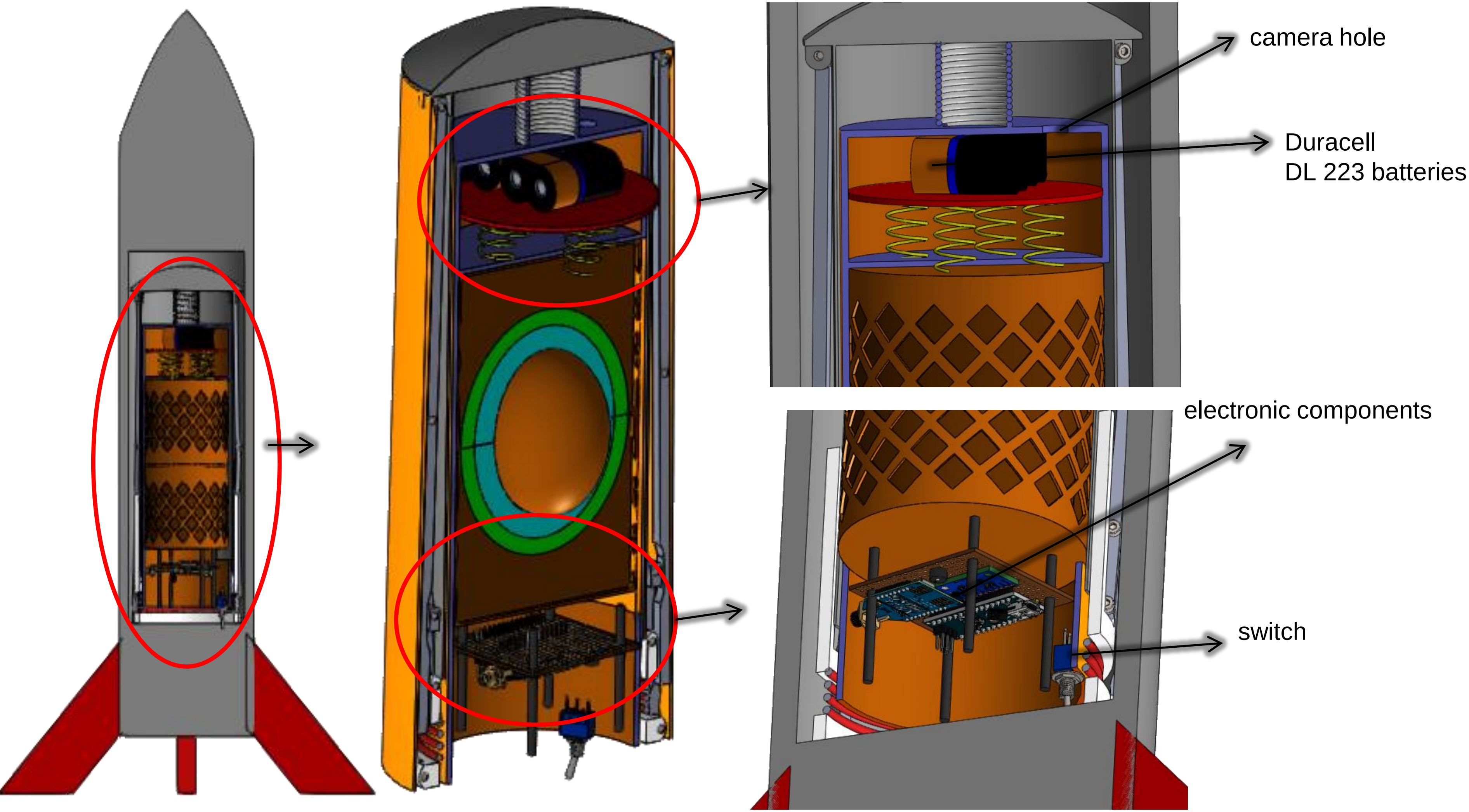
Probe's parachute is in this space

Thrust spring



Parachute connection point

Structure Survivability



Structure Survivability

	Method	Requirements
Electronics Mounting	– Electronic components like PCB board and camera will be mounted to the prob with high performance adhesives and screw	– All structures must survive 30 Gs of shock – RN#20 – All structures must be built to survive 15 Gs of acceleration RN#19
Electronics Enclosure	–A connection skeleton will be used to rigid electronic components and provide strength to the G force.	– All structures must survive 30 Gs of shock – RN#20 – All structures must be built to survive 15 Gs of acceleration RN#19
Electronic Connections	– Electronic connections will be secured using solder , hot silicon and screw	– All structures must survive 30 Gs of shock – RN#20 – All structures must be built to survive 15 Gs of acceleration RN#19
Descent control attachments	-We will use a parachute for landing control . It is round and it has a spill hole on top .	The descent rate of the probe with the heat shield released and parachute deployed shall be 5 meters/second. RN#44

Development Status: We are planing to do shock force and acceleration tests on 20 May.

Mass Budget

PROBE:

- **Electronics**

Part Name:	Weight (g):	Sources:
Battery	38x2=76 g	Datasheet
Switch	2 g	Datasheet
Voltage Sensor	<1 g	Datasheet
DC-DC Converter	1x2=2 g	Measurement
Buzzer	5 g	Datasheet
SD Card Module	6 g	Datasheet

Mass Budget

Part Name:	Weight (g):	Sources:
GPS	6 g	Datasheet
RTC	10 g	Datasheet
Coin Cell	1,2 g	Datasheet
10-DOF IMU	10 g	Datasheet
Telemetry Module	8 g	Datasheet
Camera	12 g	Datasheet
Arduino Nano	7 g	Measurement
Total	146,2 g	

Mass Budget

- **Egg protection + Egg mass**

Part Name:	Weight (g):	Sources:
Egg	60 g	Mission Requirement
Egg Protection	65 g	Measurement
Total:	125 g	

- **Probe body**

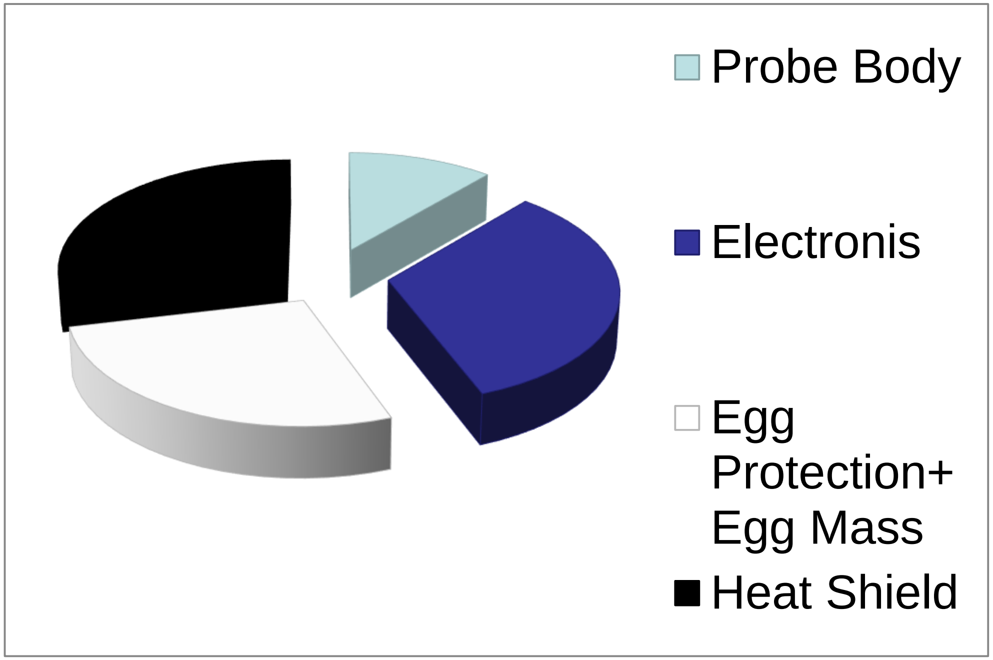
Part Name:	Weight (g):	Sources:
Probe Body	50 g	CAD Estimate
Skeleton (x4)	12 g	CAD Estimate
Parachute	10 g	Measurement
Total:	72 g	

Heat Shield:

Part Name:	Weight (g):	Sources:
Body	60 g	CAD Estimate
Spring (x2)	10 g	Measurement
Arms (x8)	5 g x 8=40 g	CAD Estimate
Total:	110 g	

Mass Budget

CANSAT	
Probe Body	72 g
Electronics	146,2 g
Egg protection + Egg mass	125 g
Heat Shield	110 g
TOTAL	453,2 g
Margins (%10)	498,52 g



Uncertaines:
The data sources of materials such as screws, epoxy electronic cables don't appear.When we consider electronic cables, screws, etc, we give a margins of 10%
RN#1: Total mass of the CanSat shall be 500 grams +/- 10 grams.

Mass Budget

RN#1: Total mass of the CanSat shall be 500 grams +/- 10 grams.

Correction Methods:

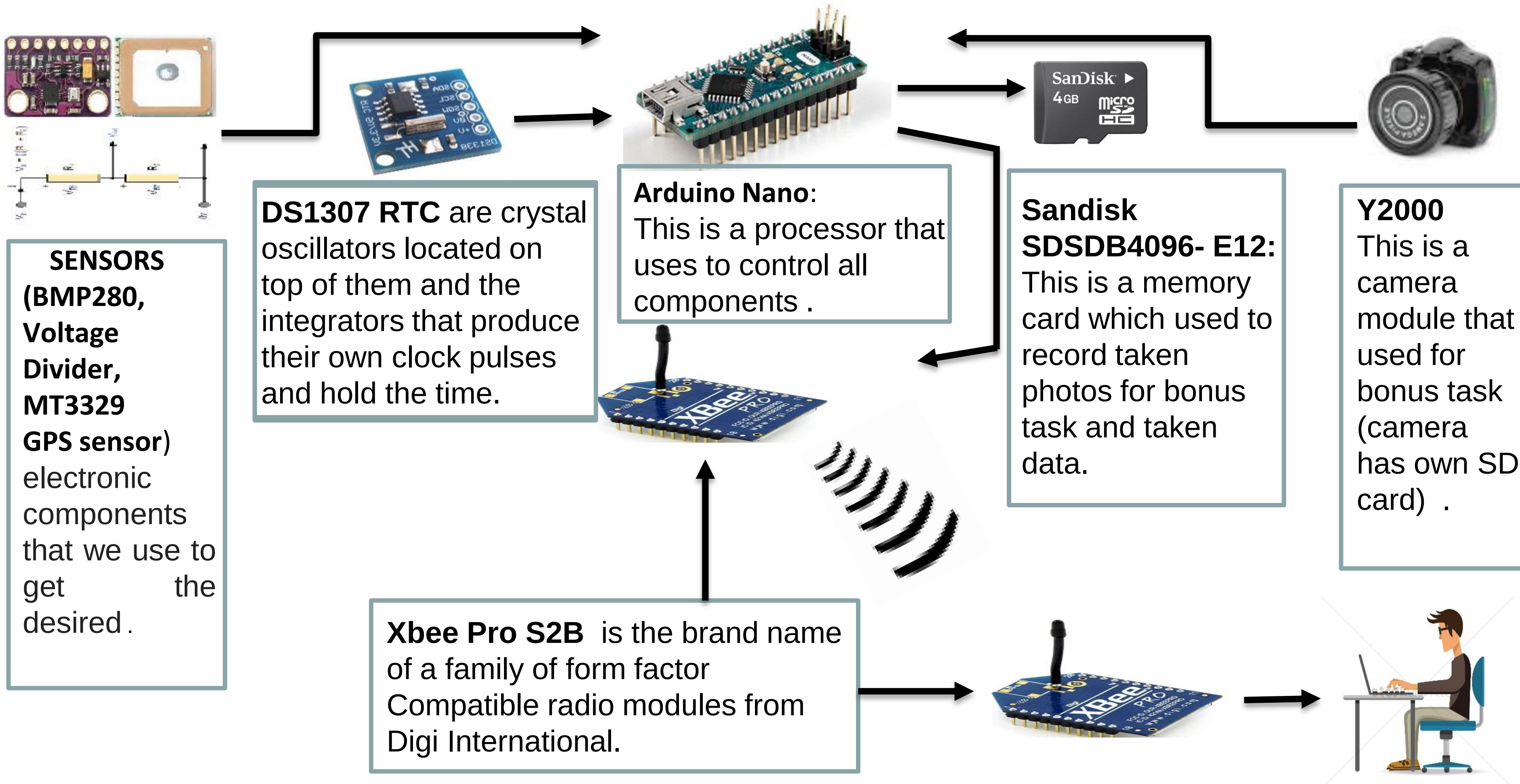
In case total mass measured is different than expected,there are two different protective walls with different wall thicknesses. And we change between them.

Correction Methods	Solution
If weight of Cansat <490 g	Container with thicker wall will be use. (For example wall thickness 25 mm) If systems are heavy, we will assembly sinker in heat shield
If weight of CanSat >510 g	Container with thicker wall will be use. (For example wall thickness 10 mm)

Communication and Data Handling (CDH) Subsystem Design

Durdali ATILGAN

CDH Overview



SENSORS (BMP280, Voltage Divider, MT3329 GPS sensor) electronic components that we use to get the desired.

DS1307 RTC are crystal oscillators located on top of them and the integrators that produce their own clock pulses and hold the time.

Arduino Nano: This is a processor that uses to control all components .

Sandisk SDSDB4096- E12: This is a memory card which used to record taken photos for bonus task and taken data.

Y2000 This is a camera module that used for bonus task (camera has own SD card) .

Xbee Pro S2B is the brand name of a family of form factor Compatible radio modules from Digi International.

Ground Control Station

CDH Changes Since PDR

Antenna Selection

Antenna Model	Gain	Weight	Connector Type	Frequency	Size
A24-HASM-450	2.14 dBi	13	SMA	2.4 Ghz	80*14 mm
2.4GHz Antenna-Adhesive (U.F.L)	2 dBi	2.2g	SMA	2.4 Ghz	27*25*0.08 mm

Rationale:
This antenna is more advantageous in terms of size weight and performance than PDR antenna.

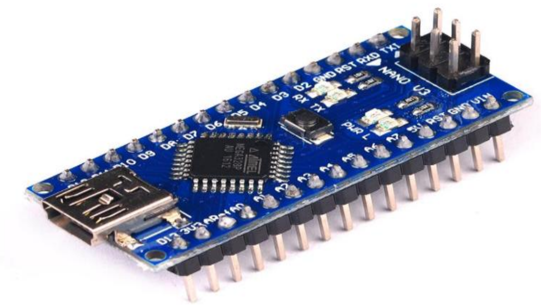
CDH Requirements

Number	Description	Rationale	Priority	VM
RN#25	During descent, the probe shall collect air pressure, outside air temperature, GPS position and battery voltage once per second and time tag the data with mission time.	Competition requirement. Prevent confusion data.	Very high	A,I,D,T
RN#26	During descent, the probe shall transmit all telemetry. Telemetry can be transmitted continuously or in bursts.	Send to taken data to ground station.	Very high	A,I,D,T
RN#27	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.	To prevent data loss and to ensure stable operation of the system	Very high	T,I,A
RN#28	XBEE radios shall be used for telemetry. 2.4 GHz Series 1 and 2 radios are allowed. 900 MHz XBEE Pro radios are also allowed.	Competition requirement.	High	I,D,T
RN#29	XBEE radios shall have their NETID/PANID set to their team number	for the data to arrive at our ground station	High	A,I,D
RN#30	XBEE radios shall not use broadcast mode.	Competition requirement	High	I,D
RN#33	All telemetry shall be displayed in real time during descent.	Competition requirement	Very high	T,I,D,A

Probe Processor & Memory Trade & Selection

Microcontroller	Speed	Data Interface	Flash Memory	RAM	Operating voltage	Price ($)
Arduino Nano	16 MHz	14-digital pins 2 serial pins 6 PWM pins 4 SPI pins I2C pins	32 Kb	2 Kb	5 v	2.52

Final Selection **Arduino Nano**	+ Easy programming + Low weight and small size + Easy to get and very cheap + Acceptable clock speed, RAM size and I/O pins + Power consumption is very low than others



Probe Processor & Memory Trade & Selection

Model	Memory	Interface	**Speed**	**Price**
Sandisk SDSDB-4096- E-12	4GB	SPI	48MB/s	$4

Final Selection : Sandisk SDSDB-4096- E-12

- **Fair price**
- **More speed**
- **Enough memory**

Sd card is used with **Arduino SD card Module(SPI)**

Probe Real-Time Clock

Part Number	Interface	VSUPPLY (V)	Time Keeping Current (nA)	Memory Type	Memory Size (Bytes)	Functions	Price	HARDWARE /SOFTWARE
DS1307	I^2C	5	300	NV SRAM	56le	RTC	$1.50	HARDWARE

Final Selection is hardware RTC. Hardware RTC has a built-in power-sense circuit that detects power failures and automatically switches to the backup supply. That mean is this way we can protect data for reset. So we selected Hardware system.

Final Selection DS1307:

- 56-Byte, Battery-Backed, General-Purpose RAM with Unlimited Writes
- Programmable Square-Wave Output Signal
- Low price

Probe Antenna Selection

Antenna Model	Gain	Dimensions	Connector Type	Frequency
2.4GHz Antenna-Adhesive(U.F.L)	2 dBi	41 x 30mm, 350mm cable	SMA	2.4 Ghz

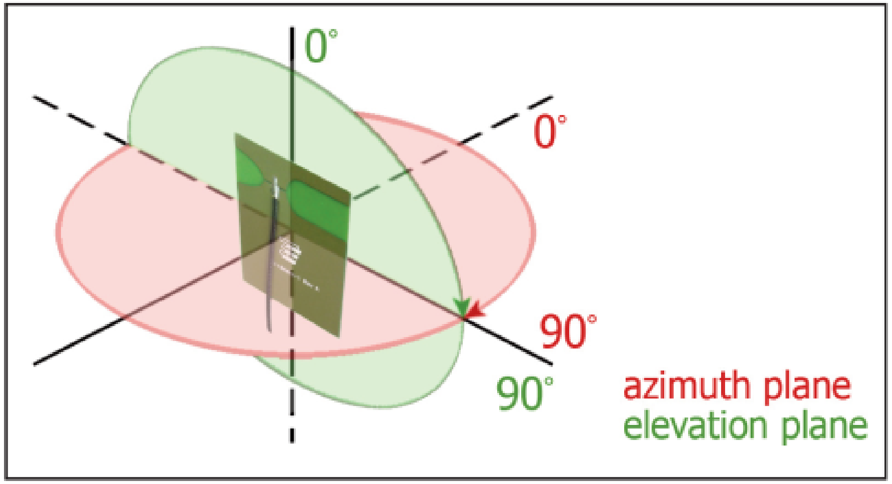
Final Selection for Antenna: 2.4GHz Antenna-Adhesive(U.F.L)

- High gain value
- Small size
- Required for longer distance communication

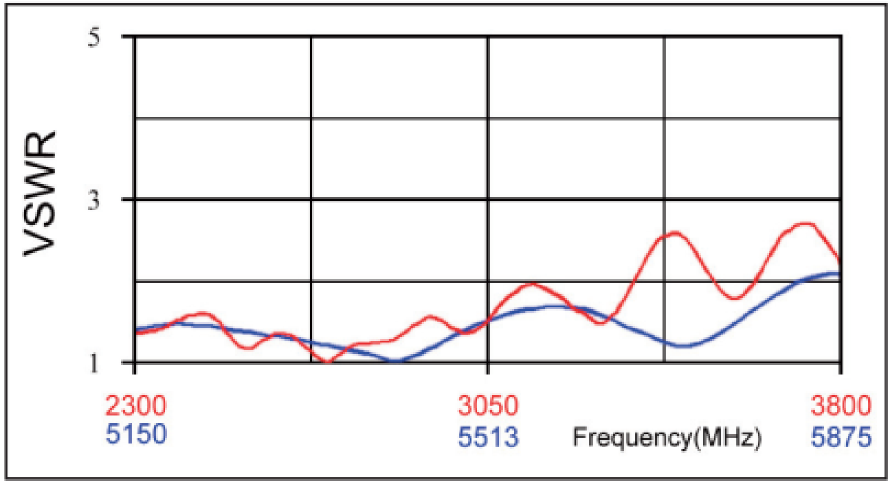
In addition to Xbee, using a directional antenna with 2 dBi gain gives an advantage in terms of data transmission. This performance is enough for transmission data to ground station. SMA connector is directly compatible with Xbee. Also our antenna’s weight is 2.2 g. This is so lightweight.

