TEKNOFEST 2019
ROCKET COMPETITION
Critical Design Report

Team Members

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Rocket General Design

SUMMARY

General Information About the Competition Rocket

	Measurement	Explanation
Length (meter):	2.33	The total length of the rocket including the nose cone.
Diametre (meter):	0.16	It is the largest diameter value of the rocket.
Dry Weight of the Rocket (kg.):	18.496	It is the weight of the rocket without engine.
Mass of Fuel(kg.):	4.835	It is the mass of the fuel in the engine.
Dry Weight of the Engine (kg.):	7.878	It is the weight of the engine without fuel.
Payload Weight (kg.):	4.489	It is the weight of the payload.
Total Takeoff Weight (kg.):	26.374	It is the weight of the rocket before take-off on the ramp.
Thrust type:	Solid Fuel Engine	The thrust of the rocket will be provided by a solid fuel engine.

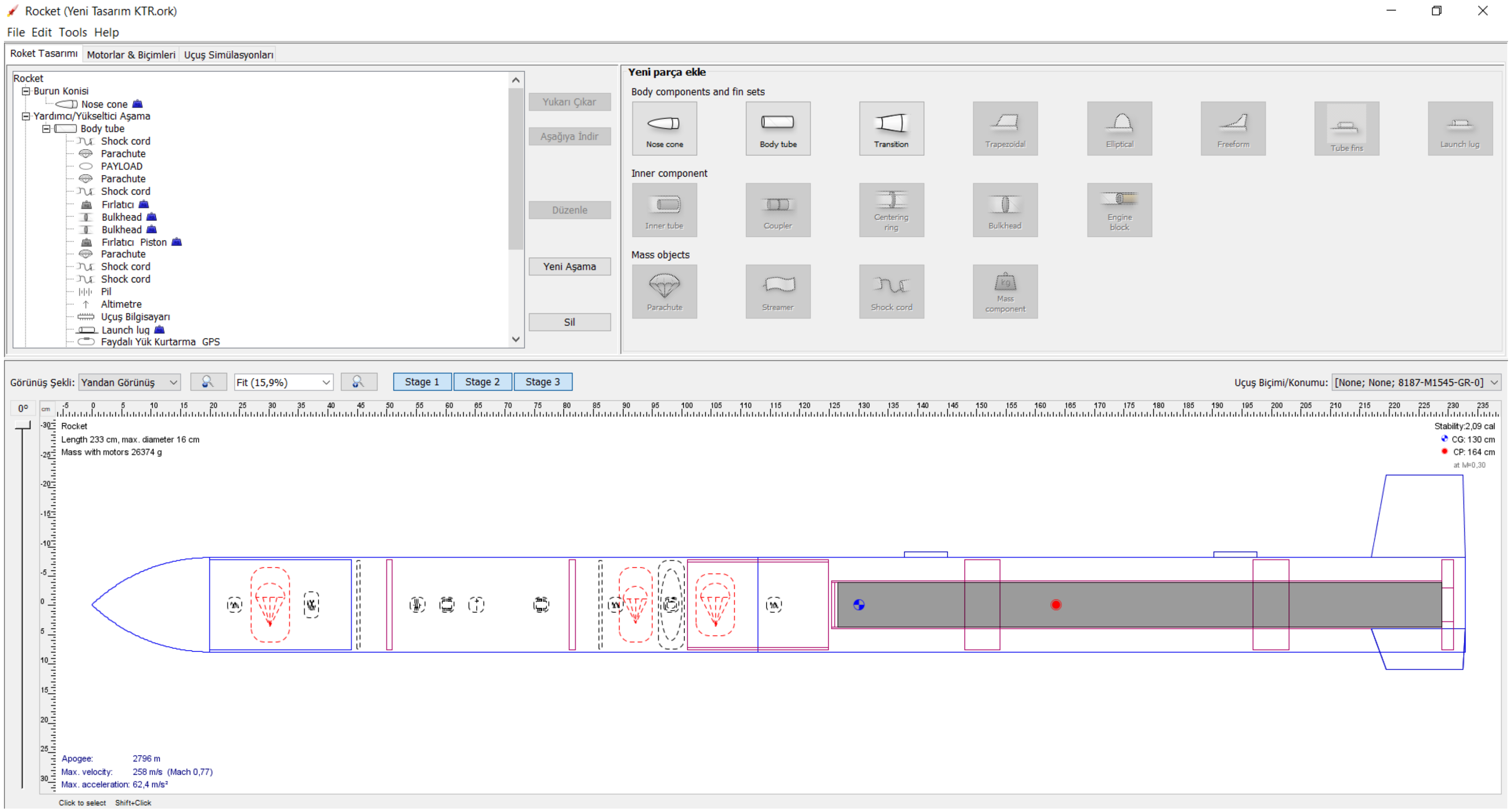
Predicted Flight Data and Analytics

	Measurement	Explanation
Takeoff Thrust/Weight Ratio:	5.98	It is the ratio of the average thrust of the engine to the weight of the rocket.
Ramp Speed(m/s):	26.3	It is the rocket's exit velocity from the ramp.
Minimum Static Equilibrium Value During Combustion:	2.49	It is the static balance value of the rocket before the engine burns out.
The greatest acceleration (g):	6.36	It is the maximum acceleration the rocket has.
Top Speed(m/s & M):	258	It is the maximum speed the rocket has.
Determined Altitude (m):	2838	It is the projected altitude of the rocket.

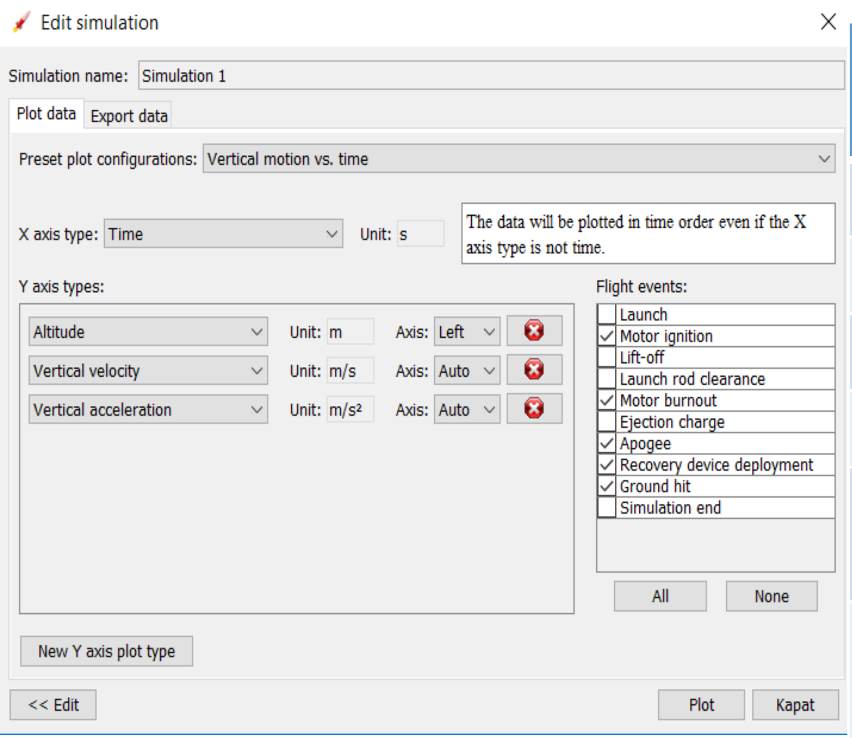
Engine Selections

Brand :	Cesaroni	Name:M1545	Class:	M
Total Thrust Value of Engine (Ns):				8186.7
Brand :	Cesaroni	Name:M1675	Class:	M
Total Thrust Value of Engine (Ns):				6162.0

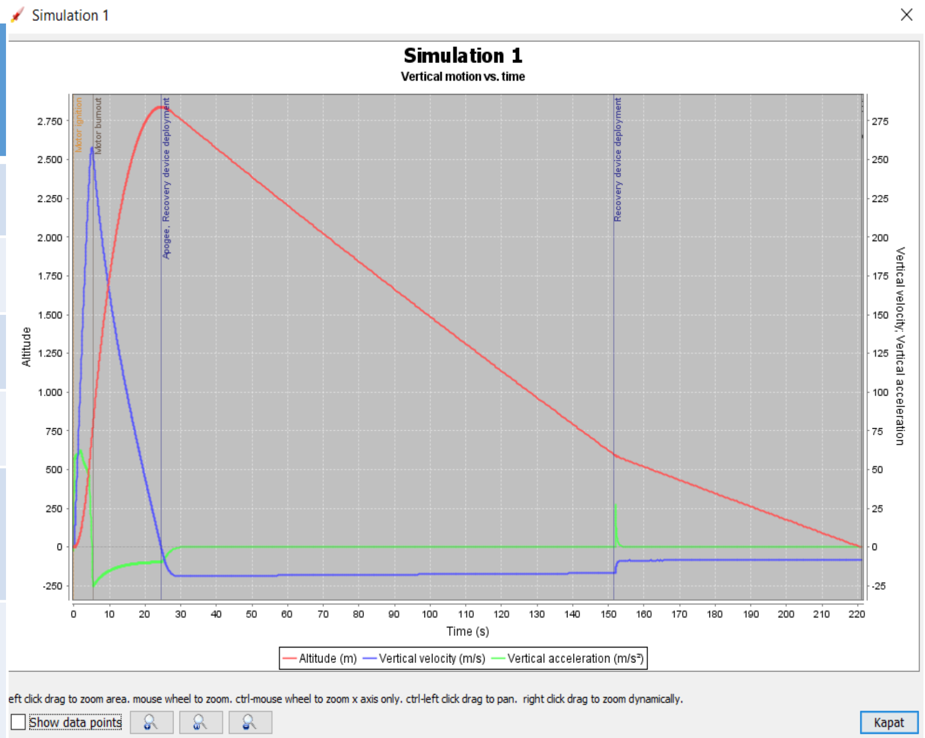
Open Rocket General Design



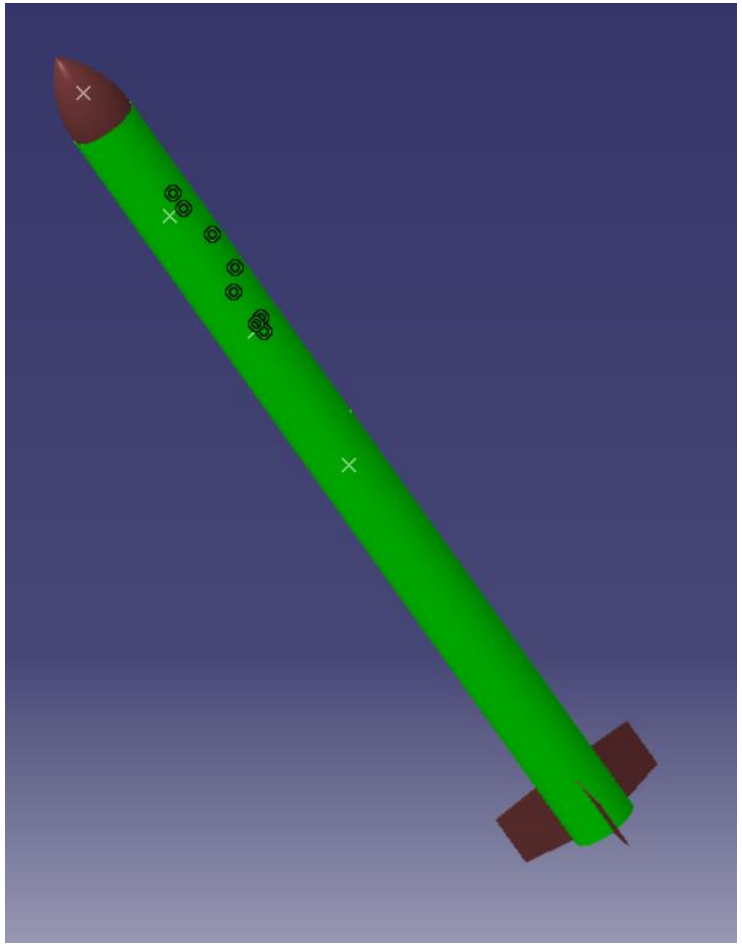
Open Rocket General Design

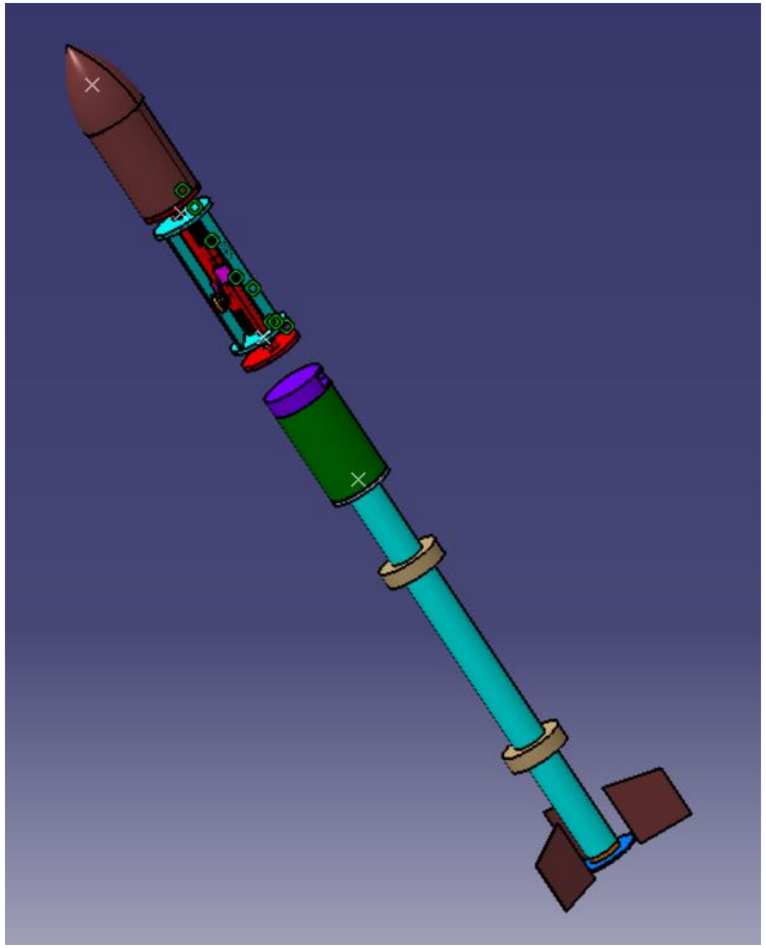


	Time (s)	Altitude (m)	Velocity (m/s)
Launching	0	0	0
Ramp Hill	0.5	5.97	26.3
Burn Out	5,4	806	251.95
Peak	24,55	2837.75	0
Parachute Deploying	151.4 6	600	-16.85
After parachute deploying	-	-	8.47