Probe Antenna Selection

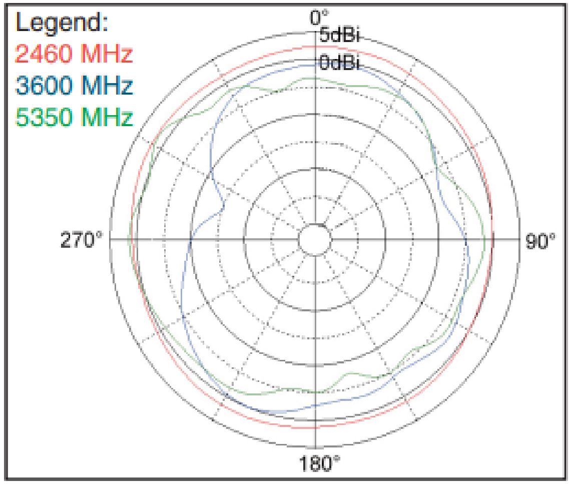
Test Orientation in Free Space



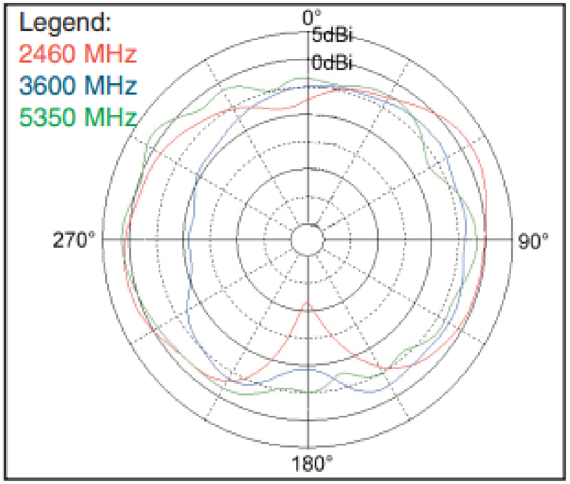
VSWR



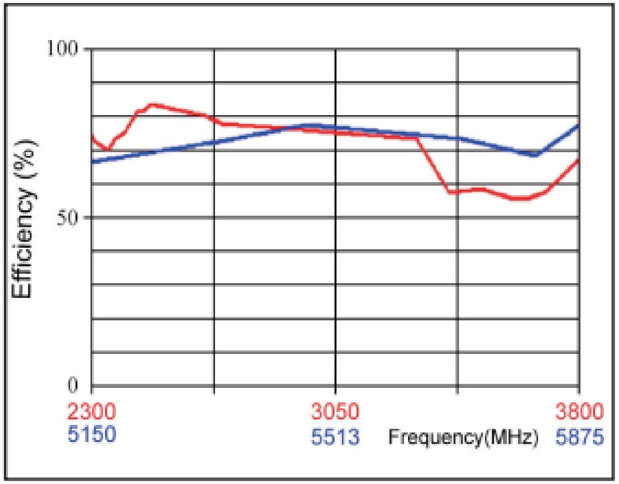
Azimuth



Elevation



Efficiency



Probe Radio Configuration

Model	**Operating Current (Receive)**	**Operating Frequency**	**RF Data Rate**	**Transmit Power Output**	**Outdoor line of sight Range**	**Price**
XBEE-PRO S2B	295mA	2.4GHz	250kbps	63mW(+18 dBm)	10496 ft	$43

Final Selection is Xbee Pro S2B thanks to

High transmit power

High range

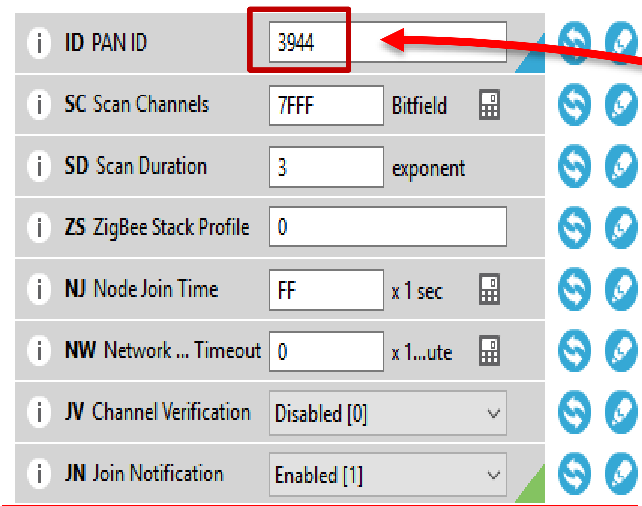
Fair price

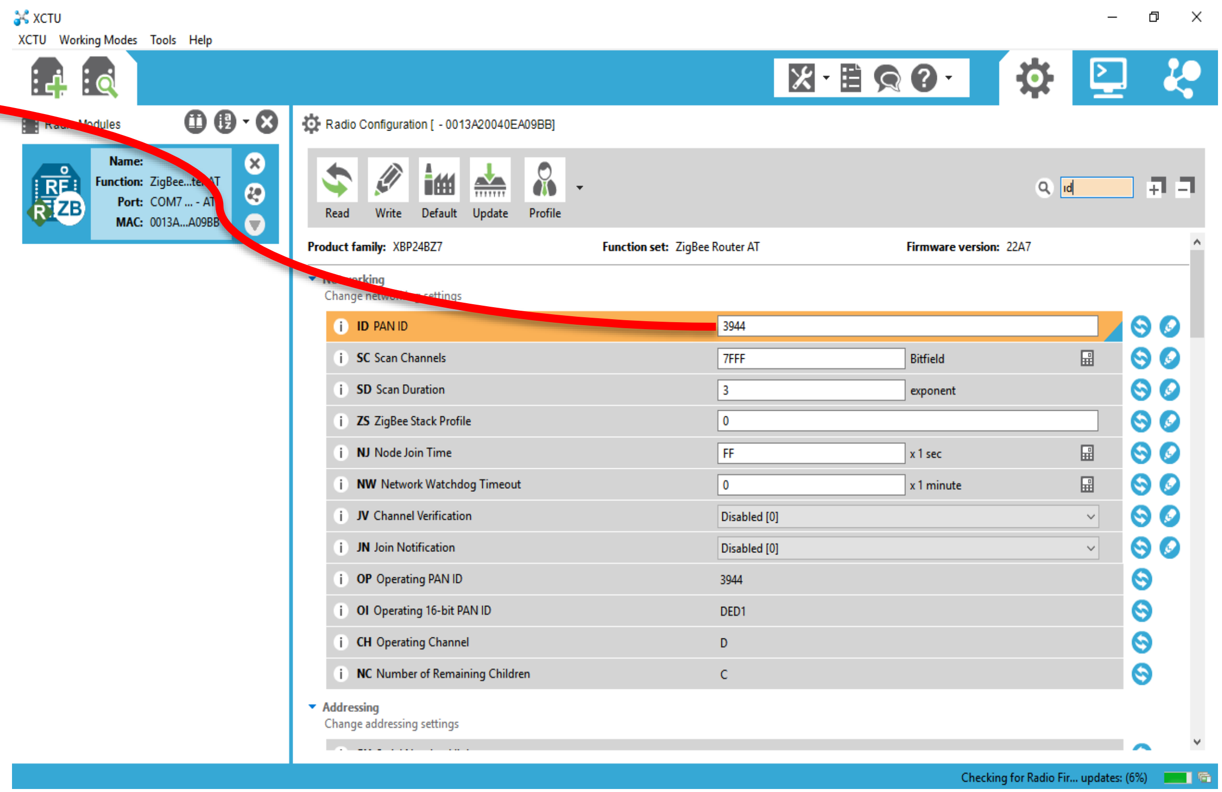
High RF data rate

Probe Radio Configuration

Transmission control:

Selected Xbee pro S2B. Confuguration between two Xbee with XCTU program. Network ID is set team number. Data are sent 1Hz and burst. When the probe put on the rocket, first Xbee will send data to second Xbee and than sending data continue until probe landing to ground.





NETID:3944

Radio Configuration Testing is made.These shown test unit.

Probe Telemetry Format

Data Format :

<TEAM ID>,<MISSION TIME>,<PACKET COUNT>,<ALTITUDE>, <PRESSURE>,<TEMP>,<VOLTAGE>,<GPS TIME>,<GPS LATITUDE>,<GPS LONGITUDE>,
<GPS ALTITUDE>,<GPS SATS>, <TILT X>,<TILT Y> ,<TILT Z>, <SOFTWARE STATE>,[<BONUS(camera)>]

Example:

<3944>,<12>,<48>,<510>,<78.04>,<89>,<8>,<5:00>,<41>,<90>,<70.07>,<10>,<3>,<61>,<4124>,<50>,<33>

<BONUS>: Count number of taken photos

Data rate of packets: Burst in 1Hz

The presented format match the Competition Guide requirements.

Probe Telemetry Format

<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 with one meter resolution.
<PRESSURE> is the measurement of atmospheric pressure.
<TEMP> is the sensed temperature in degrees C with one degree resolution.
<VOLTAGE> is the voltage of the CanSat power bus.
<GPS TIME> is the time generated by the GPS receiver.
<GPS LATITUDE> is the latitude generated by the GPS receiver.
<GPS LONGITUDE> is the longitude generated by the GPS receiver.
<GPS ALTITUDE> is the altitude generated by the GPS receiver.
<GPS SATS> is the number of GPS satellites being tracked by the GPS receiver.
<TILT X> Tilt sensor X axis value.
<TILT Y> Tilt sensor Y axis value.
<TILT Z> Tilt sensor Z axis value.
<SOFTWARE STATE> is the operating state of the software.
<BONUS> taken photos

Probe Telemetry Format

Telemetry Data

REAL-TIME PLOTTING
<ALTITUDE>(m)
<PRESSURE> (Pa)
<TEMP>(C)
<VOLTAGE>(V)
<GPS ALTITUDE>(m)
<TILT X>
<TILT Y>
<TILT Z>

JUST SHOWN
<TEAM ID>
<MISSION TIME>(s)
<PACKET COUNT>
<GPS TIME>
<GPS SATS>
<SOFTWARE STATE>
<BONUS>

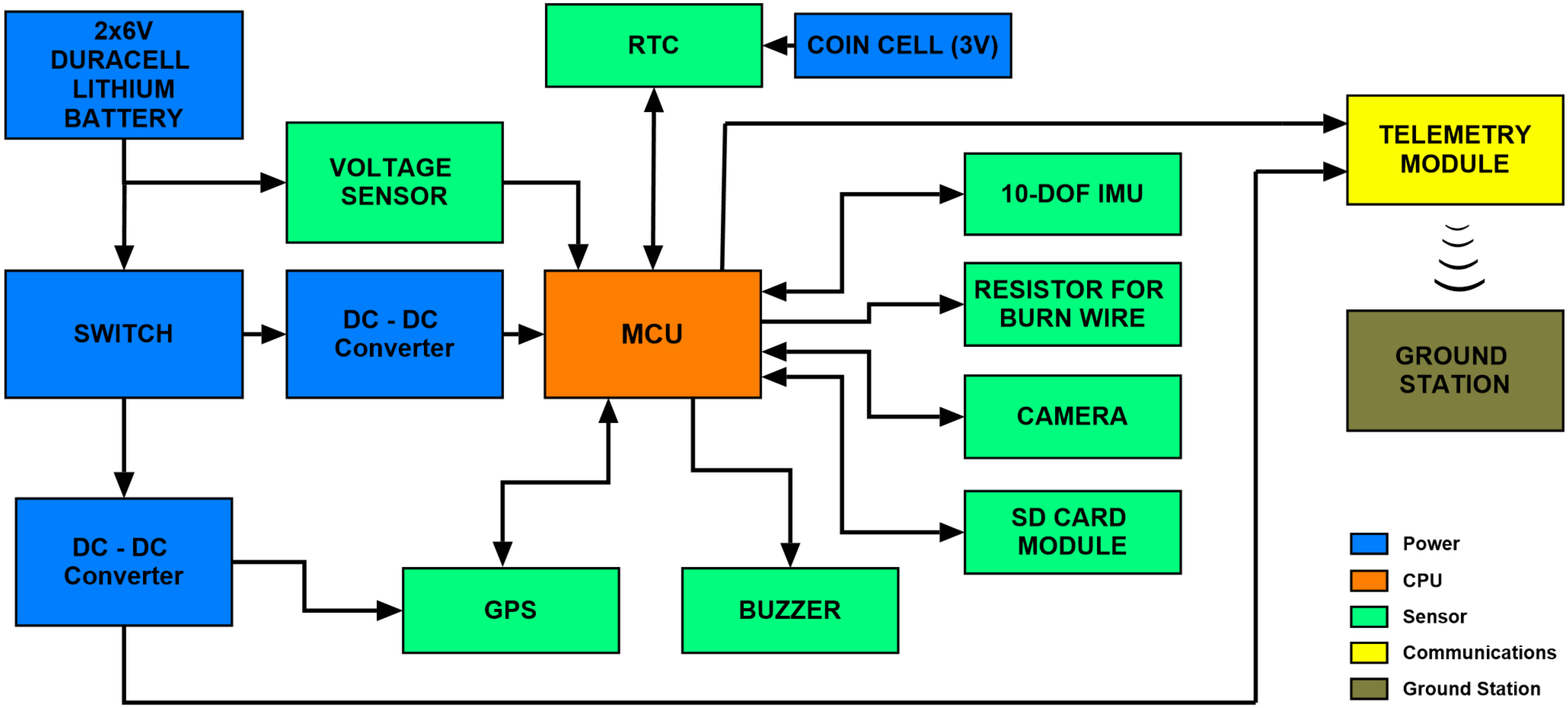
Electrical Power Subsystem Design

Serdar DOĞAN

EPS Overview

- All the sensors in the probe will be fed to the MCU powered by the battery. Received data in all sensors will be sent to the ground station with telemetry system.
- The electrical block diagram of the probe is shown under the next slide.
- A 3V coin battery is used to required power the real time clock module.
- System power is on/off the external accessible with a switch.
- Battery voltage is measured by Voltage divider on MCU.
- We used MPU-9255 to measure tilt.
- A voltage regulator circuit is used to regulate the voltage values coming from the battery.
- 12V DC lithium battery will be employed for powering the sensor subsystem, Xbee telemetry system and heat shield separation mechanism science payload.
- We used 6V DC lithium battery for burn wire melted resistor

EPS Overview



EPS Changes Since PDR

- **The LM2596 as the voltage regulator was removed from the system and the MP23070N was used.**

	LM2596	MP23070N
Mass (g)	11.6	1
Dimension (mm)	43 x 20 x 14	17 x 10 x 4
Efficiency	73%	95%
Price ($)	1.10	1.05
Current (A)	3	2

Why MP23070N

- MP23070N is very light and small.
- The MP23070N is more efficient at the voltage we use.
- MP23070N is cheaper than the other.
- The MP23070N can pass less current but is sufficient for us.

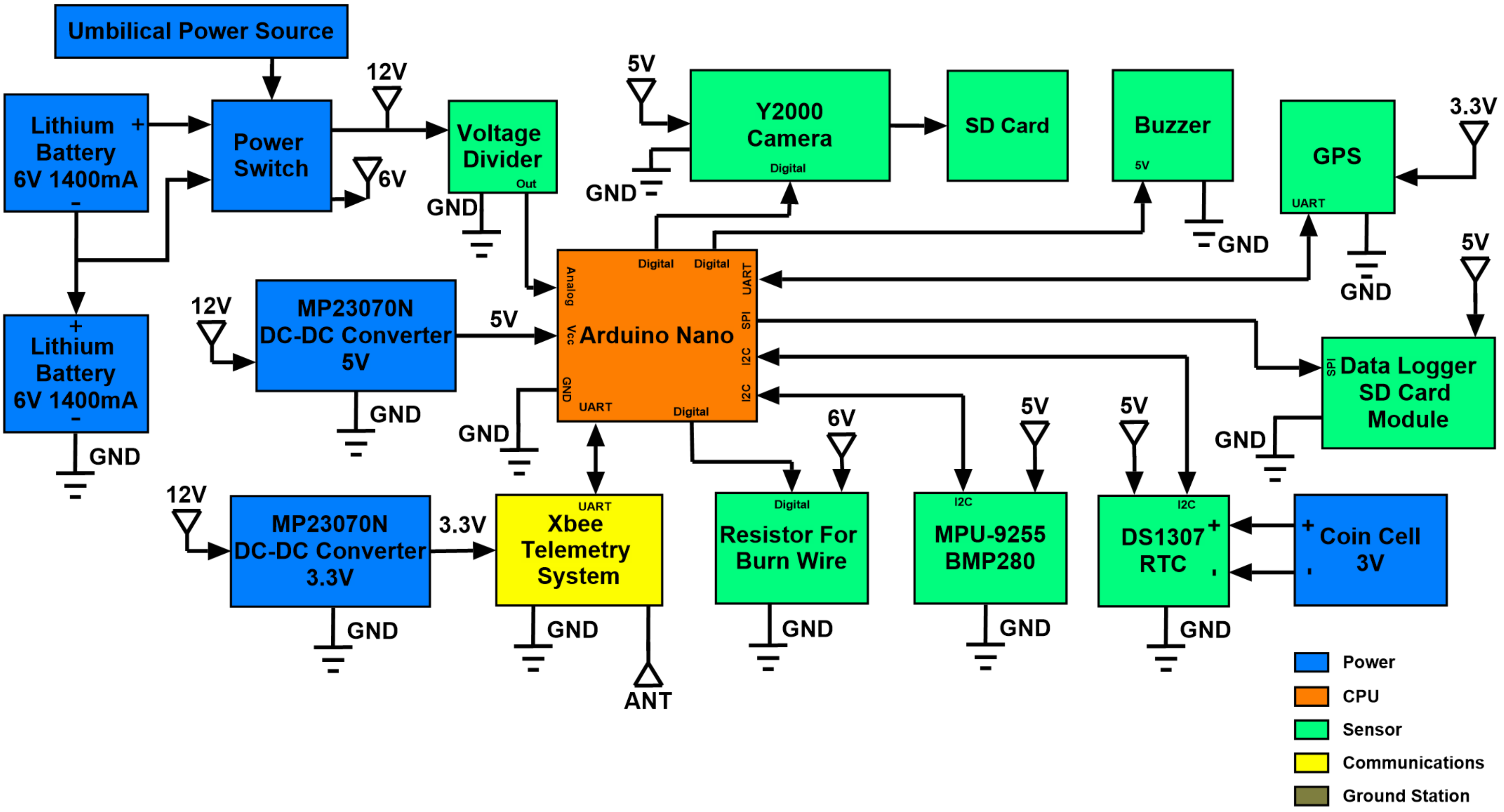
EPS Requirements

Number	Requirement	RATIONALE	Priority	VM			
				A	I	T	D
RN#28	XBEE radios shall be used for telemetry. 2.4 GHz Series 1 and 2 radios are allowed. 900 MHz XBEE Pro radios are also allowed.	Competition requirement	MEDIUM		√	√	√
RN#41	The probe must include an easily accessible power switch.	Competition requirement	HIGH	√	√		√
RN#42	The probe must include a power indicator such as an LED or sound generating device.	Competition requirement	MEDIUM	√	√		√
RN#46	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#47	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	MEDIUM	√	√		

EPS Requirements

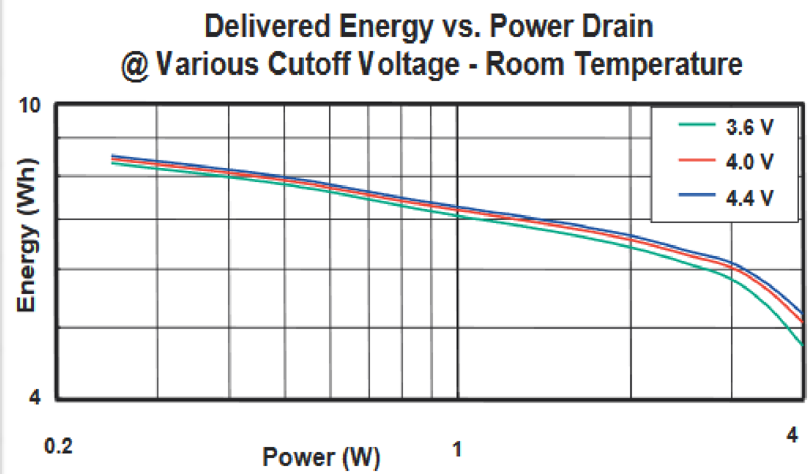
Number	Requirement	RATIONALE	Priority	VM			
				A	I	T	D
RN#48	Spring contacts shall not be used for making electrical connections to batteries. Shock forces can cause momentary disconnects.	Competition requirement	MEDIUM	✓	✓		
RN#49	A tilt sensor shall be used to verify the stability of the probe during descent with the heat shield deployed and be part of the telemetry.	Competition requirement	HIGH	✓	✓	✓	
EPS#1	Battery power is very long duration during work and flight before wait time.	Use much less battery count and reduce system's weight	HIGH	✓	✓		
EPS#2	Use of external temperature sensor	The pressure sensor can measure the temperature	LOW	✓	✓	✓	
EPS#3	Use of tilt sensor	If the system rolls over, we can observe it in the ground stations.	HIGH	✓	✓	✓	

Probe Electrical Block Diagram



Duracell DL223

Nominal Voltage:	6 V
Typical Voltage:	6.4-6.6 V
Nominal Internal Impedance:	0.4 ohm @ 1kHz
Average Weight:	38 gm
Typical Volume:	22.6 cm^3
Terminals:	Flat, Recessed Contact Nickel Plated Steel
Operating Temperature Range:	$-20°C$ to $75°C$ ($-4°F$ to $167°F$)
Capacity:	1400 mAh
Generated Current:	1400 mAh



Probe Power Budget

Components	Power Consumption	Current	Voltage	Duty Cycles	Source
Microcontroller	95 mW	19 mA	5 V	120 s	Data Sheet
10-DOF IMU	221 mW	4.42 mA	5 V	120 s	Data Sheet
RTC	1.5 mW	0.3 mA	5 V	120 s	Data Sheet
Buzzer	150 mW	30 mA	5 V	60 s	Data Sheet
Camera	300 mW	60 mA	5 V	120 s	Measurement
Burn wire melted using resistors	8400 mW	1400 mA	6 V	< 1 s	Measurement
Telemetry Module	1122 mW	340 mA	3.3 V	120 s	Data Sheet
SD Card Module	0.0528 mW	0.016 mA	3.3 V	120 s	Estimate
GPS	174.9 mW	53 mA	3.3 V	1 h	Data Sheet

Probe Power Budget

Required Power Consumption	260 mWh
Margins	%20 (i.e. 52 mWh)
Total Power Consumption	312 mWh
Produced Current(Max)	1500 mWh

- Margin is determined according to the current consumption by the sensors at different operating temperatures.