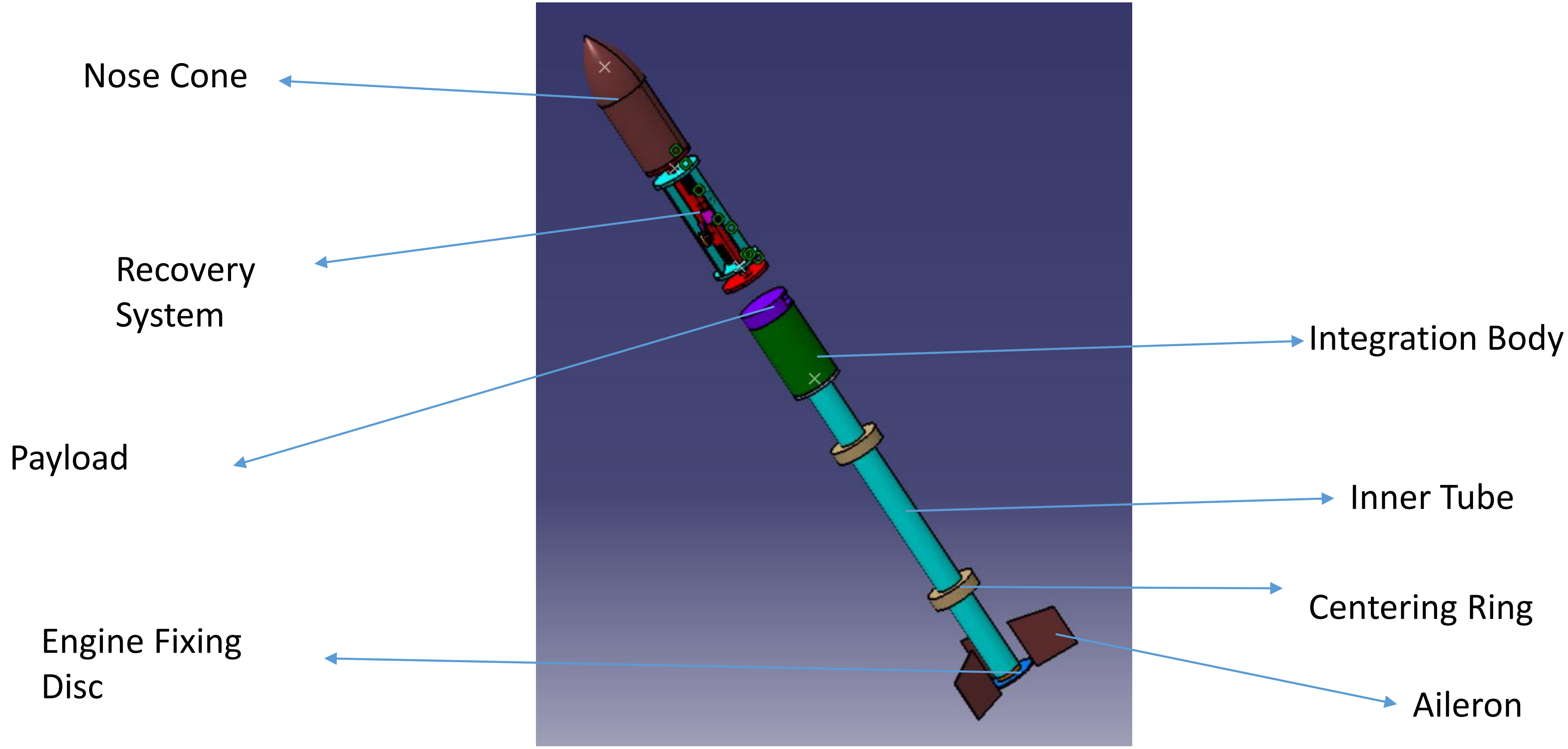


Mechanical Appearance & Mass Budget





Mechanical Appearance & Mass Budget

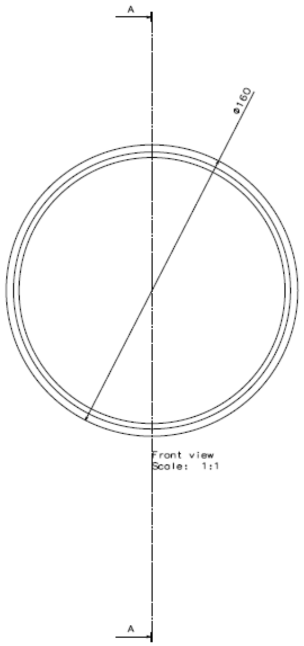


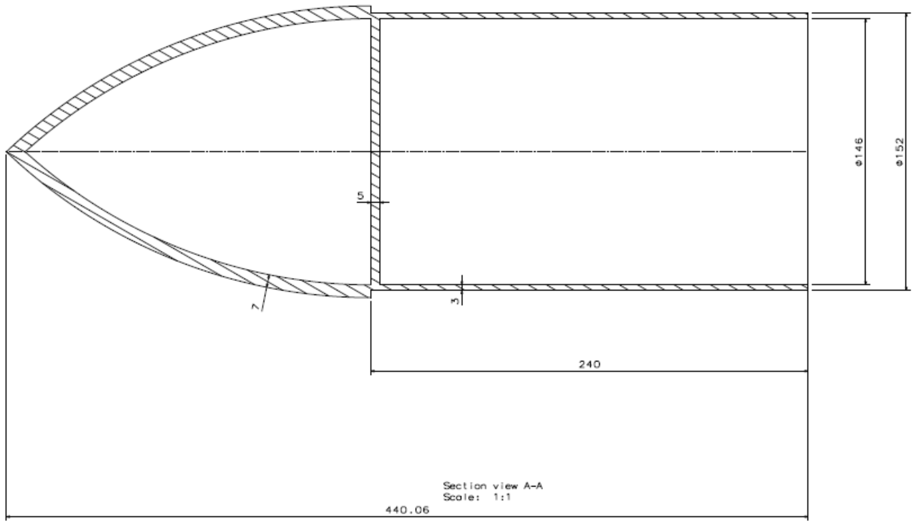
Mechanical Appearance & Mass Budget

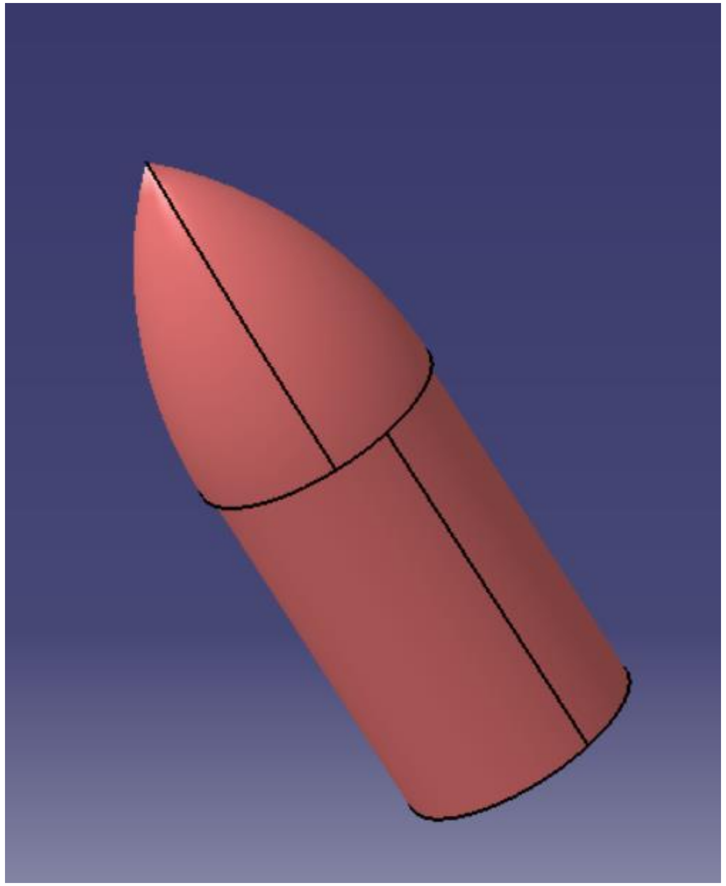
Part No	Component	Weight(Gram)	Material	Number
1	Nose Cone	1014	Polyamid	1
2	My Recovery System Main Chassis	1839	Aluminium	1
3	Launcher Piston Rod + Head	443	Aluminium	2
4	Rescue System Socket Element	146	Steel	2
5	Rescue Shooter Element	36	Steel	2
6	Payload	4489	Iron	1
7	Center Tab Main Pipe	2534	PVC	1
8	Integration Body	629	Polyamid	1
9	Eyelet Holder Disc	205	Polyamid	1
10	Engine Block	25	Polyamid	1
11	Inner Tube	1058	Polyamid	1
12	Centering Rings	928	Polyamid	2
13	Engine Stabilizer Disc	178	Polyamid	2
14	Engine Tab Tube	3270	PVC	1
15	Fins (for 3 wings)	206	Polyamid	1
16	M6 Eyebolt	50	Steel	4

Part No	Component	Weight(Gram)	Material	Number
17	Parachute(100 cm)	55.9	Rip stop nylon	1
18	Parachute(150 cm)	122	Rip stop nylon	1
19	Parachute(250 cm)	332	Rip stop nylon	1
20	Shock Cord	72		3
21	Compression Spring			4
22	Tension Spring			2

Mechanical Appearance & Mass Budget







Mechanical Appearance & Mass Budget

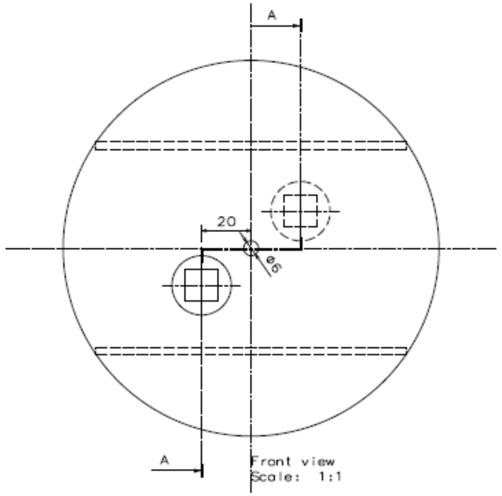
The length of the Ogive-shaped structure of the Nose Cone was determined as 20 cm. The main diameter of the nose cone was determined as 16cm. The wall thickness in the oval part of the nose cone was determined as 7 mm.

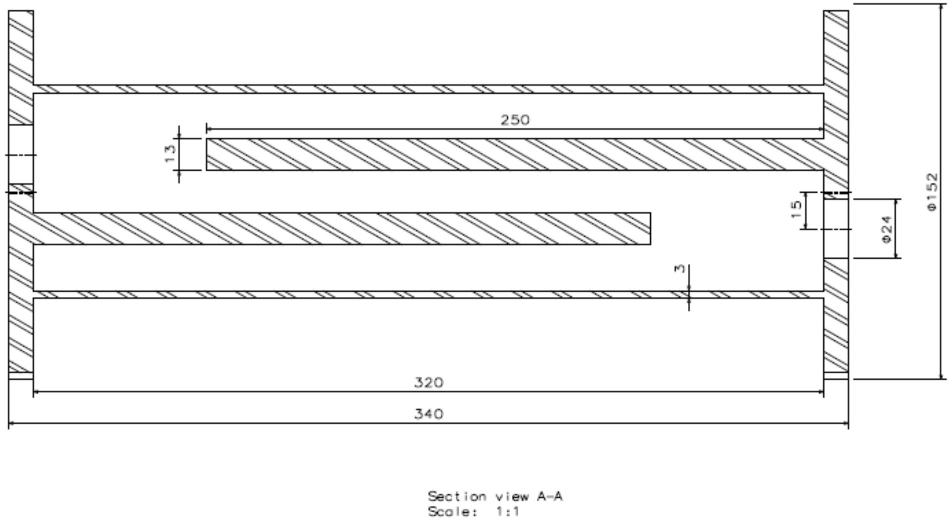
The outer diameter of the shoulder part of the nose cone, which will serve to connect the nose cone to the middle hop tube, is determined as 15.2 cm. The wall thickness of this shoulder part was determined as 3 mm. Accordingly, the inner diameter of the shoulder part will be 14.6 cm.

A disc with an outer diameter of 14.6 cm and a wall thickness of 5 mm will be placed on the part where the oval part of the nose meets the shoulder part. Here, the purpose of placing this disc is to position the eyebolt to which the shock cord will be attached. The eyebolt will be connected to the disc by means of the disc, and the shock cord will be connected to the eyebolt. The map will be located in the middle of the disk.

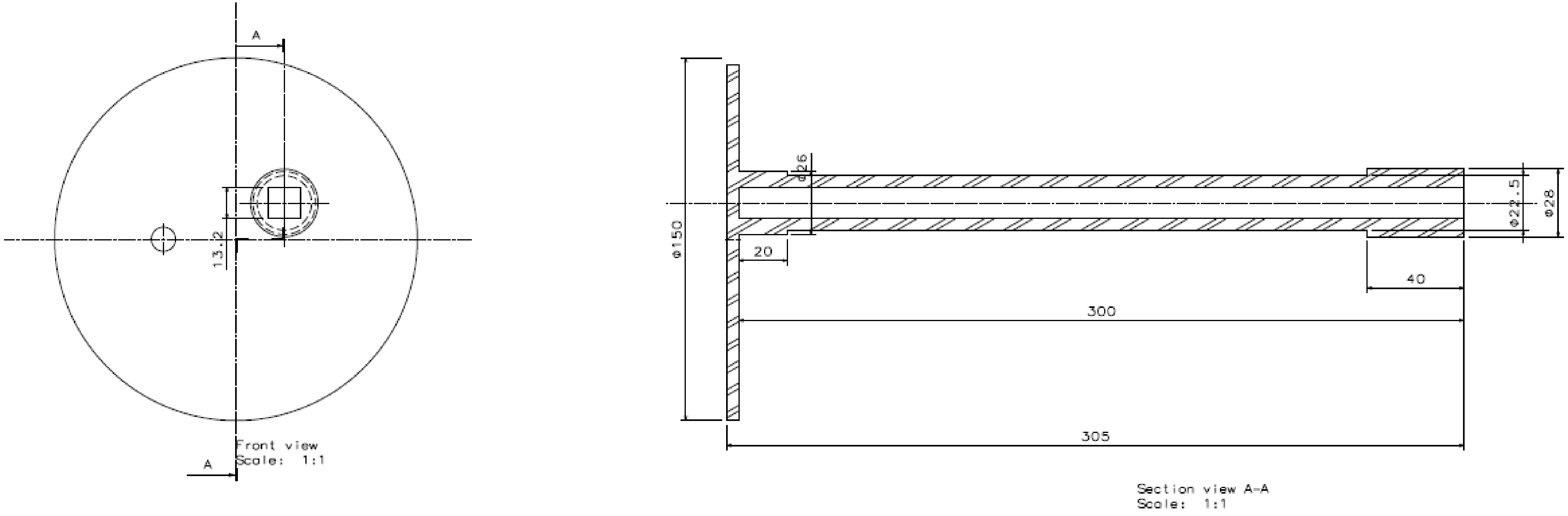
Polyamide, the material from which the nose cone will be manufactured, is a polymer with high mechanical strength. Polyamide is a durable material at low temperatures, but also has thermal stability. In addition, polyamide provides good opportunities in terms of manufacturability. Polyamide is a material that can be processed without problems.