Flight Software (FSW) Design

Kerim USLU

FSW Overview

- **Overview of the CanSat FSW design**

  All the necessary data will be sent to the MCU via sensors.The data will be stored in the SD card and will be sent to the ground station with via Xbees

- **Programming languages**

  C/C++ programming languages

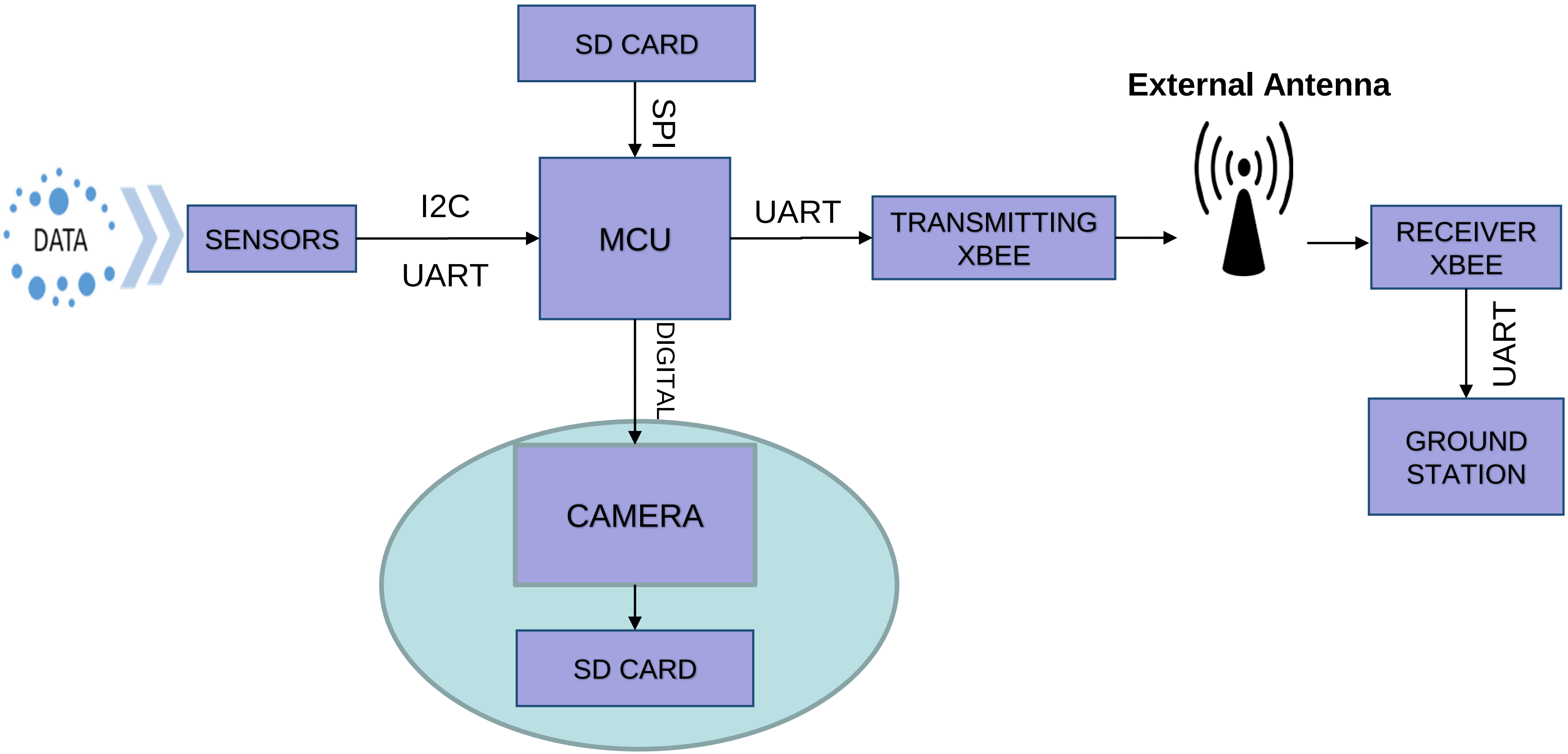
- **Development environments**

  Arduino IDE

  Sublime Text Editor

  ClickCharts by NCH software

- **FSW Design Of Basic Flow Chart**



FSW Overview

- **Brief summary FSW tasks**
  - The electronic system is activated by the power (on /off) button before the CanSat is placed on the rocket.
  - CanSat will rise with the rocket and will leave the rocket after completing the rocket rise. ABHS will open via burning of the wire.
  - All necessary data gathered from the sensors will be sent to the ground station in real time via XBEEs and simultaneously save on the SD card in CanSat.
  - ABHS will be released via burning of the wire from the probe at 300 m and the parachute will be opened.Then it will start taking photos.
  - All necessary data will continue to be saved on the SD card and sent to the ground station.
  - The buzzer will become actived when the altitude falls below 5 m. The buzzer will continue to be heard until the electronic system is turned off by the power(on / off) button.
  - The mission will be completed.

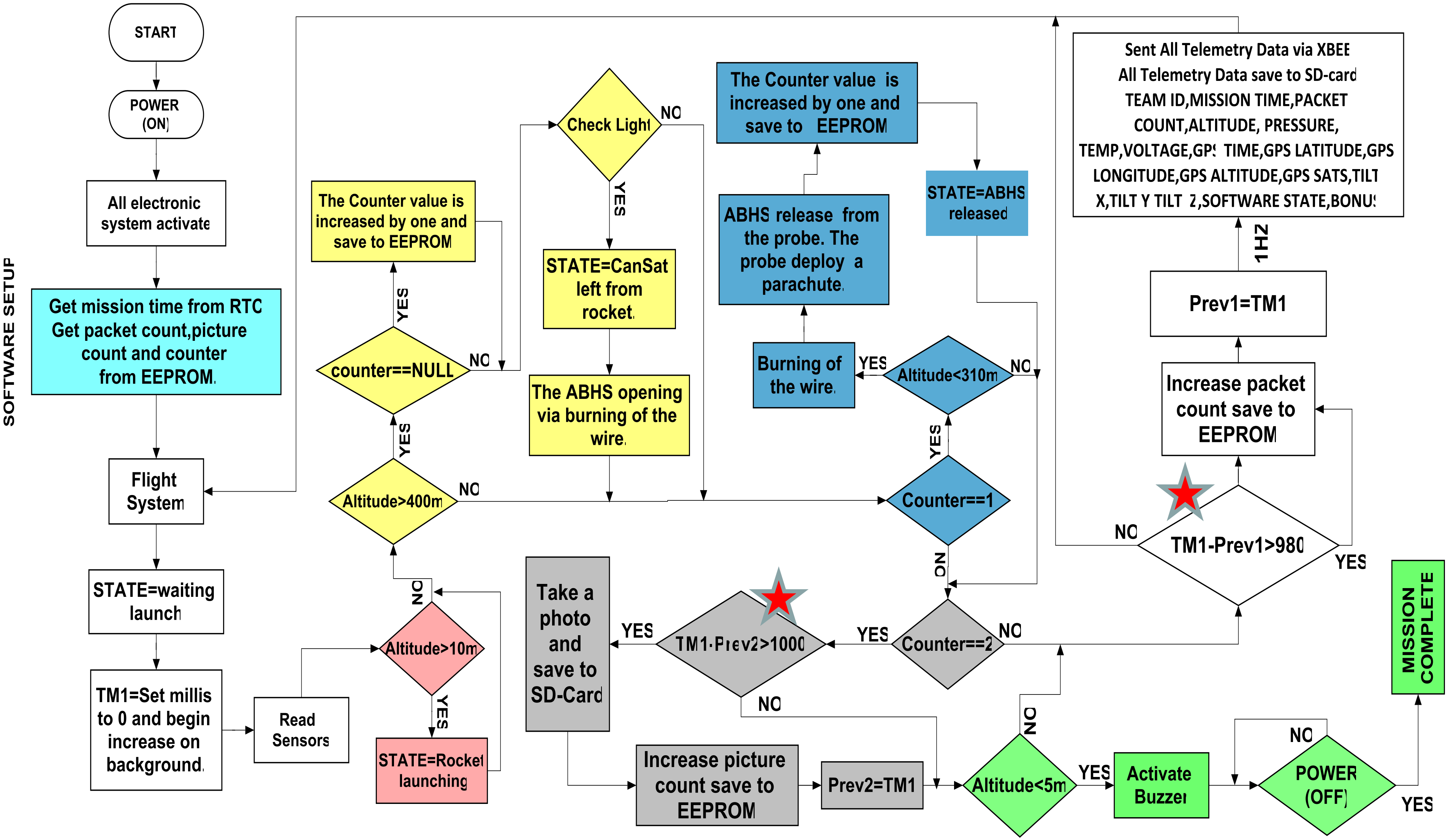
FSW Changes Since PDR

- **The algoritm has been updated.**
- ➢ **The waiting function has been removed from the algorithm flow chart on FSW state diagram.System speed has been set with using millis function and system stability has been increased.Chancing parts has been shown with red stars.**

FSW Requirements

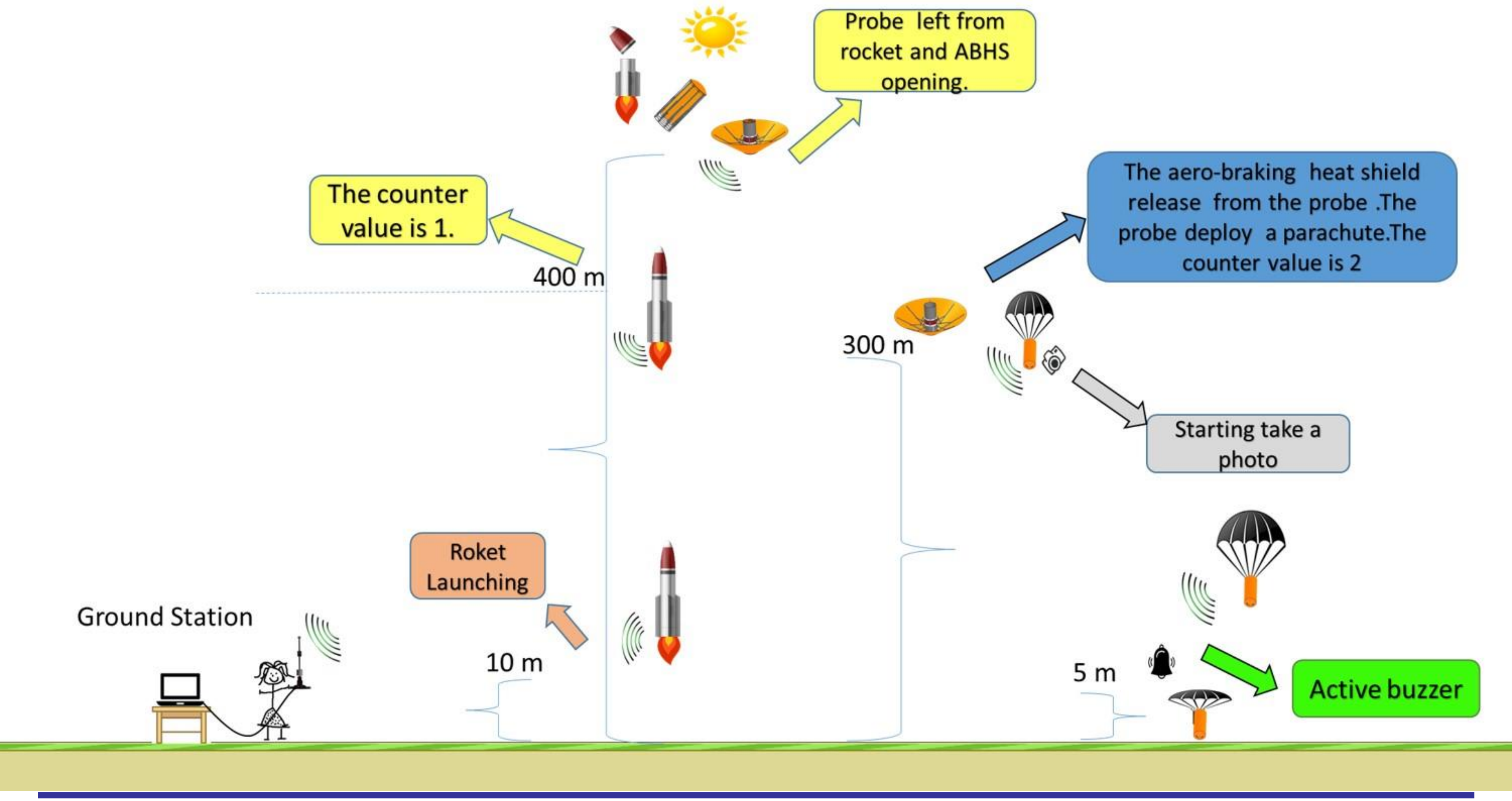
NUMBER	DESCRIPTION	RATIOANALE	PRIORITY	VM			
				A	I	T	D
RN#14	The aero braking heat shield shall be released from the probe at 300 meters.	Competition requirement.	HIGH	✓	✓		
RN#15	The probe shall deploy a parachute at 300 meters.	Competition requirement.	HIGH	✓	✓		
RN#25	During descent, the probe shall collect air pressure, outside air temperature, GPS position and battery voltage once per second and time tag the data with mission time.	Competition requirement.	HIGH	✓	✓	✓	✓
RN#26	During descent, the probe shall transmit all telemetry. Telemetry can be transmitted continuously or in bursts.	Competition requirement.	HIGH	✓	✓	✓	✓
RN#27	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.	To prevent data loss and ensure that the system is stable.	HIGH	✓	✓	✓	
RN#33	All telemetry shall be displayed in real time during descent.	Competition requirement.	HIGH	✓	✓	✓	✓
RN#34	All telemetry shall be displayed in engineering units (meters, meters/sec, Celsius, etc.)	Competition requirement.	MEDIUM		✓		✓
RN#39	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. To prevent data loss.	HIGH	✓	✓	✓	✓
RN#45	An audio beacon is required for the probe. It may be powered after landing or operate continuously.	Competition requirement.	HIGH	✓	✓		
RN#49	A tilt sensor shall be used to verify the stability of the probe during descent with the heat shield deployed and be part of the telemetry.	Competition requirement.	HIGH	✓	✓		

Probe CanSat FSW State Diagram



Probe CanSat FSW State Diagram

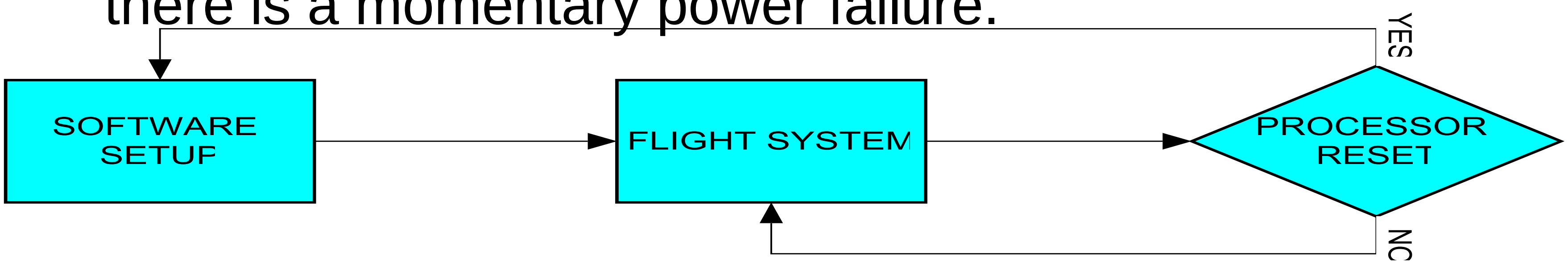
Display of FSW sub functions running during flight according to colors in FSW flow chart.



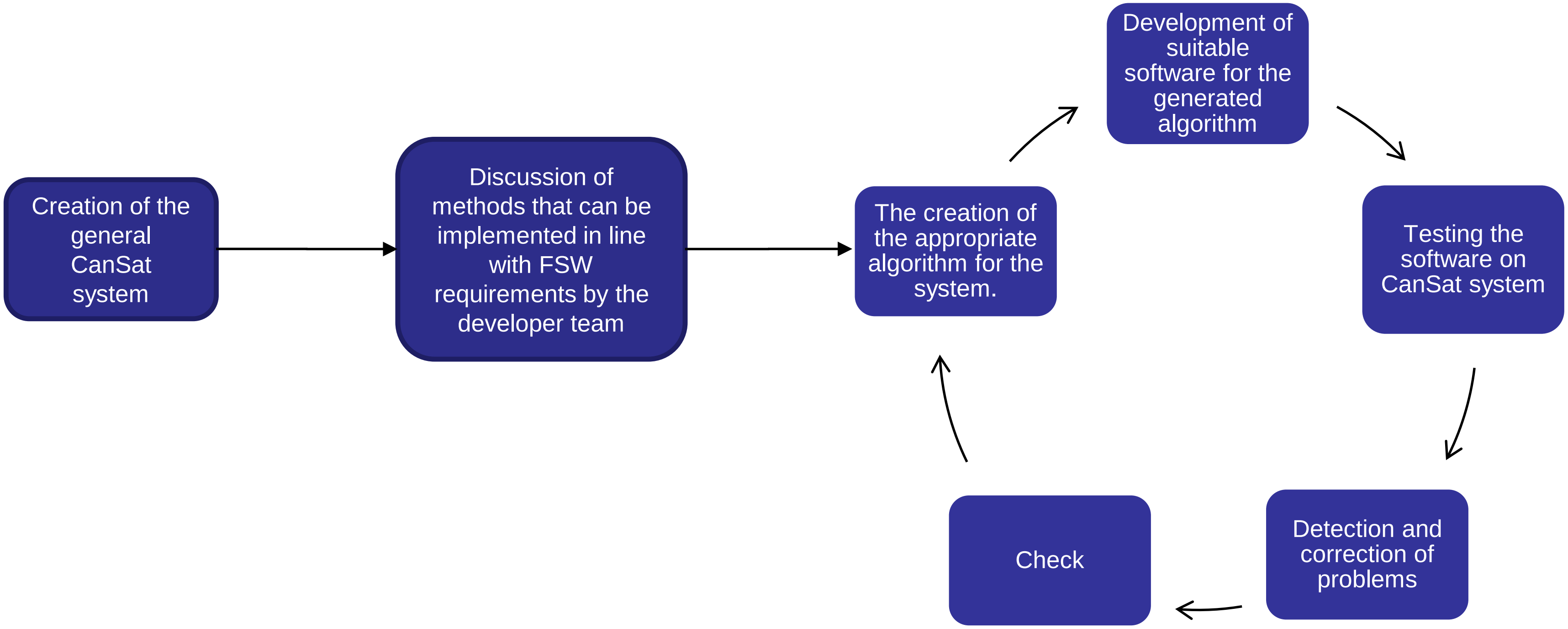
Probe CanSat FSW State Diagram

Processor Reset Control

- Mission time, packet count and counter data will be saved to EEPROM. In case of resetting of the processor, necessary data will be taken from EEPROM and data loss will be prevented.
- Any processor reset during mission, software setup part will be stored recover data.
- The RTC data will be protected stored in the internal EEPROM of the RTC. The RTC data is protected when there is a momentary power failure.