Mechanical Appearance & Mass Budget

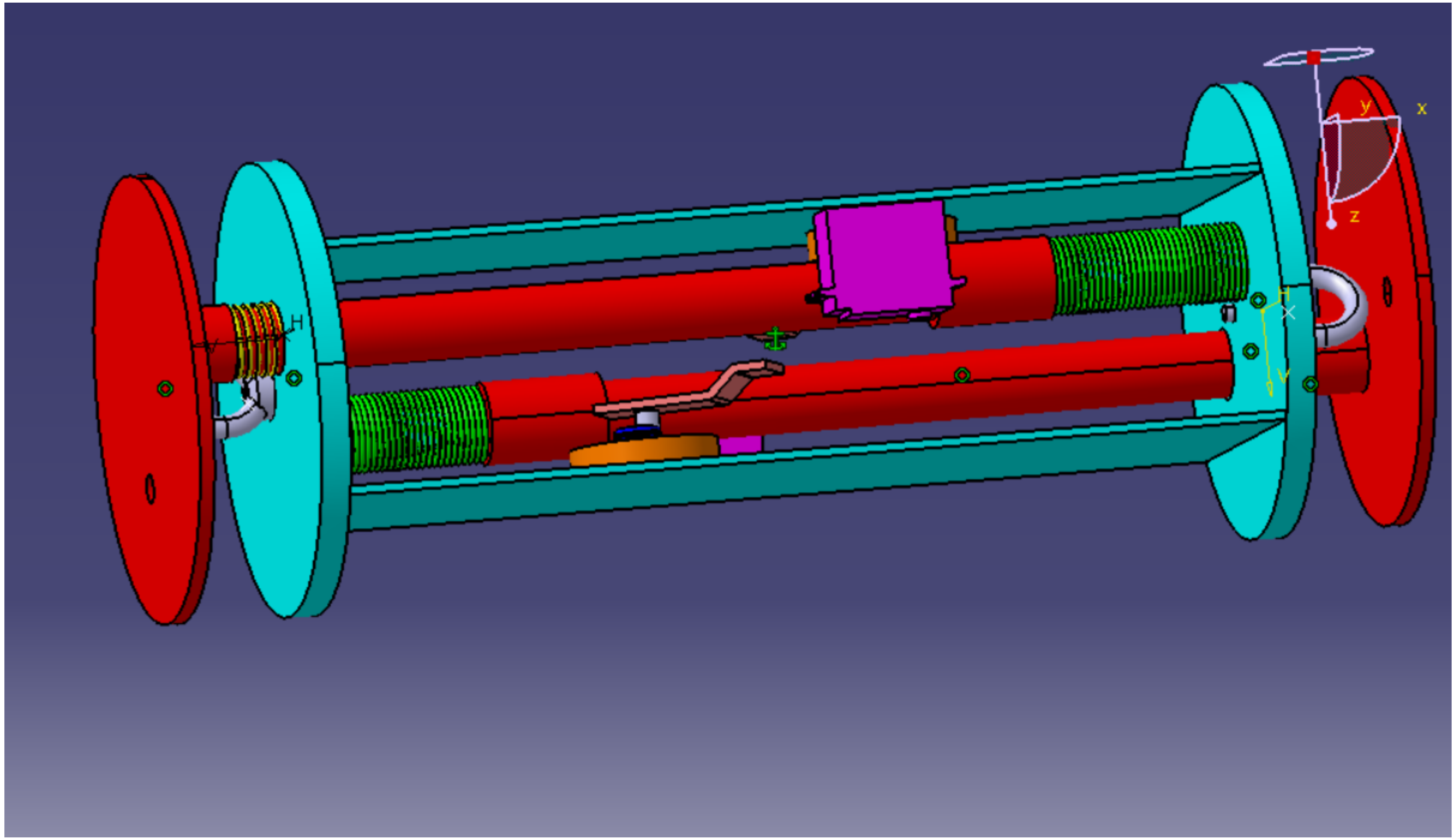




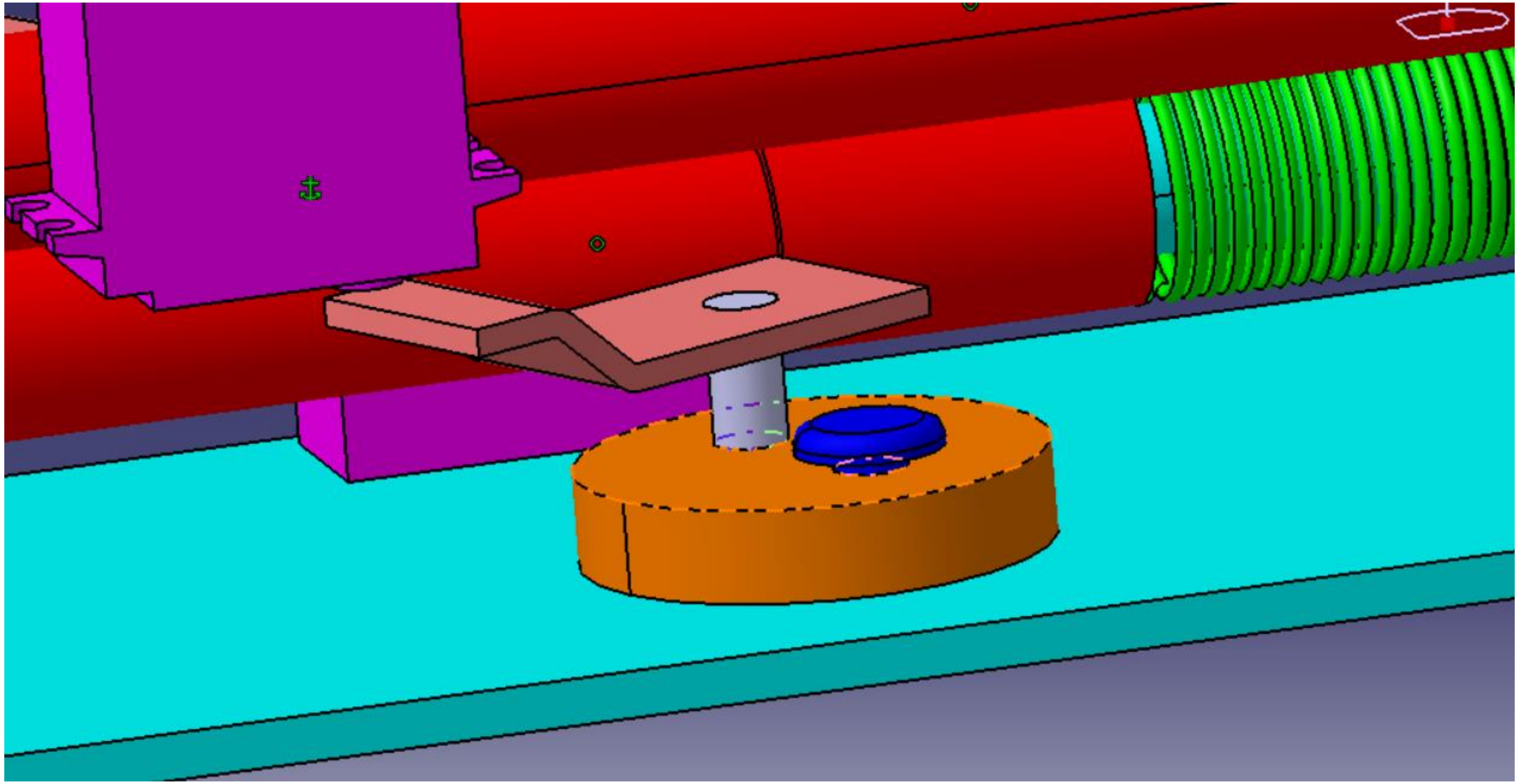
Mechanical Appearance & Mass Budget



Mechanical Appearance & Mass Budget



Mechanical Appearance & Mass Budget



Mechanical Appearance & Mass Budget

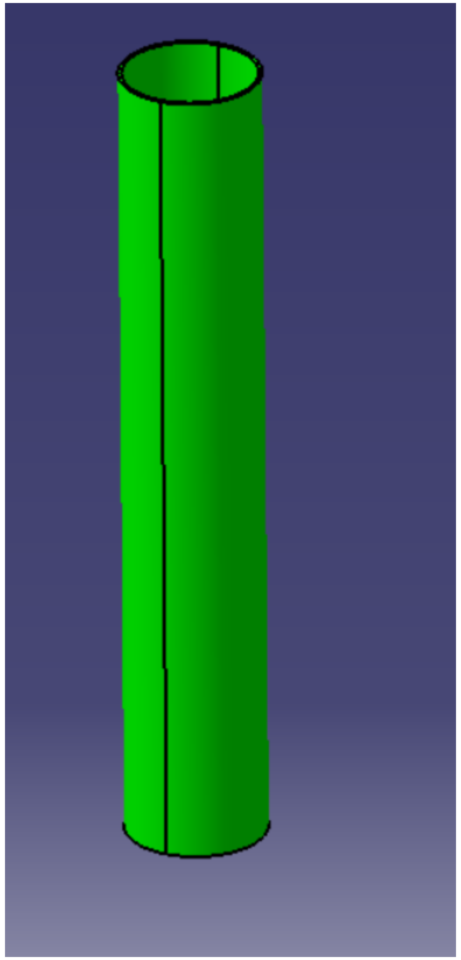
The recovery system is designed on the basis of ejecting the pistons by utilizing the mechanical energy of the springs and accordingly ejecting the elements such as the payload, nose cone and parachute on the path of the pistons. The recovery system has two pistons facing two opposite directions. The distance between the pistons when locked is 44 cm. Which is the maximum length the recovery system will cover. The heads of the pistons will be 15 cm in diameter. The rods of the pistons are thought to be hollow. A bushing with an outer diameter of 26mm and a length of 20mm, starting from the junction of the pistons with the head, has been designed. The purpose of this bush is to create a seating plane for the bow. A bushing is designed at the other end of the piston rod with a diameter of 28 mm and a length of 40 mm. The purpose of this bush is to both create a seating plane for the spring and to form the surface where the locking element in the lock mechanism will do the locking. The rods of the pistons will fit on the rectangular shafts mounted on the chassis for bedding. The shafts will pass through the space inside the pistons. The reason why the shafts are considered rectangular is to prevent the pistons from rotating around the shaft axis. The distance between the two plates on the chassis is 320 m.

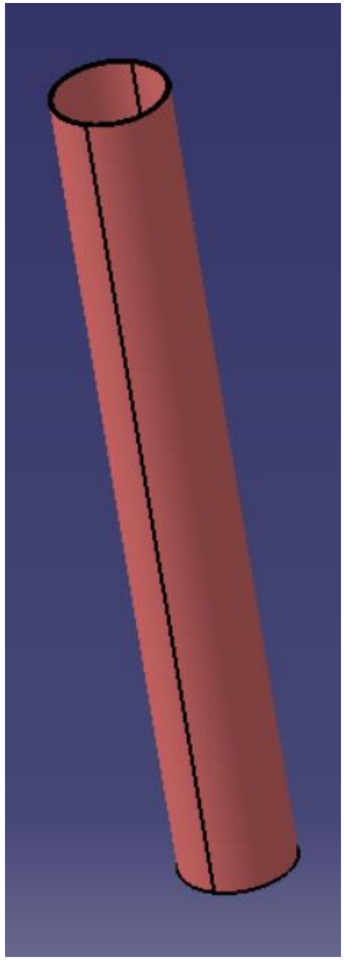
Mechanical Appearance & Mass Budget

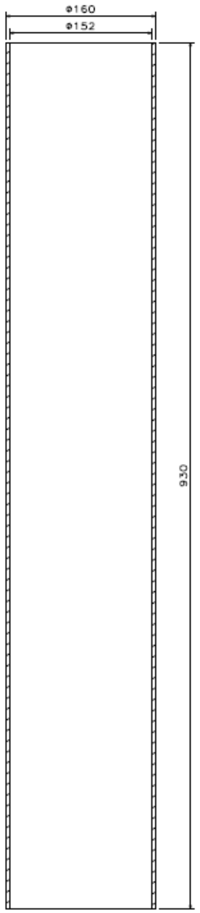