- **Software Subsystem Development Sequence**



Software Development Plan

- **Test methodology**

Testing the relevant subsections of the FSW on the sensors. → Checking the accuracy of the data coming from the sensors and configuring the sensors. → Checking whether the FSW meets the CanSat competition requirements. → Testing the FSW on the general CanSat system

- **Prototyping and prototyping environments**
  - Electronic system are created on the breadboard.
  - The necessary software is installed in arduino with Arduino IDE
  - Software errors are detected with the aid of the Arduino IDE.
  - The data stream is checked from the Arduino Serial monitor.
- **Development Team**

  Kerim USLU

  Durdali ATILGAN

  Yasin BIYIKLI

Software Development Plan

Progress since PDR

Collection and processing of necessary data.

Creation of suitable software for the use of sensors	✓
Controlling the accuracy of data from sensors	✓
Recovery of mission time and packet count in case the processor is reset.	✓
Creating of appropriate software for use the camera	✓

Communication

Checking XBEEs communication	✓
Establish connection with ground station	✓
Sending the data to the ground station in the appropriate sequence	✓

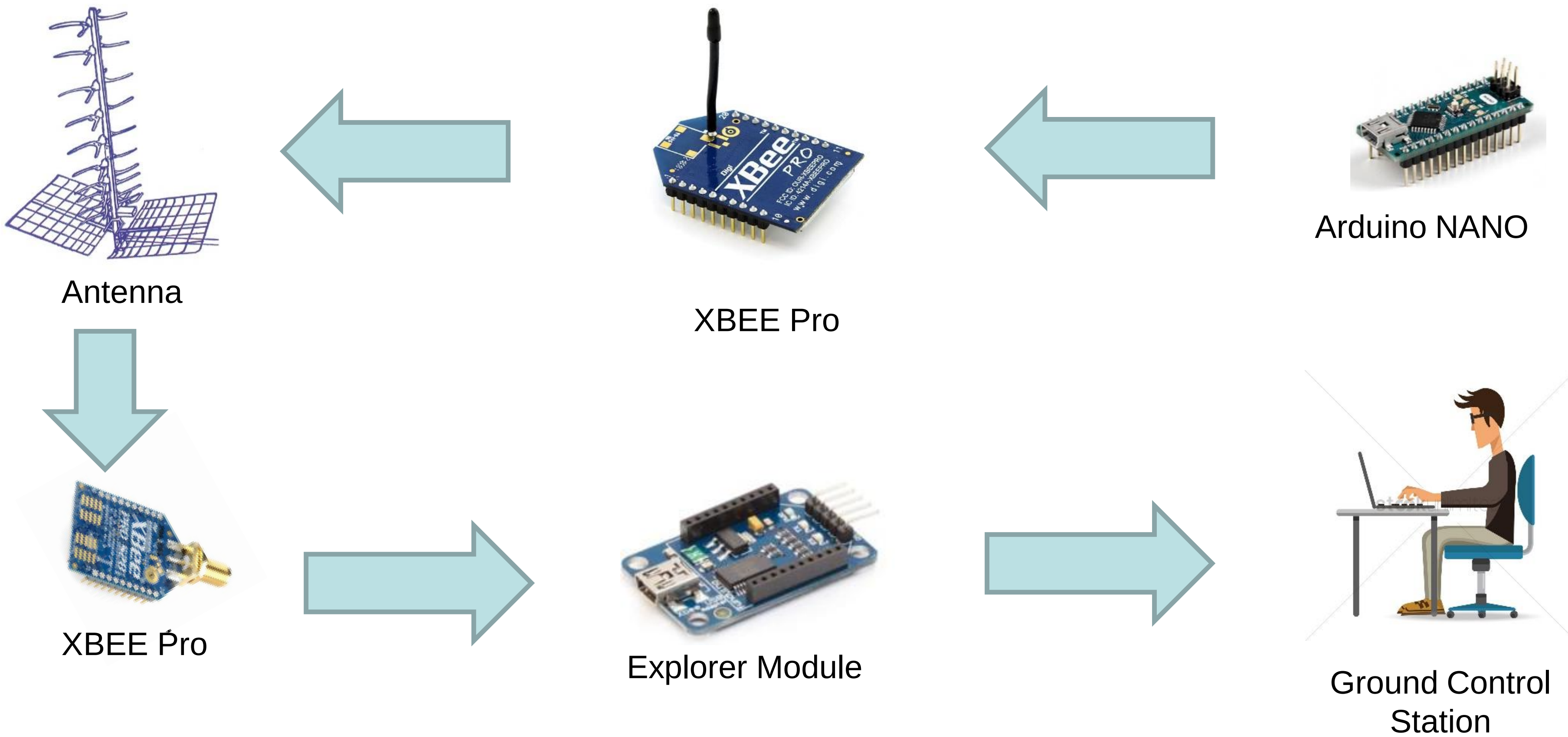
Separation mechanisms.

Software control of burning wire mechanism.	✓

Ground Control System (GCS) Design

Durdali ATILGAN

GCS Overview



- Read data are sent to receiver Xbee with transmitter Xbee.
- Data are taken by Xbee with antenna.
- These data are transferred to computer with Explorer module.

GCS Changes Since PDR

Name	Type Of Antenna	Gain	Frequency	Spread	Range	Length(cm)	Weight (g)
YAGI-20-2.4GHz	YAGI	20dBi	2.4-2.5 GHz	nondirectional	2.5 km	44.4	303
ANT 2412 D	YAGI	12 dBi	2.4-2.5 GHz	nondirectional	2.5 km	120cm	500

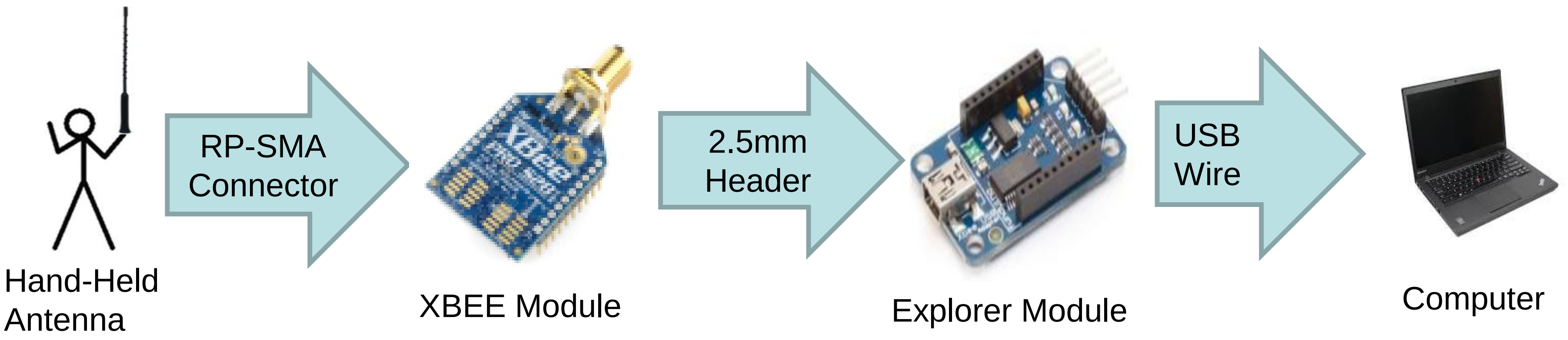
Rationale:

We changed antenna because new selection has more gain in addition to be lighter and more portability than the previous selected antenna.

GCS Requirements

NUMBER	Desciption	Rationale	Priority	VM
RN#32	Each team shall develop their own ground station.	Competition Requirement	high	T,I,D
RN#33	All telemetry shall be displayed in real time during desce nt.	Taking data according to real time	high	T,I,D,A
RN#34	All telemetry shall be displayed in engineering units (meters, meters/sec, Celsius, etc.)	know what the data is	high	I,D
RN#35	Teams shall plot each telemetry data field in real time during flight.	Competition Requirement	high	A,I,T
RN#36	The ground station shall include one laptop computer with a minimum of two hours of battery operation, XBEE radio and a hand held antenna	The competitions going on least 2 hours	Very high	A,I,D
RN#37	The ground station must be portable so the team can be position ed at the ground station operation site along the flight line. AC power will not be available at the ground station operation site.	Competition Requirement	medium	I,A
RN#39	The flight software shall maintain a count of packets transmitted, which shall increment with each packet transmission throughout the mission.The valus shall be maintained through processor resets.	Know number of taken data and To prevent data loss and to ensure stable operation of the system	high	A,T,I,D

Diagram of Ground Station



Specifications:

- Ground station can operate minimum 2 hour on battery.
- For protect overheating we use portable umbrella and cooling fan.
- We update Windows for latest version before establish ground station
- PC have not internet connection.

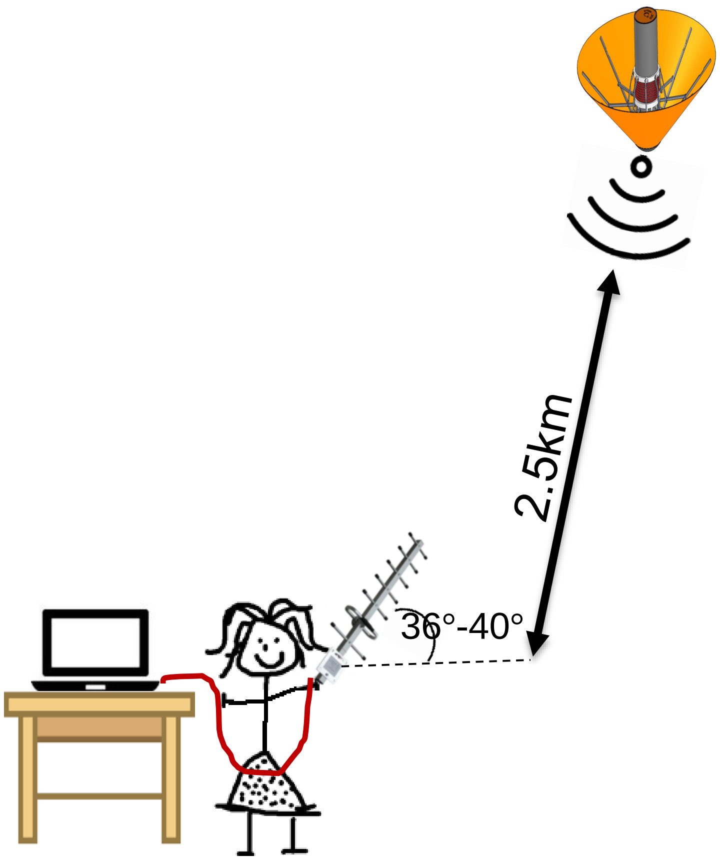
GCS Antenna

Name	Type of Antenna	Gain	Frequency	Spread	Range	Length(cm)
YAGI-20-2.4GHz	YAGI	20dBi	2.4-2.5 GHz	nondirectional	2.5 km	44.4

Final selection : YAGI-20-2.4GHand Antenna

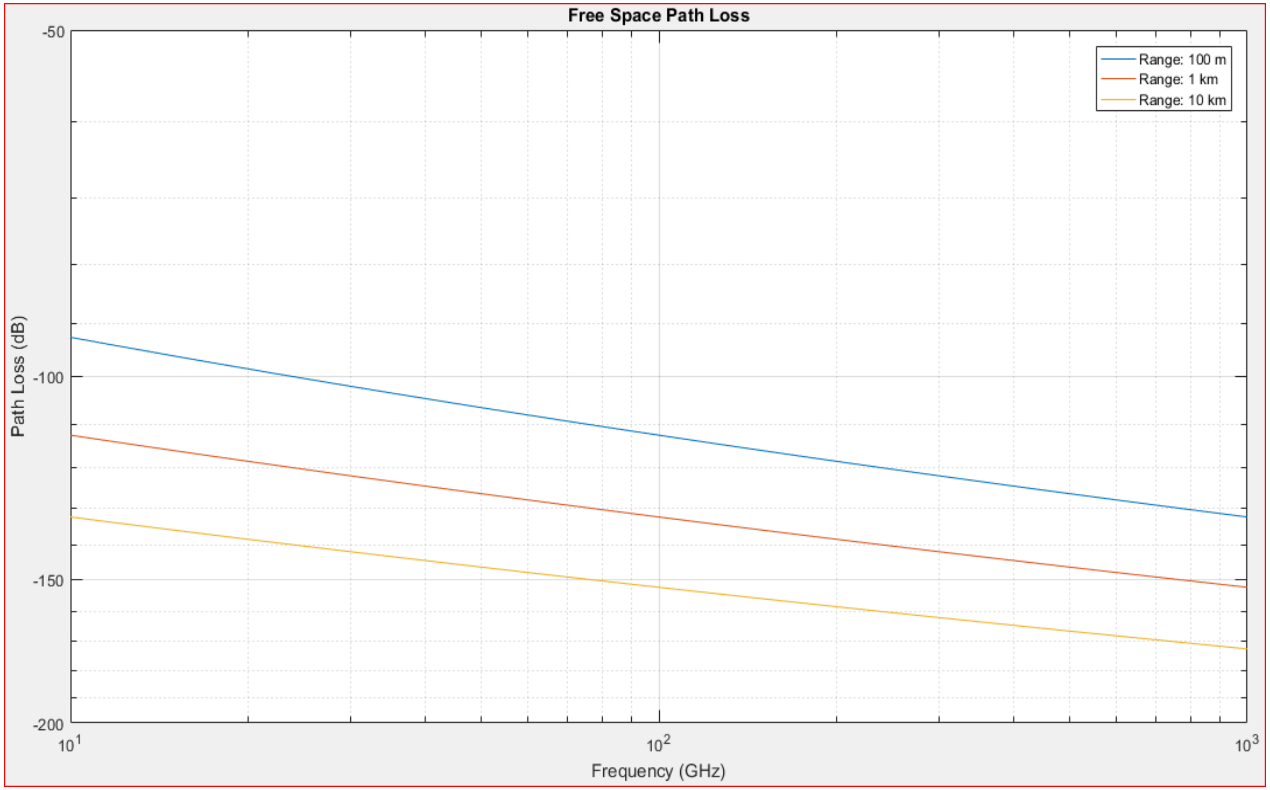
- Enough gain
- Fair price
- Setting angle is important for us therefore we select yagi
- Acceptable radiation pattern
- Newantenna selection criteria is easy availability.

Our ground station antenna is portable which its weight 303 gr and its lenght is 44.4 cm. That means this antenna appropriate with hand-held requirement. Our antenna range is 2.5 km. This distance is enough for us.



GCS Antenna

Range and Path Loss
calculated by:
L = 20 log10 (4π D / λ)
where
D = the distance between receiver and transmitter
λ = free space wavelength = c/f
c = speed of light (3 x 108 m/s)
f = frequency (Hz)



For time=0

$$L = 20\log(\,4 * \pi(\frac{728}{\frac{3 * 10^8}{(2.4 * 10^9)}}))$$

L=97,28

GCS Antenna

A simple **link budget** equation looks like this:

Received Power (dB) = Transmitted Power (dB) + Gains (dB) − Losses (dB)

$\mathbf{P_{RX}=P_{TX}+G_{Tx}- L_{FS}+G_{RX}+}$ **Fade Margin**

P_{RX}= Received Power (dBm)

P_{TX}= Transmitter Power Output (dBm)

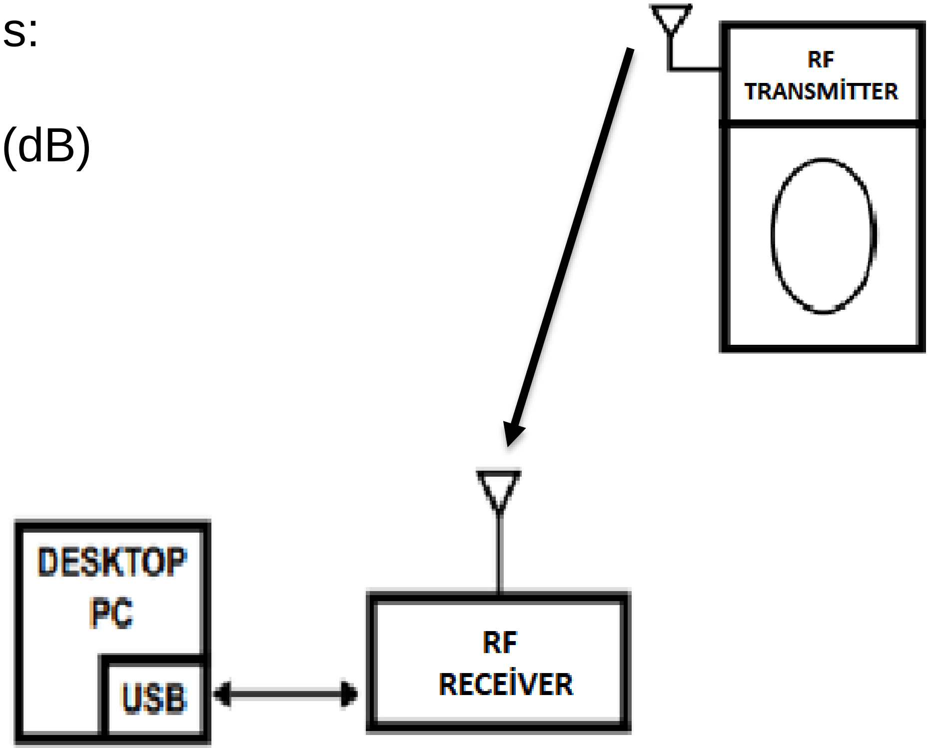
G_{Tx}= Transmitter Antenna Gain(dBi)

L_{FS}=Free-Space Loss(dB)

G_{RX}=Receiver Antenna Gain (dBi)

XbeeTransmit Power=17dBm

Xbee Receiver sensitivity= -102 dBm



PRX=18dBm+12dBi-96,94dB+5dbi+30dBm=-31,94dBm

Link predictions and margins: Calculated $\mathbf{P_{RX}}$ is -31,94 dBm> -102 dBm, and antenna's range is 2.5 km which gives us reliable margin.

GCS Software

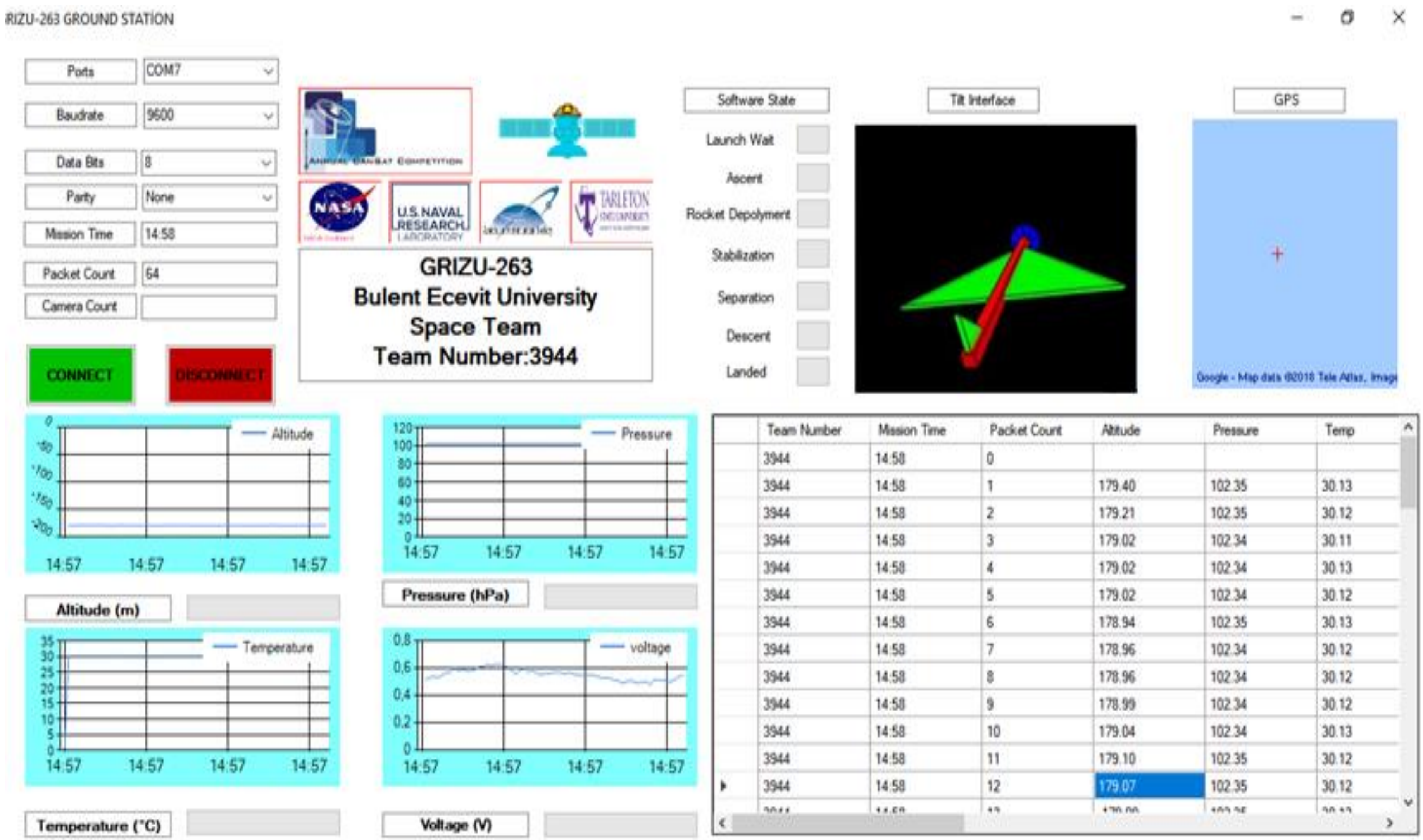
Progress since PDR:

Finally, saving the data in a .csv file has been added and tested, Tilt sensor interface tilt sensor interface started to be prepared

- **Telemetry display screen shots**

This is screen shoot of our interface. Coming data from probe are plotting to graphics. X axis is time that is RTC time and y axis value is our data. As you can see we have a table. All of the data shown in the this table and simultaneously data in the table will be recorded to.cvs file.

GCS Software



Commercial off the shelf (COTS) software

- Visual Studio student version
  •XCTU (XbeeProgramSoftware**)**
- Unity 2017.3 personal version

Real-time software

Graphs are drawn with coming from RTC on the probe and used C# charts for this.

Command software

- Prepared with C#. Shown data on the table and this data is transferred to excel, serial communication port informations and real time graphics are included.**The data are saved SD card and excel on the ground station computer.Coming from probe data between with ‘’,’’ are saved on .cvs file.**

GCS Bonus Wind Sensor

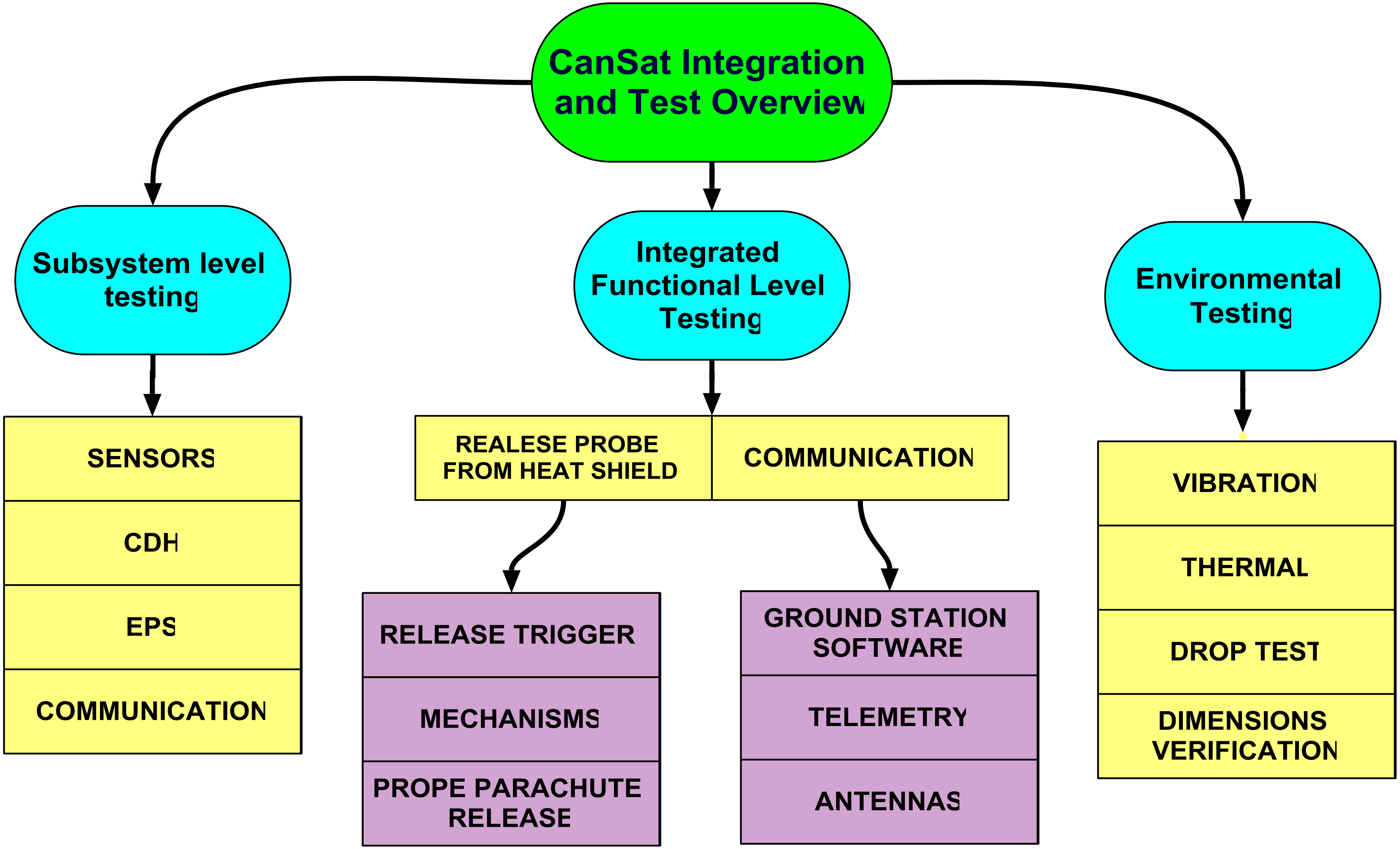
- **We will not do this bonus mission.**

- **We will chose camera for bonus mission:**
  Camera will take one photo per second.
  The count value of each photo will be sent to the ground station.
  Each photos will be saved to SD card.

CanSat Integration and Test

Abdullah TALYAN

CanSat Integration and Test Overview



CanSat Integration and Test Overview

Subsystem level testing

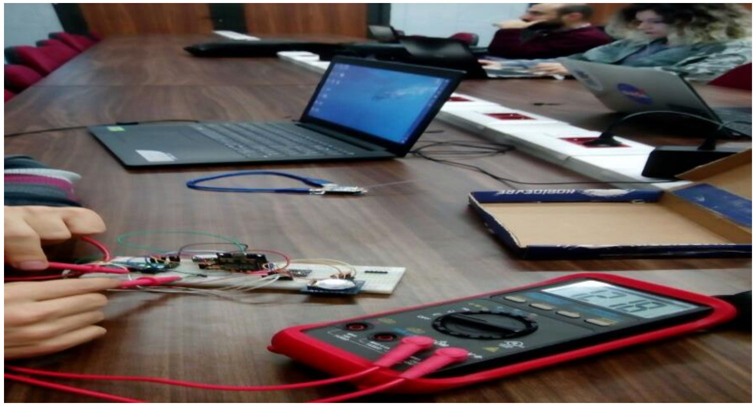
Testing of Sensors	Testing of CDH	Testing of EPS	Testing of FSW
•Firstly all electronic circuits were created on breadboard. •The robustness of all sensors will be tested. •Sensor data collection prototypes will be tested. •All sensors will be calibrated with the appropriate test codes.	• The communication between the receiver Xbee and transmitter Xbee were be tested in the XCTU program. •CDH system will be tested on breadboard and at PCB. • The accuracy of the data sent to the ground station were be tested. •The speed of sending data will be checked. •The data transmission at high distances were be checked.	•12V lithium battery will be connected in series as discussed in previous slides. •Calculated voltage and current level were be tested with multimeter as obtained in practical.	•The probe will throw with parachute from different altitudes and data will be transferred to the control system. •Time keeping algorithm will be tested in case of microcontroller reset. •Data verification will be tested at analog accuracy sensors in real time on ground control system.

CanSat Integration and Test Overview

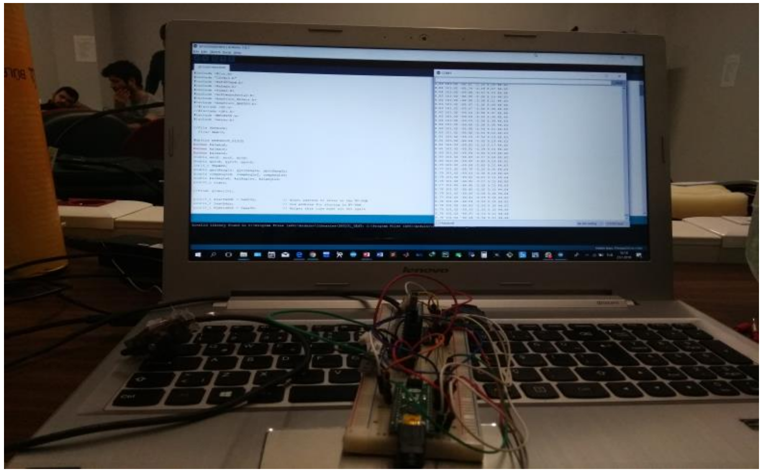
Testing of Radio communications	Testing of Mechanical	Testing of Descent Control
After the create of the electronic circuit on breadboard , data transmission of Xbees have been tested at the electronic laboratory of our university. .	•Total mass will be checked to ensure that it is within the range. • Our CanSat will be tested to ensure that it successfully survives drop testes and structure survivability tests. •It will be tested again , when all electrical subsystems are integrated.	CanSat with parachute will be released vertically from a small height to test flight pattern without payload. Cansat with parachute be released vertically from a small height with simulated mass of electronics payload to test flight pattern. Parachute will be examined with these free falls and aerodynamic suitability will be tested

CanSat Integration and Test Overview

Coming Current and Voltage to Components Testing



Sensors Stability Testing



Antennas Test

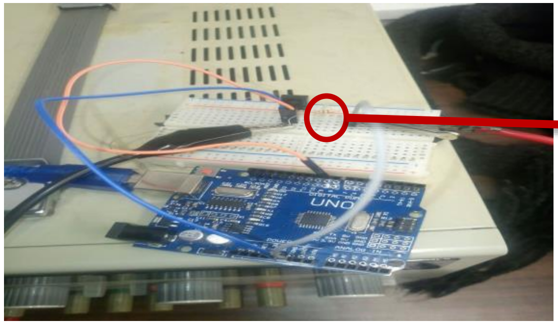
Electronic System

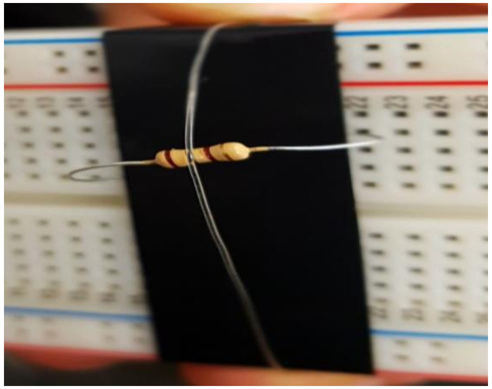
CanSat Integration and Test Overview

Integrated Functional Level Testing

Release probe from heat shield		
Release trigger	Mechanisms	Probe parachute release
Burn-wire system test have be done with the resistor, the break and the duration of the test have be done.	Opening mechanism and separation mechanism tests have be done but the system was not tested as a whole.	After opening the cover of the heat shield at 300 meters, it will be checked whether or not it will come out with the ejection spring in the heat shield. This will be done using a drone.

Burn – Wire Mechanism Test

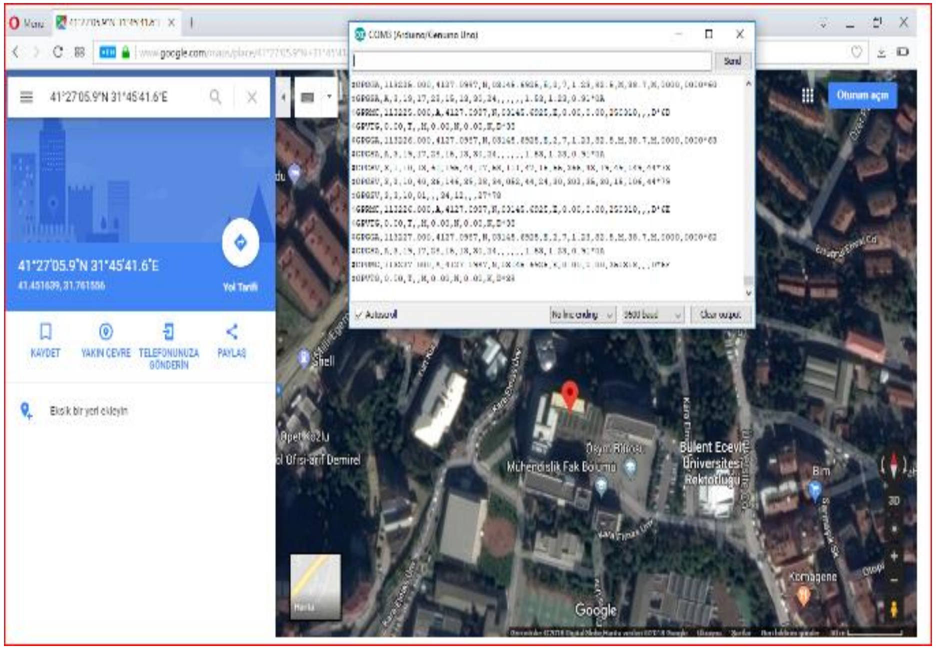




CanSat Integration and Test Overview

The accuracy of the GPS position is tested

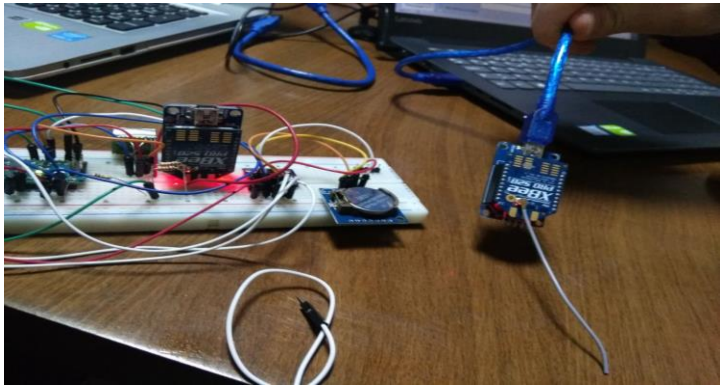
Descent direction and tumbling problem solved with the position of the center of gravity



CanSat Integration and Test Overview

Communications		
Ground station software	Telemetry	Antennas
-We tested ground station setup and how far the computer's battery was going to run.	-We tested the correctness, stability and arrival time of telemetry from the ground station.	-We tested how far the antenna can connect. -We tested connectivity issues with xBee.

Xbee's Communication Test



GCS Software Test

Environmental Testing			
Vibration	Thermal	Drop test	Dimensions verification
With Orbit Sander, the system will be shaken quickly and tested for durability	CanSat will be tested by putting it clearly on the floor. The temperature of the oven will be adjusted to 60 degrees. The system will be tested for 2 hours and the temperature resistance will be checked	The CanSat will be left manually at the height of 80 cm. This rope will be cut and the cansat will be dropped. Damage of system and the deterioration of the general structure of the system will be checked.	One metal plate will be cut and the diameter of this plate will be 125 mm and it will be checked whether our system passes through this plate

Test Procedures Descriptions

Part	Objective	Procedure	Requirements	Pass/Fail Criteria	Pass/Fail
Air pressure sensor	Verify accuracy of altitude, pressure readings	All the sensors are connected on the electronic board, tested by computer and the results are taken. the accuracy of the results obtained was accessed.	25	The value we get is equal to the actual heights and the press	✓
Air temperature sensor	Verify accuracy of temperature readings		25	The data confirms the real weather temperature.	✓
GPS sensor	Verify accuracy of location readings		25	What we get from GPS data confirms our truth location	✓
Tilt sensor	It give notice if the system tumble		25,49	Electronic board angle of inclination, measured in relation to gravity	✓

Test Procedures Descriptions

Part	Objective	Procedure	Requirements	Pass/Fail Criteria	Pass/Fail
Voltage sensor	To measure of battery voltage	All the sensors are connected on the electronic board, tested by computer and the results are taken. the accuracy of the results obtained was assessed.	25,	Voltage divider is connected to electronic circuit and the value is read with voltmeter	✓
Camera	To take pictures		Bonus Object	Take pictures with the camera. and the resolution of 640 x480 was checked	✓
ELECTRICAL POWER SYSTEM TESTING	To obtain desired voltage from two batteries connected in series for CanSat.	•After installation of all circuits, short circuit tests were conducted to check any wrong connections. •Power capability will be test when Cansat spending maximum voltage	21	If batteries provide desired voltage to Cansat.	✓

Test Procedures Descriptions

Part	Objective	Procedure	Requirements	Pass/Fail Criteria	Pass/Fail
CDH	check whether communication s provided	To verify transmission of datas between Xbees on XCTU.	25,28,29,30	If data comes to XCTU correctly	√
CDH	Check Xbee’s and antenna’s range	To test connection from different ranges	28,36	Data comes to GCS from 500m	√
FSW	software control of separation mechanisms.	To test burn-wire mechanism on breadboard control via Arduino	25,27,35	If the fishline breaks when we give logic 5V to wire-burning mechanism	√
FSW	To test Stabile operation of the system and provide the relevant requirements	To observe on ground station interface.	27	When electronic system power (off-on) , If recovery of mission time and packet count	√
FSW	Stable operation of the system and provide the relevant requirements	To observe transmission speed on ground station İnterface.	27,28	if the data comes appropriate sequence and speed to the ground station.	√

Test Procedures Descriptions

Part	Objective	Procedure	Requirements	Pass/Fail Criteria	Pass/Fail
GCS-FSW	Check the interface whether work correctly	To test Taken datas from serial port place on interface.	25,27,32, 36	Plotting real time and shown telemetry data	✓
GCS	Control the presented format match the Competition Guide requirements.	Datas what read from serial will compare with competition guide requirements.	25,32, 36	If the presented format match the Competition Guide requirements.	✓
GCS-CDH	Measure the qualification of the antenna	To measure distance while reciever and transmitter antennas connecting.	25,32, 36	If received data from 500m	✓