Although materials such as steel are foreseen for some of the lower parts of the rescue system, it has been decided to manufacture the parts that assume the main weight of the material from aluminum. One of the main reasons for choosing aluminum is its weight advantage. In the prototype stage, the weight bearing materials were made of steel and the weight problem was observed. For this reason, it was decided to make the weight-bearing materials from aluminum, with minor changes in the design. It is possible to give the piston head, the piston rod, the chassis of the recovery system as examples of the materials bearing weight.

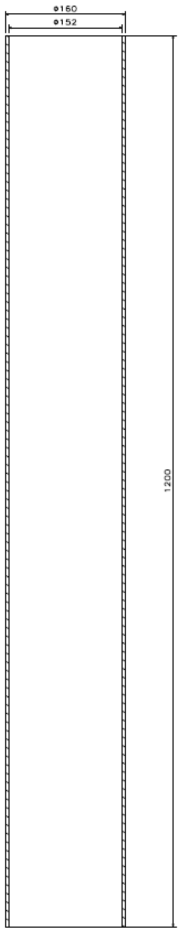
Aluminum is a very light material in weight. Its density is one third that of steel or copper. Although lightweight, aluminum is a strong material. Aluminum is an easily malleable, machinable and castable material.

Mechanical Appearance & Mass Budget









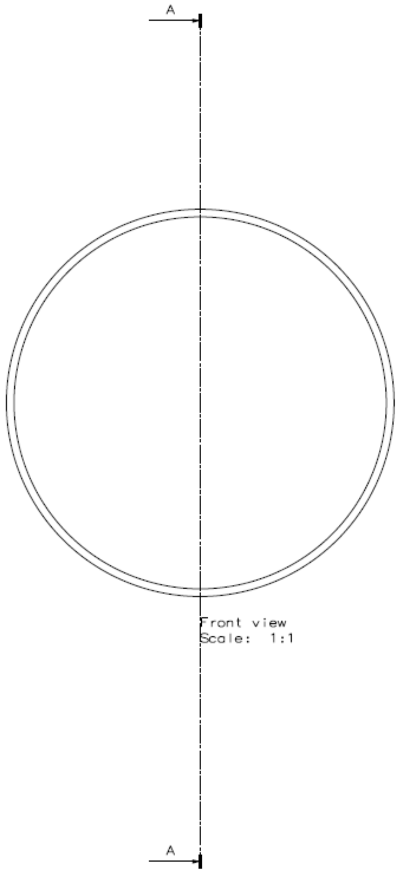
Mechanical Appearance & Mass Budget

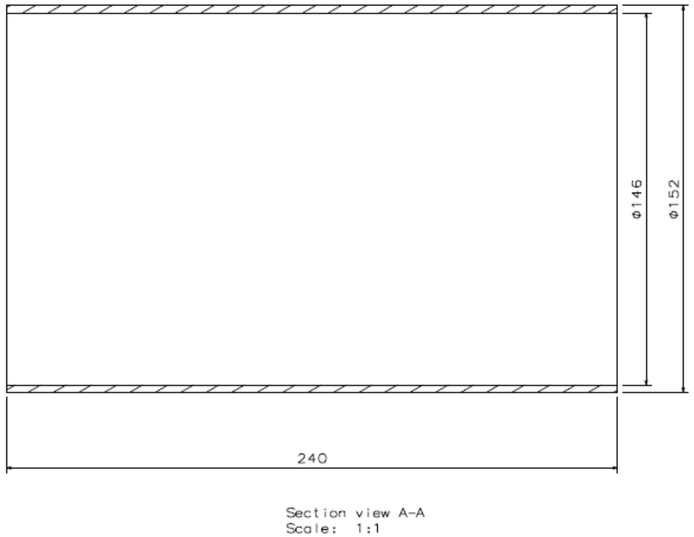
It was decided to manufacture the pipes of the main body, which will contain all the sub-systems, from PVC. As a result of the design, it was decided to use two pipes. Although the diameters of these pipes are equal, their dimensions are different. The outer diameter of the pipes is 160mm and the wall thickness is 4mm. Therefore, the inner diameter of the pipes will be 152 mm.

As mentioned before, the diameters of the pipes are equal, but the dimensions are different. For design reasons, the length of the pipe of the middle section, which will contain the rescue system, payload, parachutes and avionics system, is determined as 930 cm; The length of the engine tab pipe, which contains the engine and other subsystems to be used to fix the engine, has been determined as 1200 cm.