Test Procedures Descriptions

Part	Objective	Procedure	Requerim ents	Pass/Fail Criteria	Pass/Fail
ENVIRONMENTAL DROP TESTING	To test the drop survivablity of the Cansat .	The CanSat will be left manually at the height of 80 cm. This rope will be cut and the cansat will be dropped. Damage of system and the deterioration of the general structure of the system will be checked.	13,16,19,20, 21,22,48	If the deterioration of the general structure of the system works well.	Not tested yet
EGG DROP TESTING	To test the survivability of the egg.	Egg protection container was thrown to ground from different altitudes.	7,8,13,16,19 ,20,21,22, 48	If probe can protect hen's egg.	✓
ENVIRONMENTAL DIMENSION VERIFICATION TESTING	To verify the CanSat will properly fits in the rocket payload section and slide out at deployment time	It will be passed through a metal plate with a diameter of 125 mm.	1,6	If Cansat is within the desired measurement values.	✓

Test Procedures Descriptions

Part	Objective	Procedure	Requirements	Pass/Fail Criteria	Pass/Fail
ENVIRONMENTAL VIBRATION TESTING	To test integrity of all the components, electronics and battery connections.	Probe will be placed on vibration test machine and vibration machine will be operated at different frequencies.	7,16,19, 20,21, 22,48	If Cansat can remain one piece and solid.	Not tested yet
ENVIRONMENTAL THERMAL LEVEL TESTING	Thermal tests will be performed to verify that the connections and parts work also in a hot environment.	•The Payload will be placed inside the oven and while electronics are turned on. •The system will be tested for 2 hours and the temperature resistance will be tested.	21	If Cansat still operate well.	Not tested yet

Test Procedures Descriptions

Part	Objective	Procedure	Requirements	Pass/Fail Criteria	Pass/Fail
RELEASE MECHANISM LEVEL TESTING	This is to test the release trigger mechanism of the burn wire system on Cansat.	•CanSat will be taken to 320m with the help of quadrocopter. •300m will be default value to activate the release trigger mechanism. •When the quadrocopter reached 300m, Heatshield will be released from probe.	13,14,15, 16, 17,19,20, 22	If Heatshield release at desired altitude.	Not tested yet

Mission Operations & Analysis

Yasin BIYIKLI

Overview of Mission Sequence of Events

ANNUAL CANSAT COMPETITION

ARRIVAL

- Arrival on the launch location
- Preparing the cansat system for flights and tests (Whole Team)
- Checking whether CanSat has any damage on any part.
- Set up of ground control system(GSC)

PRE-LAUNCH

- Antenna check (GSC)
- Communication check (GSC)
- Windows updates will be checked.
- Buzzer check (GSC)
- Drop test(MCO- GSC –CC)
- Separation mechanism test (CC)
- Safety control (Whole Team)
- Size, weight and fit check control (MCS)
- The installation of electronic equipment and sensors will be analyzed (Whole Team)

LAUNCH

- Rocket takes off and CanSat seperated from rocket.(Near apogee)
- CanSat will collect air pressure, air temperature, altitude,GPS position, battary voltage and tilt sensor for stability verification during descent.
- Probe and Heat shield will be separeted at 300 meters.
- Probe and Heat Shield will decline with 10-30 m/s
- Parachute will open at 300 meters and We'll start taking pictures at 300 meters
- It will decline with 5 m/s
- When it reaches 5 meters the buzzer will start ringing
- When the Probe is landing The egg will not damage.

Overview of Mission Sequence of Events

FLIGHT RECOVERY

- After finding payload we'll take the SD card and back up pictures on GCS.
- Get backed up telemetry data from SD card. (GSC)

DATA ANALYSIS

- Checking pictures number and quality
- Checking and backing up telemetry data plot outliers
- Team members interested in configuring the ground station, preparing CanSat, and integrating CanSat into the rocket will be identified.

Post Flight Review

- Delivery of received data to jury
- Preparation of post-flight review presentation file
- Delivery of the PFR file to the Jury.
- Explaining the PFR file to other participants.

Overview of Mission Sequence of Events

CONFIGURE LOCATION STATION

- The person who will be interested in this section will arrange the necessary equipment (Laptop, Antenna etc.) at the ground station. (GSC)
- Implement communication system setup and test the communication system

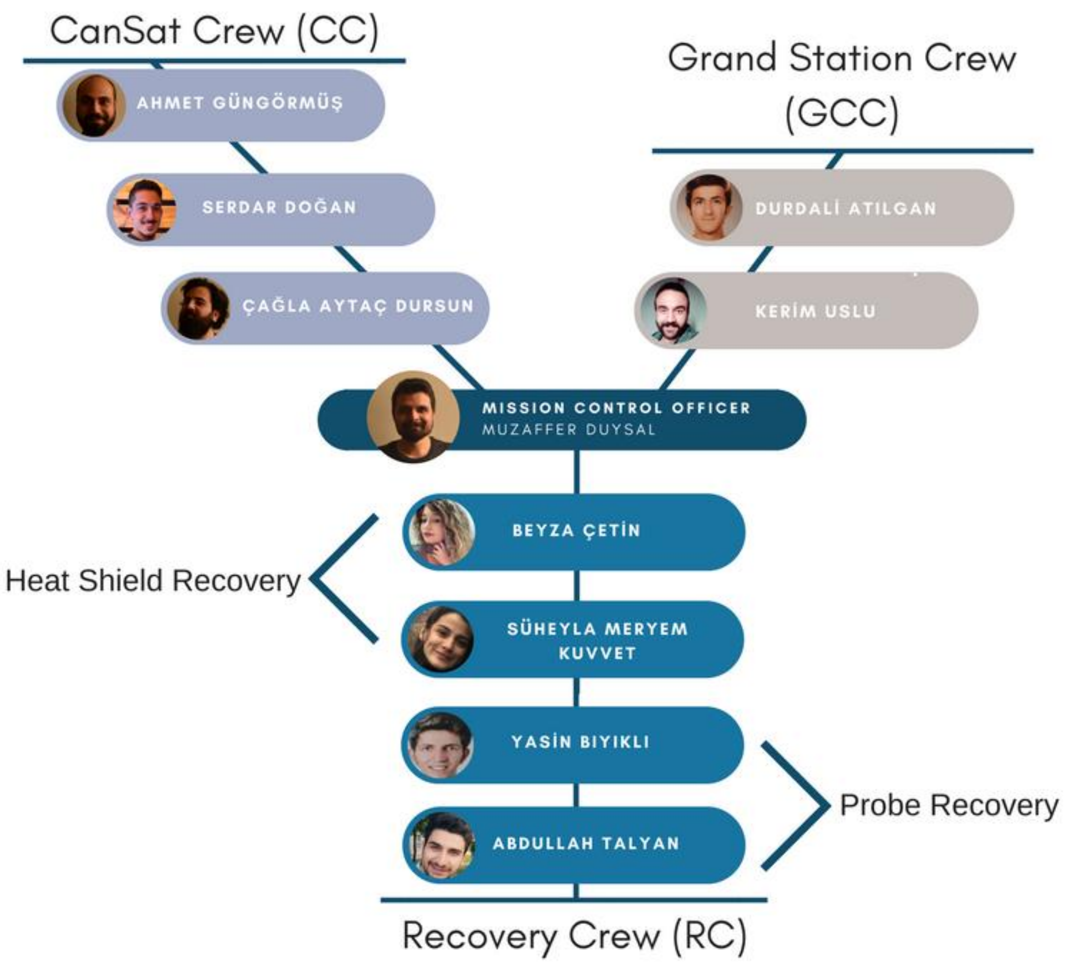
PREPARING CANSAT

- The person who will work in this department will prepare for CanSat general tasks.
- Most tests of the CanSat will be done and the latest calibrations will be done for the sensors
- After we have done all the tests, he will deliver the CanSat to the launcher

INTEGRATING CANSAT

- The people in this section will make the CanSat fully assembled and ready to launching. Care should be taken to ensure that all parts are properly mounted when this is done.
- After we have done all the tests, he will deliver the CanSat to the launcher

Overview of Mission Sequence of Events



Overview of Mission Sequence of Events

- The antenna that we use is portable
- The antenna is connected with SMA connector to Xbee and Xbee is connected to computer with USB.
- It’s not necessary to point the antenna to somewhere. Just needed to stay with 43º angle between the ground.
- Ground station designed as seen in the picture with portable structure.
- Ground station can operate minimum 2 hour on battery.
- In order to protect overheating we use portable umbrella and cooling fan.
- We will update Windows for latest version before establish ground station
- PC will not have internet connection.

Overview of Mission Sequence of Events

CanSat Assemble

- Electronic circuits will be assemble
- The egg will be into place egg protection system.
- The probe will be into place heat shield.
- The on/off switch will be opened and cansat will be run.

CanSat Test

- CanSat weight test.(It will be 500g)
- CanSat size and fit check
- Drop test
- Seperation mechanism test
- General CanSat system test
- The antenna and communication tests
- Electronic and sensor setup test
- Telemetri informations will be analyzed and handed over within an SD card.

Mission Operations Manual Checklist

Configuring the ground station

- Antenna Check
- Communicati on test

Preparing the CanSat

- CanSat assamble
- Separation mechanism control
- Weight and size control
- Drop test
- Pre-Launch CanSat last check

Integrating the CanSat into the rocket

The launch preparation procedures

- Launch procedure
- Removal procedure

It will be prepared to Two copies of the Mission Operations Manual file before launch.

Development Status

-May 10 will be final prototyping
-A test flight will be conducted on 20 May

CanSat Location and Recovery

CANSAT FINDING STRATEGY

- When the buzzer reaches 5 meters, the data transfer will stop and the buzzer will start
- Also, location can found with Global Positioning System. (GPS)
- The heat shield recovery will be done with alarm working with the RTC battery.
- As a coin cell of the tests to be done after the battery voltage has dropped to a certainlevel, the alarm will start to sound.

CANSAT COLOR

- We set our Probe and Heat Shield color to orange

CANSAT RETURN ADDRESS

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

- Bülent Ecevit University Space Team
grizu-263 #Team 3944
contact@grizu263.space

Mission Rehearsal Activities

Ground System Radio Link Check Procedures

- Xbee and antenna connection is prepared.
- Speed and direction of the telemetry data is checked.
- It will ensure the accuracy of the frequency range.

Powering on/off the CanSat

- The on / off switch on the cansat is opened and cansat is operated.

Launch Configuration Preparations

- CanSat will be ready to receive data.

Mission Rehearsal Activities

Loading the CanSat in the Launch Vehicle

- - CanSat is placed on the rocket by the Mission control officer with final checks.

Telemetry Processing, Archiving, and Analysis

- All telemetry data is analyzed in the ground station interface and recorded on sd card .Its correctness and stability are checked
- The flight time is compared with the number of packages received.
- It will ensure that no data loss.

Recovery

- CanSat will be recovered with the help of the buzzer.
- The heat shield recovery will be done with alarm working with the RTC battery.
- Also, location can found with Global Positioning System. (GPS)

The purpose of this section is to summarize and cross reference the compliance to the CanSat Competition Mission Guide requirements.

Requirements Compliance

Yasin BIYIKLI

Requirements Compliance Overview

The design was prepared and the requirements were fulfilled by considering cost, speed and prohibited materials.

Mechanical Team

• The probe, heat shield orientation landing protection and landing speed test have been successfully completed.

• The necessary tests have been successfully completed to ensure that the probe egg is not damaged from the launch stage to the landing stage

•Designs are completed with necessary sizing for probe and heat shield.Material selection for weight control is made.

• Heat shield and probe will separation at 300 meters.

Electrical and Software Team

• The tests of collecting the probe air pressure, the outside air temperature, the GPS position and the battery voltage once in a few seconds and saving the data have been successfully completed

•The software test, which activated the 5m audio beacon on the floor to recover the probe, was successfully completed

•Appropriate camera tests were performed for the bonus task

Analyzes and tests were compared. No problem encountered

Requirements Compliance (1 of 9)

Requirement Number	Requirement	Comply / No Comply / Partial	X-Ref Slide(s) Demonstrating Compliance	Team Comments or Notes
1	Total mass of the CanSat (probe) shall be 500 grams +/- 10 grams.	Comply	86,87	OK
2	The aero-braking heat shield shall be used to protect the probe while in the rocket only and when deployed from the rocket. It shall envelope/shield the whole sides of the probe when in the stowed configuration in the rocket. The rear end of the probe can be open.	Comply	65,66,67,68, 69,70,71,72	OK
3	The heat shield must not have any openings.	Comply	23,24,25,26	OK
4	The probe must maintain its heat shield orientation in the direction of descent.	Comply	38,53	*OK*
5	The probe shall not tumble during any portion of descent. Tumbling is rotating end-over-end.	Comply	38,53	OK

Requirements Compliance (2 of 9)

Requirement Number	Requirement	Comply / No Comply / Partial	X-Ref Slide(s) Demonstrating Compliance	Team Comments or Notes
6	The probe with the aero-braking heat shield 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	23,24,25,26	OK
7	The probe shall hold a large hen's egg and protect it from damage from launch until landing.	Comply	17,72,73	OK
8	The probe shall accommodate a large hen's egg with a mass ranging from 54 grams to 68 grams and a diameter of up to 50mm and length up to 70mm.	Comply	17,75,84	OK
9	The aero-braking heat shield shall not have any sharp edges to cause it to get stuck in the rocket payload section which is made of cardboard.	Comply	49,50,51,52	OK
10	The aero-braking heat shield shall be a florescent color; pink or orange.	Comply	160	OK

Requirements Compliance (3 of 9)

Requirement Number	Requirement	Comply / No Comply / Partial	X-Ref Slide(s) Demonstrating Compliance	Team Comments or Notes
11	The rocket airframe shall not be used to restrain any deployable parts of the CanSat.	**Comply**	**34,35,36,37**	**OK**
12	The rocket airframe shall not be used as part of the CanSat operations.	**Comply**	**34,35,36,37**	OK
13	The CanSat, probe with heat shield attached shall deploy from the rocket payload section.	**Comply**	**43**	OK
14	The aero-braking heat shield shall be released from the probe at 300 meters.	**Comply**	**17,43**	OK
15	The probe shall deploy a parachute at 300 meters.	**Comply**	**43**	OK
16	All descent control device attachment components (aero-braking heat shield and parachute) shall survive 30 Gs of shock.	**Partial Comply**	**144**	Tested with prototypes. Need actual design test.
17	All descent control devices (aero-braking heat shield and parachute) shall survive 30 Gs of shock.	**Partial Comply**	**144**	Tested with prototypes. Need actual design test.

Requirements Compliance

Requirement Number	Requirement	Comply / No Comply / Partial	X-Ref Slide(s) Demonstrating Compliance	Team Comments or Notes
18	All electronic components shall be enclosed and shielded from the environment with the exception of sensors.	**Comply**	**80,81**	OK
19	All structures shall be built to survive 15 Gs of launch acceleration.	**Partial Comply**	**144**	Tested with prototypes. Need actual design test.
20	All structures shall be built to survive 30 Gs of shock.	**Partial Comply**	**144**	Tested with prototypes. Need actual design test.
21	All electronics shall be hard mounted using proper mounts such as standoffs, screws, or high performance adhesives.	**Comply**	**80,81**	*OK*
22	All mechanisms shall be capable of maintaining their configuration or states under all forces.	**Comply**	**80,81**	OK
23	Mechanisms shall not use pyrotechnics or chemicals.	**Comply**	**80,81**	OK

Requirements Compliance (5 of 9)

Requirement Number	Requirement	Comply / No Comply / Partial	X-Ref Slide(s) Demonstrating Compliance	Team Comments or Notes
24	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	144	OK
25	During descent, the probe shall collect air pressure, outside air temperature, GPS position and battery voltage once per second and time tag the data with mission time.	Comply	33,34,35,36,37, 38,39,89	OK
26	During descent, the probe shall transmit all telemetry. Telemetry can be transmitted continuously or in bursts.	Comply	99	OK
27	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	97	*OK*
28	XBEE radios shall be used for telemetry. 2.4 GHz Series 1 and 2 radios are allowed. 900 MHz XBEE Pro radios are also allowed.	Comply	97	OK

Requirements Compliance (6 of 9)

Requirement Number	Requirement	Comply / No Comply / Partial	X-Ref Slide(s) Demonstrating Compliance	Team Comments or Notes
29	XBEE radios shall have their NETID/PANID set to their team number.	Comply	98	OK
30	XBEE radios shall not use broadcast mode.	Comply	98,99	OK
31	Cost of the CanSat shall be under $1000. Ground support and analysis tools are not included in the cost.	Comply	179	OK
32	Each team shall develop their own ground station.	Comply	132,133,134	*OK*
33	All telemetry shall be displayed in real time during descent.	Comply	132,133,134	OK
34	All telemetry shall be displayed in engineering units (meters, meters/sec, Celsius, etc.)	Comply	133	OK
35	Teams shall plot each telemetry data field in real time during flight.	Comply	132,133,134	OK

Requirements Compliance

Requirement Number	Requirement	Comply / No Comply / Partial	X-Ref Slide(s) Demonstrating Compliance	Team Comments or Notes
36	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	128	OK
37	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	128	OK
38	Both the heat shield and probe shall be labeled with team contact information including email address.	Comply	160	OK
39	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	99,100,101	*OK*
40	No lasers allowed.	Comply	32	OK
41	The probe must include an easily accessible power switch.	Comply	80	OK

Requirements Compliance (8 of 9)

Requirement Number	Requirement	Comply / No Comply / Partial	X-Ref Slide(s) Demonstrating Compliance	Team Comments or Notes
42	The probe must include a power indicator such as an LED or sound generating device.	**Comply**	**17,18**	OK
43	The descent rate of the probe with the heat shield deployed shall be between 10 and 30 meters/second.	**Comply**	**54,55,56,57,58**	OK
44	The descent rate of the probe with the heat shield released and parachute deployed shall be 5 meters/second.	**Comply**	**54,55,56,57,58**	OK
45	An audio beacon is required for the probe. It may be powered after landing or operate continuously.	**Comply**	**17,18**	*OK*
46	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**	**109**	OK

Requirement Number	Requirement	Comply / No Comply / Partial	X-Ref Slide(s) Demonstrating Compliance	Team Comments or Notes
47	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**	**109**	OK
48	Spring contacts shall not be used for making electrical connections to batteries. Shock forces can cause momentary disconnects.	**Comply**	**70,71,72**	OK
49	A tilt sensor shall be used to verify the stability of the probe during descent with the heat shield deployed and be part of the telemetry.	**Comply**	**38**	OK

Management

Süheyla Meryem Kuvvet

Status of Procurements

Electronics Components	Quantitiy	Order Date Delivery date	Status
MT3329 (GPS Sensor)	1	11.07.2017 11.14.2017	Received
Voltage Divider	1	11.07.2017 11.14.2017	Received
Y2000 (Camera)	1	11.07.2017 11.14.2017	Received
Miniature Buzzer	1	11.07.2017 11.14.2017	Received
Arduino Nano	1	11.07.2017 11.14.2017	Received
Xbee Pro S2B	2	11.07.2017 11.14.2017	Received
Duracell DL223 (Battery)	2	11.07.2017 11.14.2017	Received
KTS102 (Switch)	1	11.07.2017 11.14.2017	Received
MP23070N (DC-DC Converter)	1	11.07.2017 11.14.2017	Received
Sandisk 4 gb	1	11.07.2017 11.14.2017	Received
Sandisk 2 gb	1	11.07.2017 11.14.2017	Received
DS1307 (RTC)	1	11.07.2017 11.14.2017	Received
CR2032 3V (Coin Cell)	1	11.07.2017 11.14.2017	Received
10-DOF IMU	1	11.07.2017 11.14.2017	Received

Mechanical Components	Quantity	Order Date Delivery date	Status
Fiberglass	90mm*250mm	03.15.2018 03.22.2018	Received
Carbon Stick x4	8mm*10mm*270mm	03.15.2018 03.20.2018	Received
Silnylon 30D Nylon 66	210mm(Radius)	03.15.2018 -	-
Heat Shield			
Fiberglass	100mm*300mm	03.15.2018 03.22.2018	Received
Carbon Steel x2	104mm*10mm	03.15.2018 03.20.2018	Received
Carbon Stick x8	8mm*10mm*267mm	03.15.2018 03.20.2018	Received
Steel x25	2mm	03.15.2018 03.22.2018	Received
Egg Protection Mechanism			
Mattress	1 m^2	02.15.2018 02.22.2018	Received
Bubble Wrap	1 m^2	02.15.2018 02.22.2018	Received
Egg Protected Container		-	-
Egg	1	-	-
Polyethylene Tube	1	03.15.2018 03.22.2018	Received

- **All the necessary electronic for Cansat and Payload were ordered and delivered a month ago**
- **All the necessary raw materials for the mechanics were ordered and delivered a month ago. Production is being done.**
- **We have no problem about maintaining the products and budgeting.**

Shipping and Transportation

- First of all, we will go to Istanbul which is our boarding place. We will go between Zonguldak and Istanbul with personal cars.