PVC is superior to other alternatives due to its properties. Robust, light and strong, they have good insulating properties. It is possible to increase durability and hardness properties by applying different additives to PVC materials.

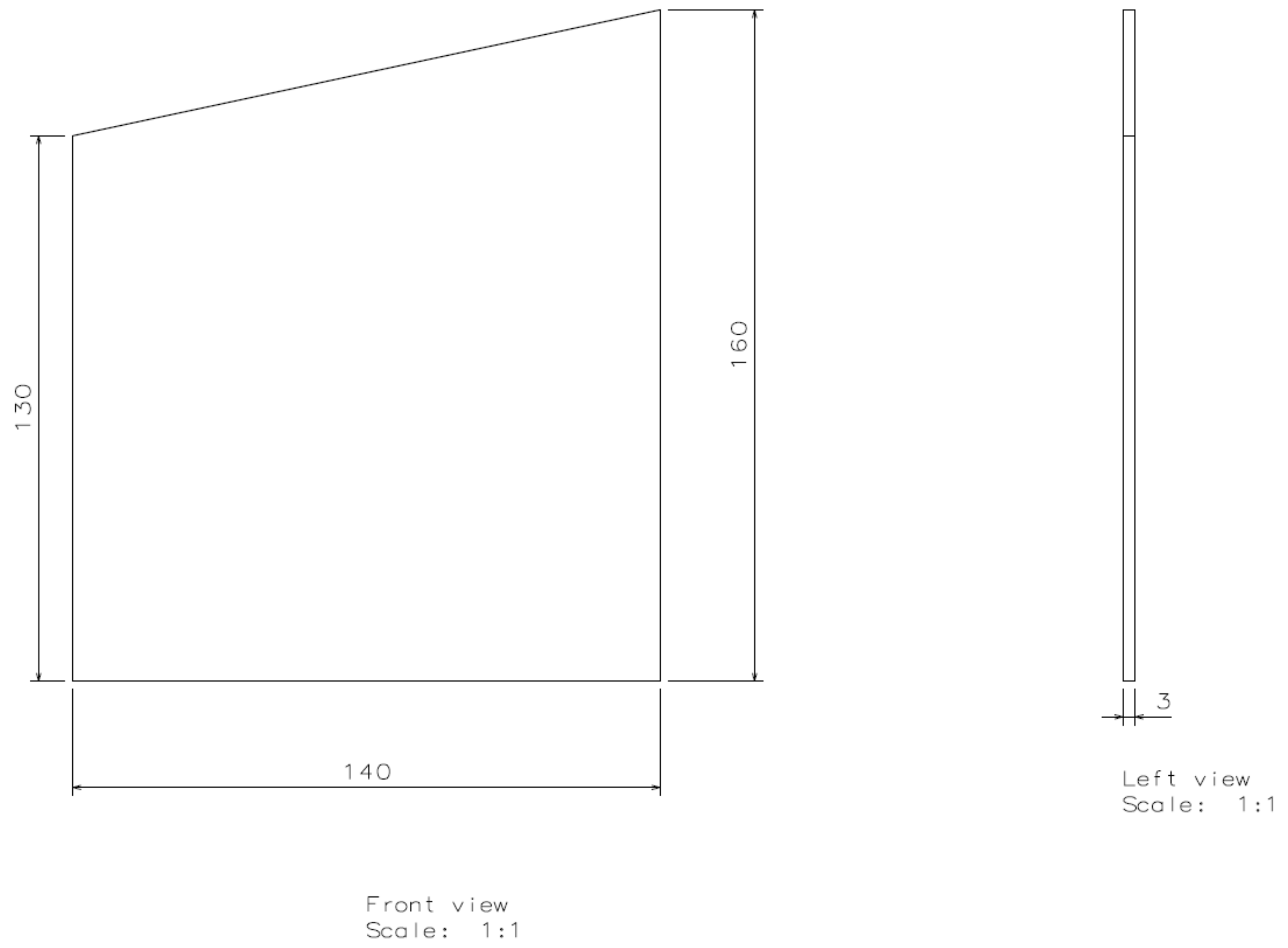
Mechanical Appearance & Mass Budget



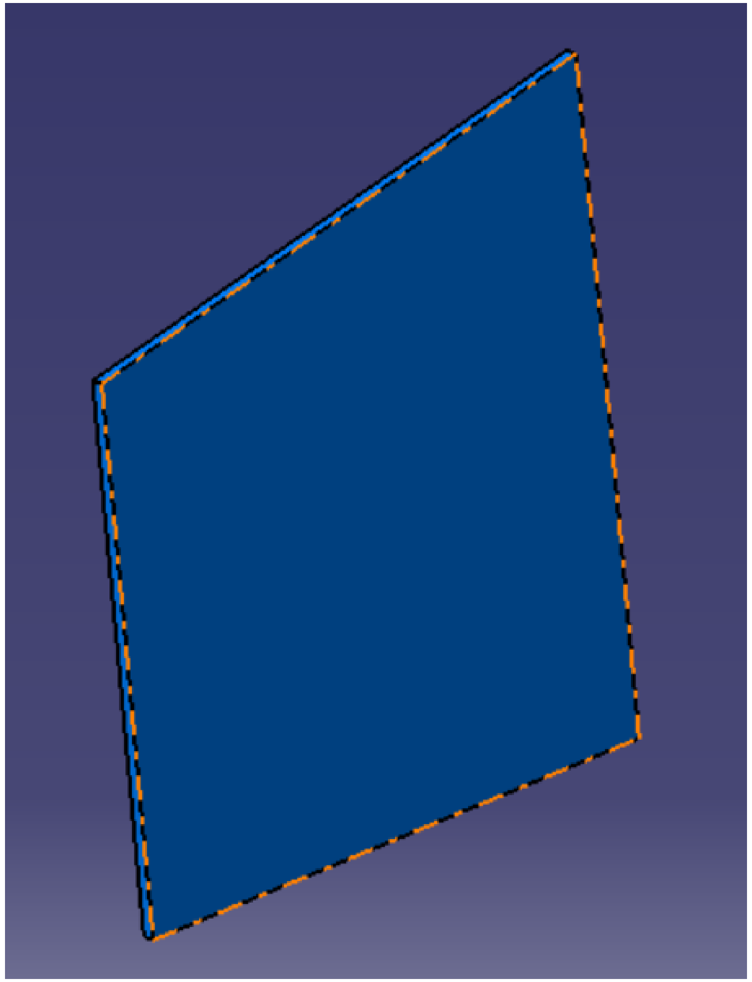


The integration body is the element to be used to fix two separate PVC pipes available in the rocket design. The outer diameter of the integration body is the same as the inner diameter of the PVC pipes and is determined as 152mm. The inner diameter of the integration body is 146mm. The length of the integration body has been determined as 240mm.

Mechanical Appearance & Mass Budget



Mekanik Görünüm & Kütle Bütçesi



Mechanical Appearance & Mass Budget

The fin design will be made in trapezoidal geometry as a result of considering various variables. The surface of the fin design that will contact the rocket is 160 mm, while the other tip is 130 mm. The distance between the two ends of the fin is 140 mm. The wall thickness of the fin was determined as 3mm. Fins will be made of polyamide material.