- Istanbul - On America's journey, we will make sure that our materials are securely packed and we will deliver the package to the cargo section of the plane. We will make sure that there won't be any problems

- In America, we will rent a car and we will bring our packages to where the arbiter are going. We hope to have a safe and trouble-free journey in this way.

CanSat Budget – Hardware

Electronics Hardware

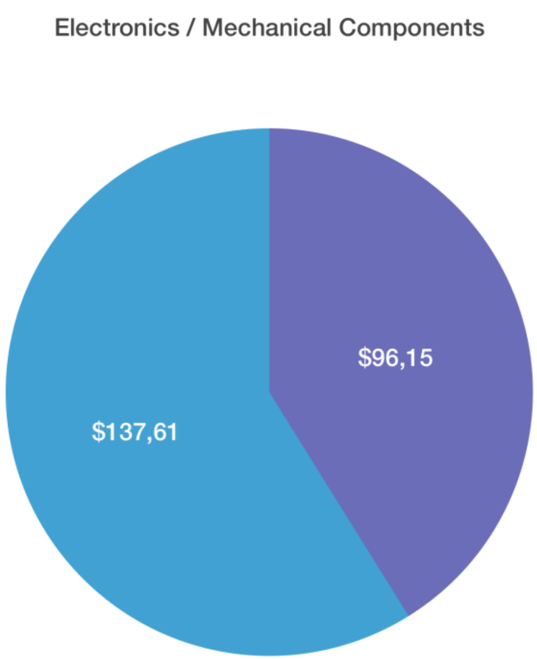
Electronics Components	Quantitiy	Unit Price	Price (Total)	Considerations
MT3329 (GPS Sensor)	1	$27,00	$27,00	Actual
Voltage Divider	1	$0,45	$0,45	Actual
Y2000 (Camera)	1	$4,56	$4,56	Actual
Miniature Buzzer	1	$1,05	$1,05	Actual
Arduino Nano	1	$11,70	$11,70	Actual
Xbee Pro S2B	1	$53,00	$53,00	Actual
Duracell DL223 (Battery)	2	$7,05	$14,10	Actual
KTS102 (Switch)	1	$0,30	$0,30	Actual
MP23070N (DC-DC Converter)	1	$1,05	$1,05	Actual
Sandisk 4 gb	1	$4,00	$4,00	Actual
Sandisk 2 gb	1	$3,00	$3,00	Actual
DS1307 (RTC)	1	$1,10	$1,10	Actual
CR2032 3V (Coin Cell)	1	$0,30	$0,30	Actual
10-DOF IMU	1	$16,00	$16,00	Actual
Total			**$137,61**	

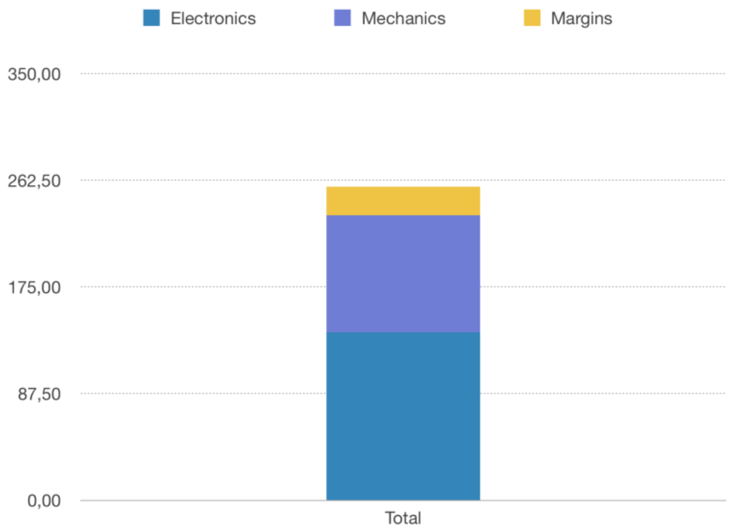
Mechanics Components

Mechanical Components	Quantity	Unit Price	Price (Total)	Considerations
Fiberglass	90mm*250mm	$15,00	$2,00	Estimate
Carbon Stick x4	8mm*10mm*270mm	$9,70	$14,55	Actual
Silnylon 30D Nylon 66	210mm(Radius)	$12,50	$30,00	Estimate
Heat Shield				
Fiberglass	100mm*300mm	$15,00	$5,00	Estimate
Carbon Steel x2	104mm*10mm	$2,00	$4,00	Estimate
Carbon Stick x8	8mm*10mm*267mm	$9,70	$29,10	Estimate
Steel x25	2mm	$4,70	$4,70	Estimate
Egg Protection Mechanism				
Mattress	1 m^2	-	$0,10	Estimate
Bubble Wrap	1 m^2	-	$0,40	Estimate
Egg Protected Container		-	$5,00	Estimate
Egg	1	-	$0,30	Actual
Polyethylene Tube	1	-	$1,00	Estimate
Total			**$96,15**	

CanSat Budget - Total

Electronics	137,61
Mechanical	96,15
Exact Total	**$233,76**
Margin (%10)	$23,38
Total	**$257,14**





CanSat Budget – Other Costs

GROUND STATION

Part	Model	Quantitiy	Price	Price (Total)	Considerations
Computer	-	1	Our Own Computer	-	Actual
XBEE	Xbee-Pro S2B	1	$53,00	$53,00	Actual
ANTENNA	YAGI-20-2.4 Ghz	1	$32,00	$32,00	Actual
Total				$85,00	

INCOME

		Price (Total)
Sponsors	Various Companies	$7.000,00
Grants	Bulent Ecevit University	$3.250,00
Total		$10.250,00

OTHER

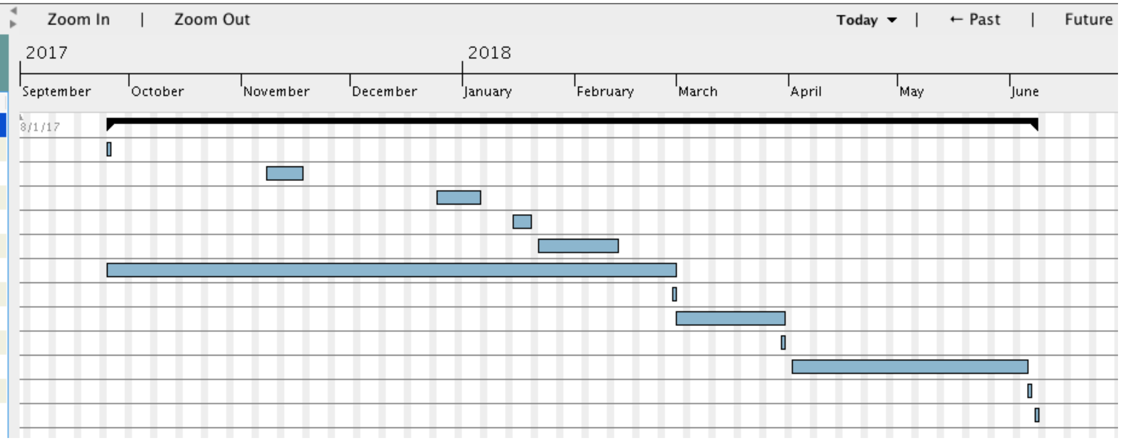
	Quantity	Price (Total)	Considerations
Prototyping		$150,00	Estimate
Test facilities and equipment		University Budget	
Rental	Car x 2	$800,00	Estimate
Computers		Our Own Computers	
Travel	9 person	$4.500,00	Estimate
VISA (USA)	9 person	$1.440,00	Estimate
Hotel	9 person	$2.500,00	Estimate
CanSat Competition Fee		$100,00	Actual
Total		$9.490,00	

Everything about the budget continues as planned. We do not have any problems. ☺

Program Schedule

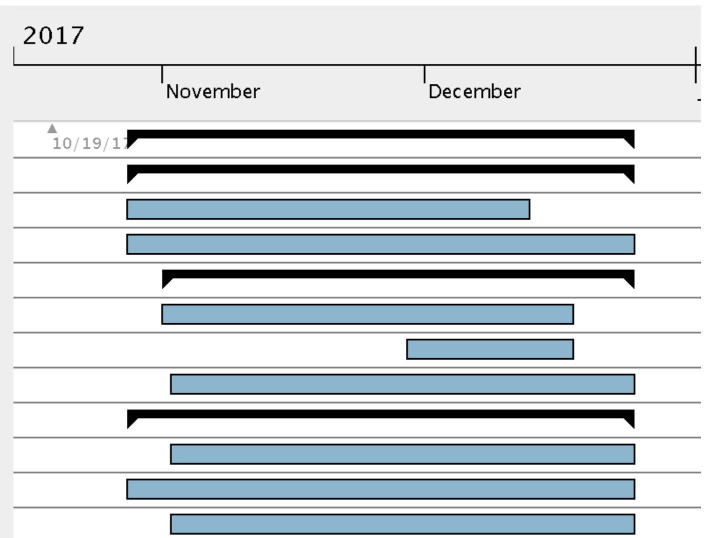
Milestones

ne	Begin date	End date	Completed
Milestone	9/25/17	6/8/18	
Project Start	9/25/17	9/25/17	√
University Midterm Exams	11/8/17	11/17/17	√
University Final Exams	12/25/17	1/5/18	√
University Condition Exams	1/15/18	1/19/18	√
Semester	1/22/18	2/12/18	√
PDR	9/25/17	2/28/18	√
Teleconferance for PDR	2/28/18	2/28/18	√
CDR	3/1/18	3/30/18	√
Teleconferance for CDR	3/30/18	3/30/18	-
Final Tests and Demo Flights	4/2/18	6/5/18	-
Flight to USA	6/6/18	6/6/18	-
CanSat Competition & PFR Presentation	6/8/18	6/8/18	-



Major Development

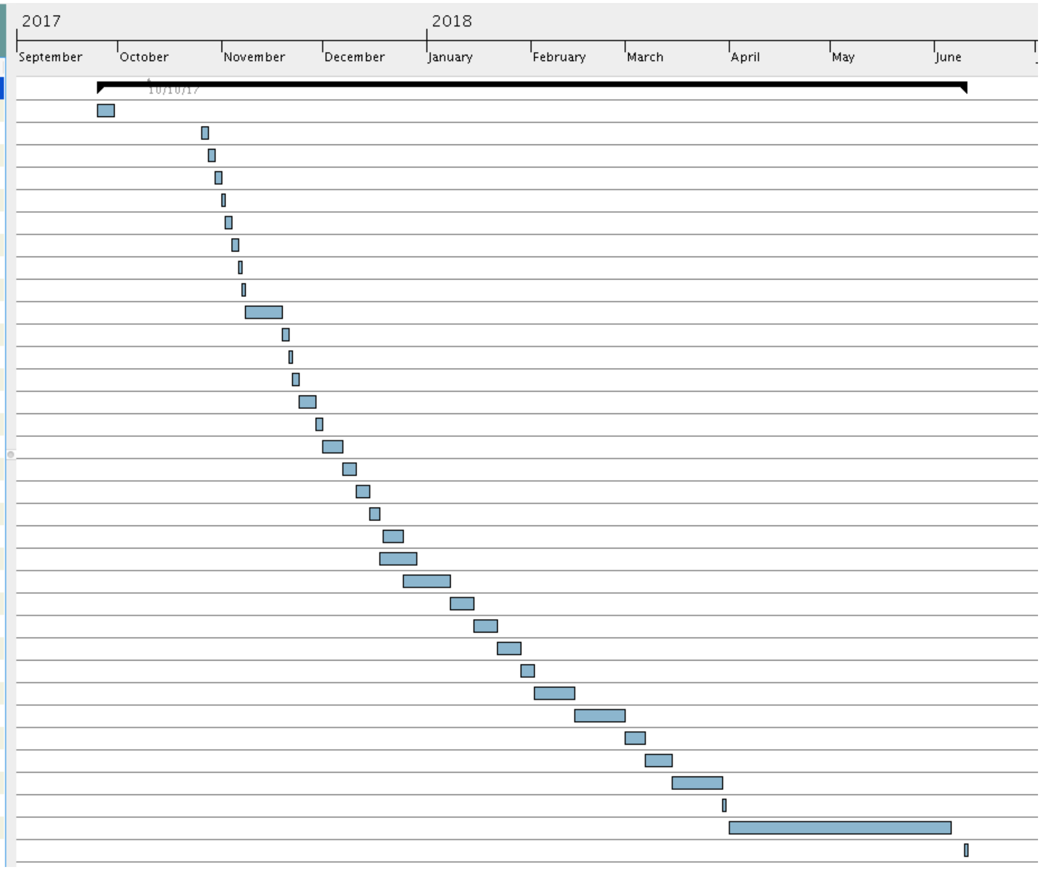
Name	Begin date	End date	Completed
Major Development	10/28/17	12/24/17	
Mechanical	10/28/17	12/24/17	
Descent Control Subsystem Design	10/28/17	12/12/17	%100
Mechanical Subsystem Design	10/28/17	12/24/17	%100
Electrical	11/1/17	12/24/17	
Sensors	11/1/17	12/17/17	%100
Powers	11/29/17	12/17/17	%100
Tests	11/2/17	12/24/17	%100
Software	10/28/17	12/24/17	
Communication and Data Handling Subsystem Design	11/2/17	12/24/17	%100
Flight Software Design	10/28/17	12/24/17	%85
Ground Control System Design	11/2/17	12/24/17	%90



Program Schedule

Electrical and Electronics

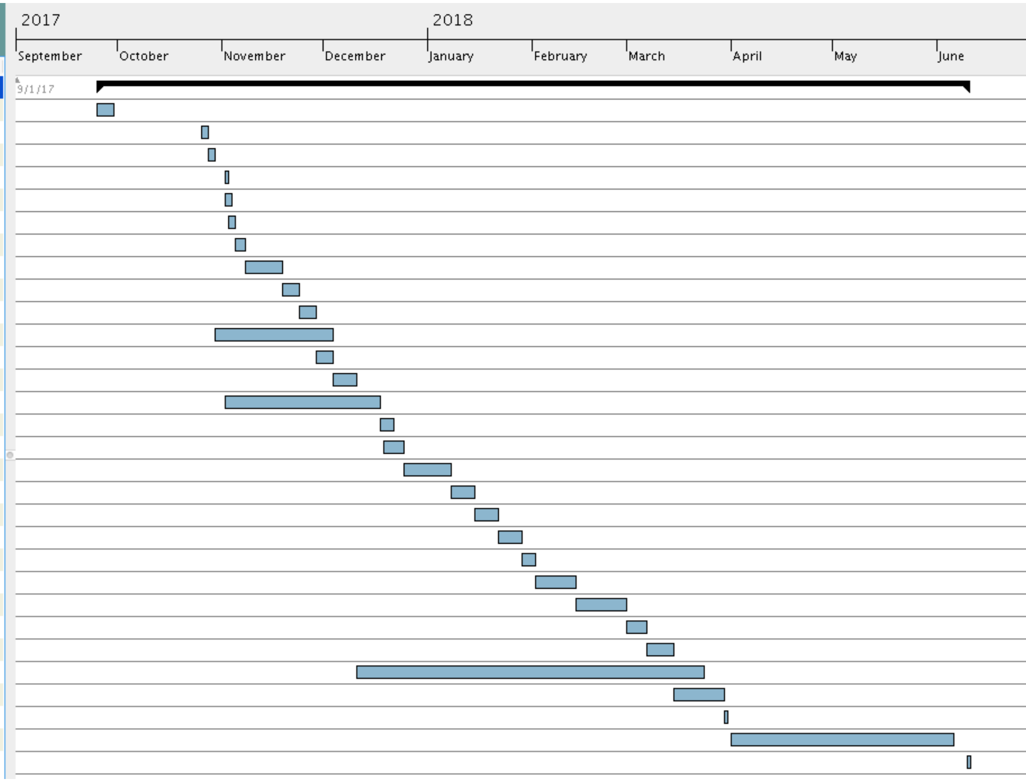
e	Begin date	End date	Completed
Electrical and Electronics	9/25/17	6/10/18	
Team friends choice for the contest	9/25/17	9/29/17	%100
Examination of Competiton Requirements	10/26/17	10/27/17	%100
Contest Mission Discussion	10/28/17	10/29/17	%100
Preparing the preliminary work by examing the general purpose of EPS	10/30/17	10/31/17	%100
Xbee and antenna selection	11/1/17	11/1/17	%100
Identification and testing of sensors to be used	11/2/17	11/3/17	%100
Selection of Progressive tilt sensor to be used for landing	11/4/17	11/5/17	%100
Calibration and testing of tilt sensors	11/6/17	11/6/17	%100
Selection of real time clock module	11/7/17	11/7/17	%100
University Midterm Exams	11/8/17	11/18/17	%100
Selection of GPS module	11/19/17	11/20/17	%100
Selection of servo motors for parachuting	11/21/17	11/21/17	%100
Specifying the SD Card used to record telemetry data	11/22/17	11/23/17	%100
Determination of camera and SD Card for bonus mission	11/24/17	11/28/17	%100
MCU Battery selection to feed	11/29/17	11/30/17	%100
Preparation of the regulator circuit voltages	12/1/17	12/6/17	%100
Desinging electric blog diagram for probe	12/7/17	12/10/17	%100
Selection of telemetry to send data to the ground station	12/11/17	12/14/17	%100
Establishing a dynamic breadbord for the required design	12/15/17	12/17/17	%100
xbee communication test	12/19/17	12/24/17	%100
General meeting for PDR	12/18/17	12/28/17	%100
University Final Exams	12/25/17	1/7/18	%100
Preparing For PDR file	1/8/18	1/14/18	%100
University Condition Exam	1/15/18	1/21/18	%100
Getting the PDR file ready	1/22/18	1/28/18	%100
Improvement Studies for PDR	1/29/18	2/1/18	%100
Semester	2/2/18	2/13/18	%100
Preparing presentation for teleconference	2/14/18	2/28/18	%100
CDR file preparing	3/1/18	3/6/18	%100
Tests for CDR file	3/7/18	3/14/18	%100
Getting the CDR file ready	3/15/18	3/29/18	%100
Teleconference for CDR file	3/30/18	3/30/18	-
Final Tests and Demo Flights	4/1/18	6/5/18	-
PFR File	6/10/18	6/10/18	-



Program Schedule

Software

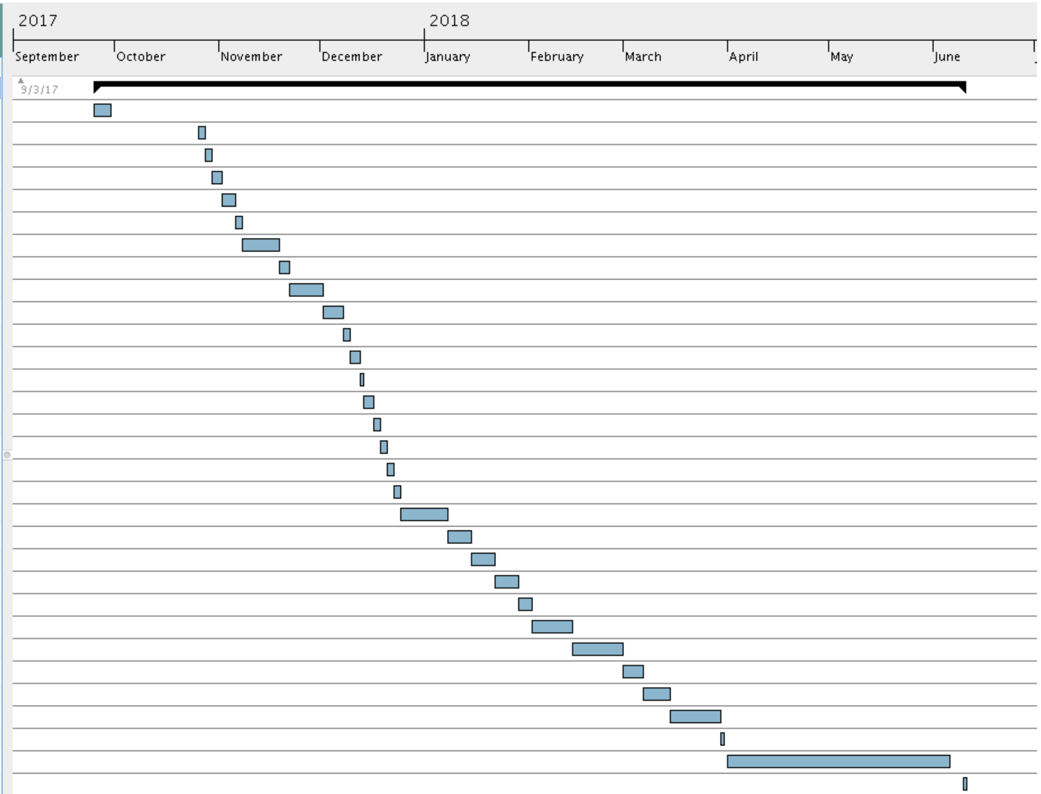
Name	Begin date	End date	Completed
Software	9/25/17	6/10/18	
Team friends choice for the contest	9/25/17	9/29/17	%100
Examination of Competiton Requirements	10/26/17	10/27/17	%100
Contest Mission Discussion	10/28/17	10/29/17	%100
Decision of programming language and establishment of necessary programs	11/2/17	11/2/17	%100
Identification and testing of sensors to be used	11/2/17	11/3/17	%100
Determinition of microprocessor to be used	11/3/17	11/4/17	%100
Preparation of software for sensors	11/5/17	11/7/17	%100
University Midterm Exams	11/8/17	11/18/17	%100
Xbee the configuration	11/19/17	11/23/17	%100
Data from sensors transferring with Xbee	11/24/17	11/28/17	%95
Algorithm preparation	10/30/17	12/3/17	%100
Construction of Codes Required to Protect Data on Telemetry	11/29/17	12/3/17	%100
Required Encoding for Bonus Photo Capture	12/4/17	12/10/17	%100
Decision making and design of GCS interface design	11/2/17	12/17/17	%80
General meeting for PDR	12/18/17	12/21/17	%100
Xbee Coding on Programming	12/19/17	12/24/17	%100
University Final Exams	12/25/17	1/7/18	%100
Preparing For PDR file	1/8/18	1/14/18	%100
University Condition Exam	1/15/18	1/21/18	%100
Getting the PDR file ready	1/22/18	1/28/18	%100
Improvement Studies for PDR	1/29/18	2/1/18	%100
Semester	2/2/18	2/13/18	%100
Preparing presentation for teleconference	2/14/18	2/28/18	%100
CDR file preparing	3/1/18	3/6/18	%100
Tests for CDR file	3/7/18	3/14/18	%100
Testing the FSW in the general CanSat system	12/11/17	3/23/18	%100
Getting the CDR file ready	3/15/18	3/29/18	%100
Teleconference for CDR file	3/30/18	3/30/18	-
Final Tests and Demo Flights	4/1/18	6/5/18	-
PFR File	6/10/18	6/10/18	-



Program Schedule

Mechanical

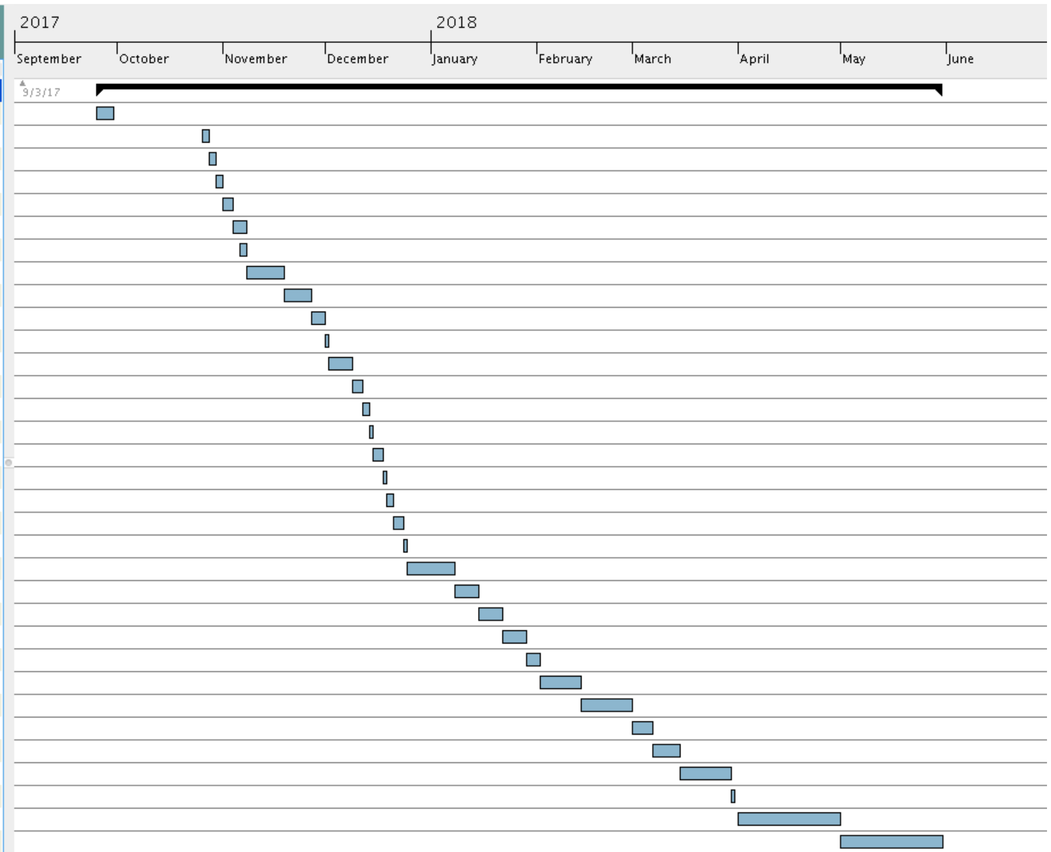
Name	Begin date	End date	Completed
Mechanical	9/25/17	6/10/18	
Team friends choice for the contest	9/25/17	9/29/17	%100
Examination of Competiton Requirements	10/26/17	10/27/17	%100
Contest Mission Discussion	10/28/17	10/29/17	%100
Presentations of ideas for the separation of the probe from the heat shield	10/30/17	11/1/17	%100
Examination of required accounts and designs for shaking the load	11/2/17	11/5/17	%100
Selection of parachute material	11/6/17	11/7/17	%100
University Midterm Exams	11/8/17	11/18/17	%100
Design and testing in parachute cad environment	11/19/17	11/21/17	%100
Drawing the heat shield in the cad environment	11/22/17	12/1/17	%100
Design of Heat Shield	12/2/17	12/7/17	%100
Heat shield test	12/8/17	12/9/17	%100
Evaluation of opening mechanisms and design of selected design	12/10/17	12/12/17	%100
Selection of probe material and shape	12/13/17	12/13/17	%100
Determination of electronic material locations in probe	12/14/17	12/16/17	%100
Inside the probe with my circuits draw in the CAD environment	12/17/17	12/18/17	%100
Probe design	12/19/17	12/20/17	%100
Provision of materials necessary for the protection of eggs	12/21/17	12/22/17	%100
Application of tests required for egg protection	12/23/17	12/24/17	%100
University Final Exam	12/25/17	1/7/18	%100
Preparing For PDR file	1/8/18	1/14/18	%100
University Condition Exam	1/15/18	1/21/18	%100
Getting the PDR file ready	1/22/18	1/28/18	%100
Improvement Studies for PDR	1/29/18	2/1/18	%100
Semester	2/2/18	2/13/18	%100
Preparing presentation for teleconference	2/14/18	2/28/18	%100
CDR file preparing	3/1/18	3/6/18	%100
Tests for CDR file	3/7/18	3/14/18	%90
Getting the CDR file ready	3/15/18	3/29/18	%100
Teleconference for CDR file	3/30/18	3/30/18	-
Final Tests and Demo Flights	4/1/18	6/5/18	-
PFR File	6/10/18	6/10/18	-



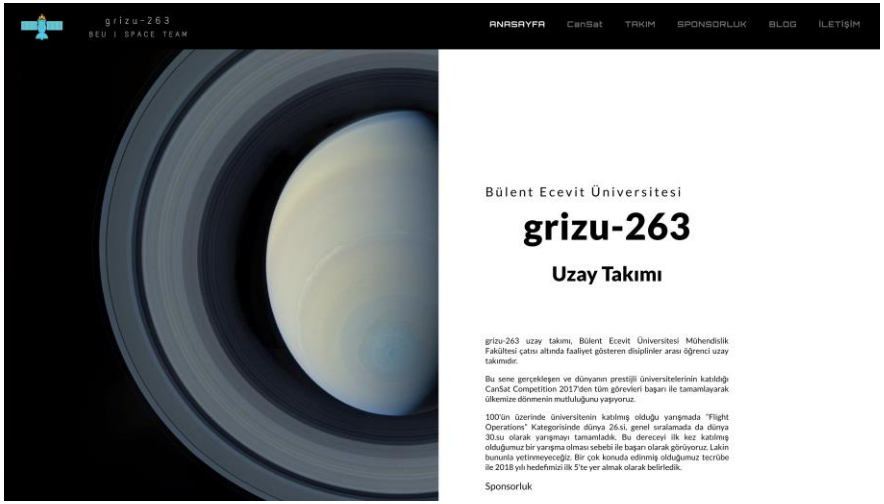
Program Schedule

Sponsorship

ame	Begin date	End date	Completed
Sponsorship	9/25/17	5/30/18	
Team friends choice for the contest	9/25/17	9/29/17	%100
Examination of Competiton Requirements	10/26/17	10/27/17	%100
Contest Mission Discussion	10/28/17	10/29/17	%100
Providing information about sponsorship	10/30/17	10/31/17	%100
Sponsorship General Meeting	11/1/17	11/3/17	%100
Wep site update (www.grizu-263.space)	11/4/17	11/7/17	%100
Designing and updating social media accounts	11/6/17	11/7/17	%100
University Midterm Exams	11/8/17	11/18/17	%100
Preparing a sponsorship file	11/19/17	11/26/17	%100
Thanks to the sponsors last year	11/27/17	11/30/17	%85
Sponsorship General Meeting	12/1/17	12/1/17	%100
Looking for Sponsors	12/2/17	12/8/17	%95
Sponsorship interview	12/9/17	12/11/17	%95
Sponsorship agreement	12/12/17	12/13/17	%90
Sponsorship General Meeting	12/14/17	12/14/17	%100
Printing T-shirts and brochures	12/15/17	12/17/17	%100
General meeting for PDR	12/18/17	12/18/17	%100
Ideas for extra revenue source	12/19/17	12/20/17	%90
In launching the ideas presented for their income sources	12/21/17	12/23/17	%90
Sponsorship general project	12/24/17	12/24/17	%90
University Final Exam	12/25/17	1/7/18	%100
Preparing For PDR file	1/8/18	1/14/18	%100
University Condition Exam	1/15/18	1/21/18	%100
Getting the PDR file ready	1/22/18	1/28/18	%100
Improvement Studies for PDR	1/29/18	2/1/18	%100
Semester	2/2/18	2/13/18	%100
Preparing presentation for teleconference	2/14/18	2/28/18	%100
CDR file preparing	3/1/18	3/6/18	%100
Tests for CDR file	3/7/18	3/14/18	%100
Getting the CDR file ready	3/15/18	3/29/18	%100
Teleconference for CDR file	3/30/18	3/30/18	-
Airline tickets, visas, etc.	4/1/18	4/30/18	-
Accommodation, such as car rental planning of topics.	5/1/18	5/30/18	-



Social Media and Publicity

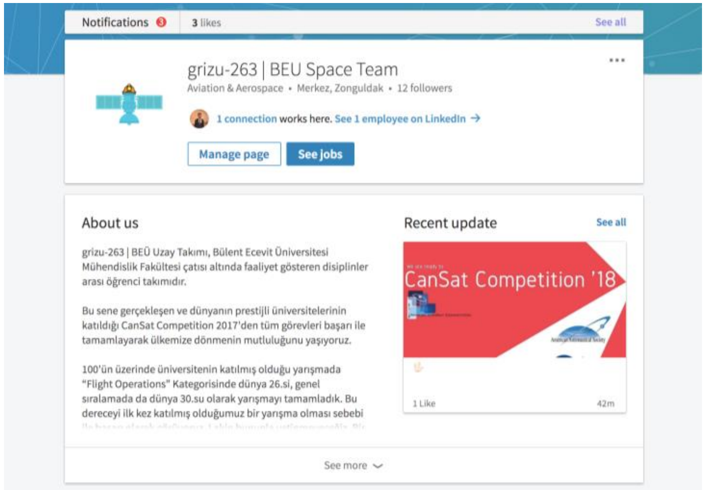


www.grizu-263.space

Our website has been active since September 2016.Average number of unique visitors per day 11 Alexa Traffic Rank: 3.300.000

[LinkedIn]()

We have activated our LinkedIn page, now there are about 42 followers. But it grows fast. Our followers are mostly academicians and university students.

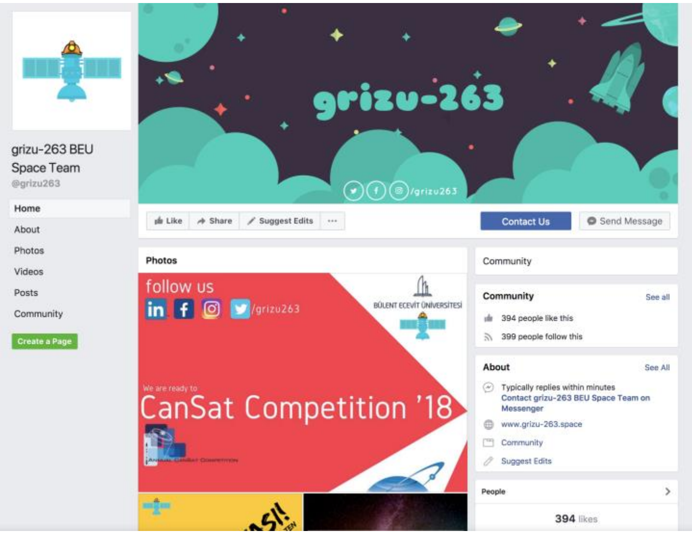


Twitter

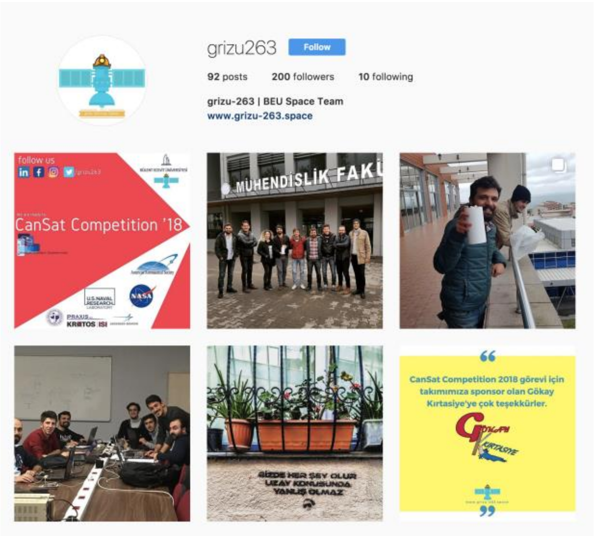
Our Twitter page opened in October 2016. Approximately 152 posts were shared in the team, cansat competition, space, engineering and science fields. We have about 127 followers.

Facebook

Our Facebook page has been active since September 2016. We have about 415 followers. Our posts are shown to an average of 1000-1250 people per week. We are sharing more in teams, competition, science, space and engineering.



Social Media and Publicity

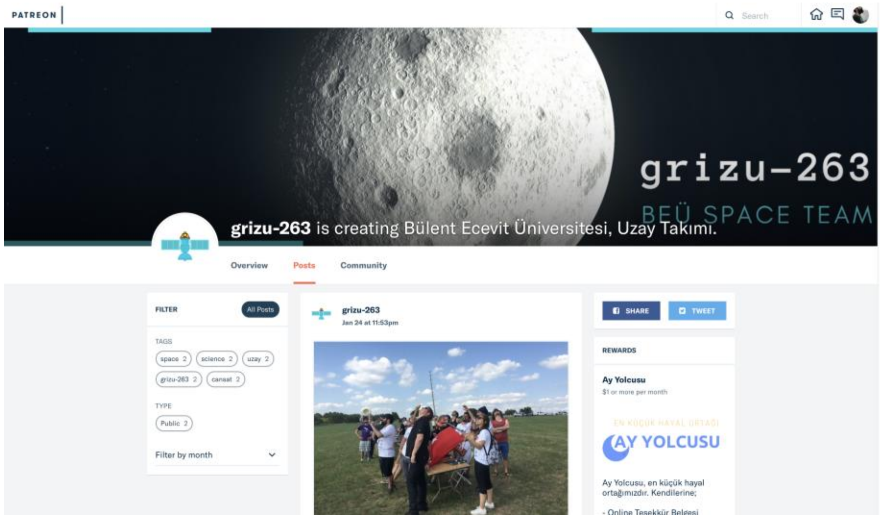


Instagram

We have about 430 followers on our Instagram page. We use it for promotional purposes, like our other social media accounts, and we have a high engagement rate.

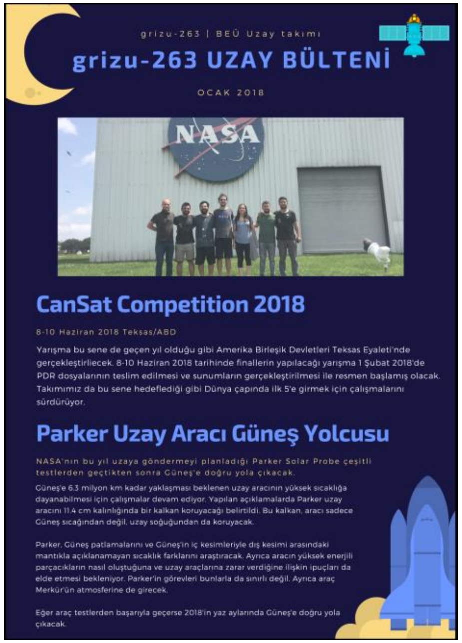
Patreon

Last time we opened the patron account 1 month ago. Apart from sponsorship, those who want to donate can do it here. We have 6 donations.



Social Media and Publicity

Other Presentation and Information Tools



Team (grizu-263), space, engineering and science are published monthly by our bulletin.

We have a brochure for promotional purposes.

Other Presentation and Information Tools

Our promotion and sponsorship file. It is a 14 page file consisting of school support, team and competition presentation, what we did and various information. It is used in sponsorship negotiations and in various situations.

Other Presentation and Information Tools

Thanks for sending us the sponsors who supported us in the previous year

Various posters we have prepared for the previous year.

Conclusions

Accomplishments:

- The algorithm for sensor control is decided
- Mechanical designs were made
- GPS have been test. We enterned this unit on Google maps and found that our location is correct.
- Air pressure sensor, air temperature sensor, tilt sensor, camera and GPS sensor assemble on the electonics board and has been test.
- Material selection has been made
- Opening test was made with burn wire melted.

Unfinished work:

- Heat shield and probe is not doing to separation mechanical test
- Heat shield ,Vibration Test and Termal Test has not been yet.
- Rehearsal test has not been yet with drone. Drone will go out 700 meters and drone will separation Cansat.

Conclusions

Testing to complete:

- Xbee communication has been achieved succesfully.
- The antenna has been tested.
- Cansat drop test has been done. It was seen not tumble down over.
- GCS interface tested has been tested.
- Egg protection system has been tested.
- Parachute drop test has been done.

FSW Software Status:

- FSW subsystems have been tested. FSW system will be tested again on CanSat system as a whole on 20th May.