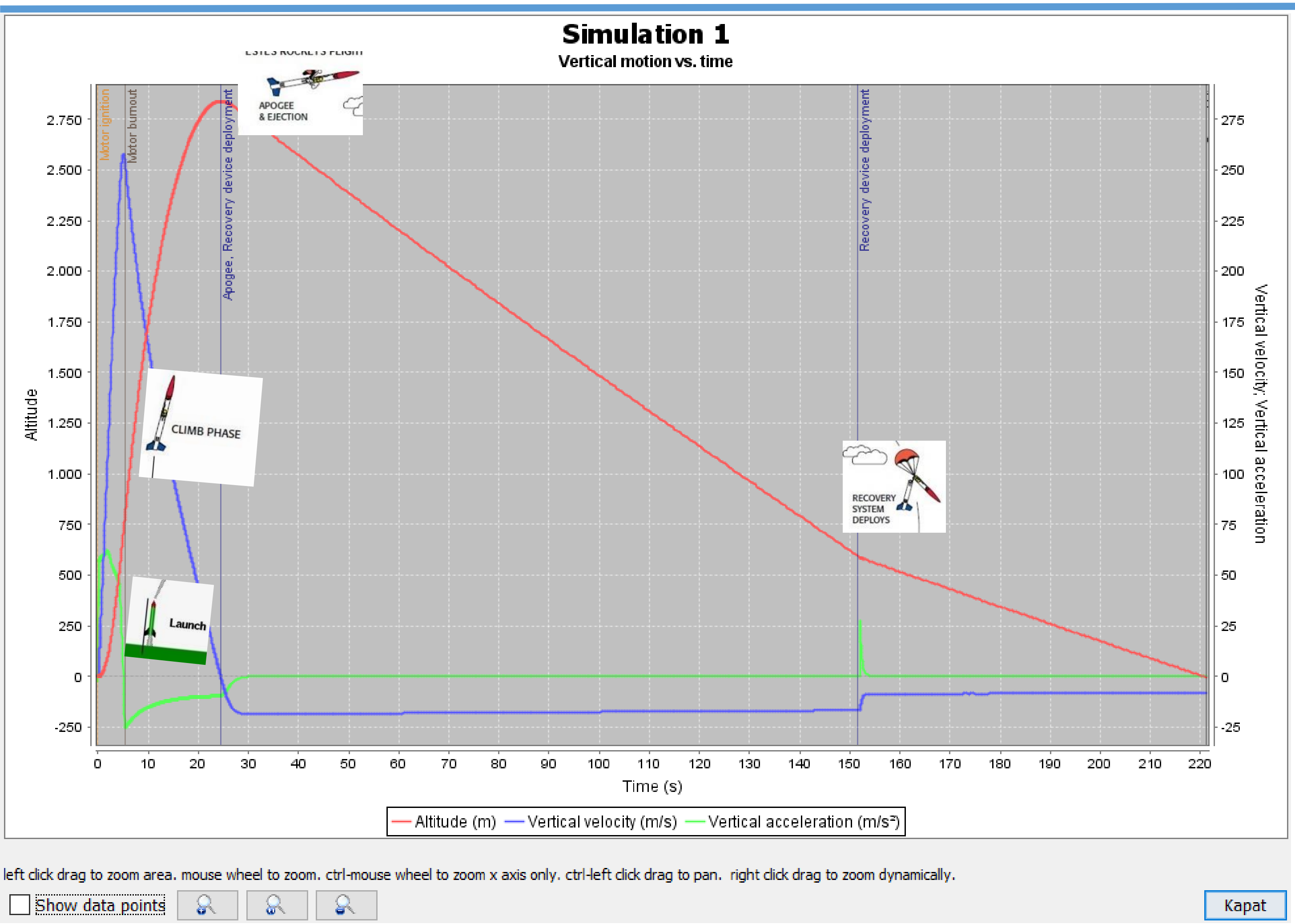
Polyamide, the material from which the fin will be manufactured, is a polymer with high mechanical strength. Polyamide is a durable material at low temperatures, but also has thermal stability. In addition, polyamide provides good opportunities in terms of manufacturability. Polyamide is a material that can be processed without problems.

Mechanical Appearance & Mass Budget

The avionics system is the system that includes the pressure-temperature sensor, GPS module, Xbee and Xbee Explorer module, accelerometer and Aurdino Mega. The sizes and models of the aforementioned sensors and modules are given below.

BMP180- 14x12mm - Pressure and temperature sensor
Neo6mv2-25x25mm - GPS
BNO055-20x27x4 - Accelerometer
Xbee-22mm-20mm
Xbee Explorer-23mm-40mm
Arduino Mega-101.6x53.4mm
Stratologger- 50.8x21mm

Operation Concept(CONOPS)

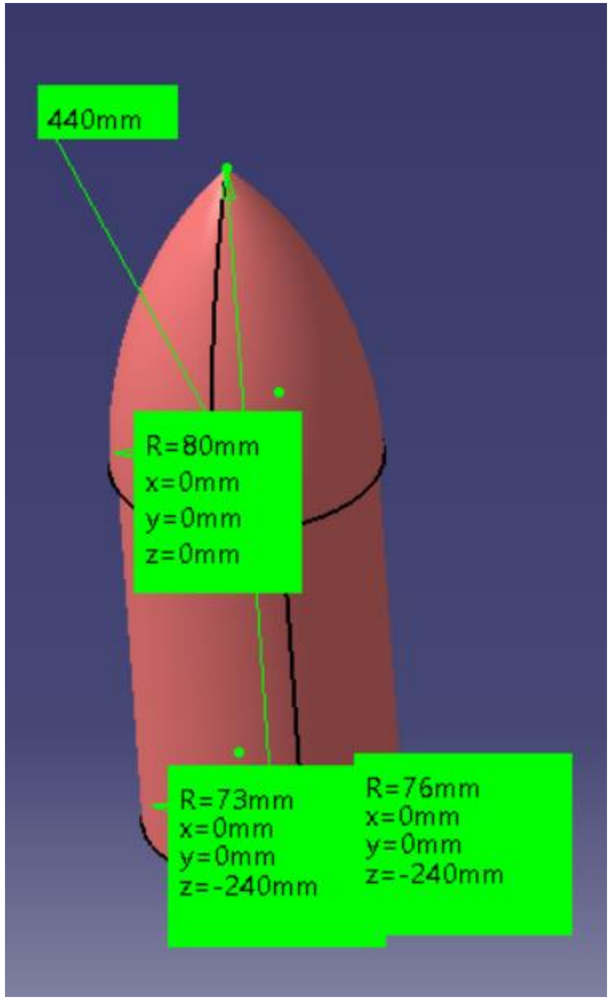


The rocket will take off with the rocket engine provided by the competition committee and start climbing. When the rocket reaches its peak, it will launch the parachute and payload thanks to the spring-driven non-pyro recovery system. Then, while the rocket glides with the effect of the first parachute up to the determined altitude of 600m, the payload will fall separately, and its position will be followed instantly.

Then, when the altitude of 600 meters is reached, the sensors will detect this situation and will start the servo motors and re-drive the rescue system. Thus, the large parachute will eject in the direction of the nose cone and the rocket will hit the ground at a speed of 8.42m/s.

Rocket Subsystems

Nose Cone



The main dimensions of the nose cone are indicated on the side. The nose cone is 20 cm in length and 16 cm in diameter. The wall thickness of the Ogive geometry is 0.7 cm. The length of the shoulder part of the nose cone is 24 cm. Its diameter is 15.2 cm. The geometry of the nose cone is designed as Ogive.

The materials from which the nose cone can be manufactured are considered as polyamide, balsa and aluminum. Although aluminum is a light metal, the use of aluminum was considered disadvantageous because it was denser than the other materials specified in the options, and aluminum remained in the background. In addition, the ductility of aluminum and the possibility of machinability are the advantages of aluminum.

Polyamide is an engineering plastic. It is a lighter material than aluminum. Polyamide is a plastic with high mechanical strength. It is healthy. They have problem-free processing. All these features make polyamide one step ahead. Polyamide also exhibits good sliding properties on its surface; The presence of this feature in the nose cone provides advantages for airflow and aerodynamic properties.

Nose Cone

Although it has the lightest weight among our balsa options, balsa has remained in the background because it is disadvantageous in terms of strength and availability. As a result, polyamide was chosen as the nose cone material.

The production date of the nose cone has been determined as 5-19 July.

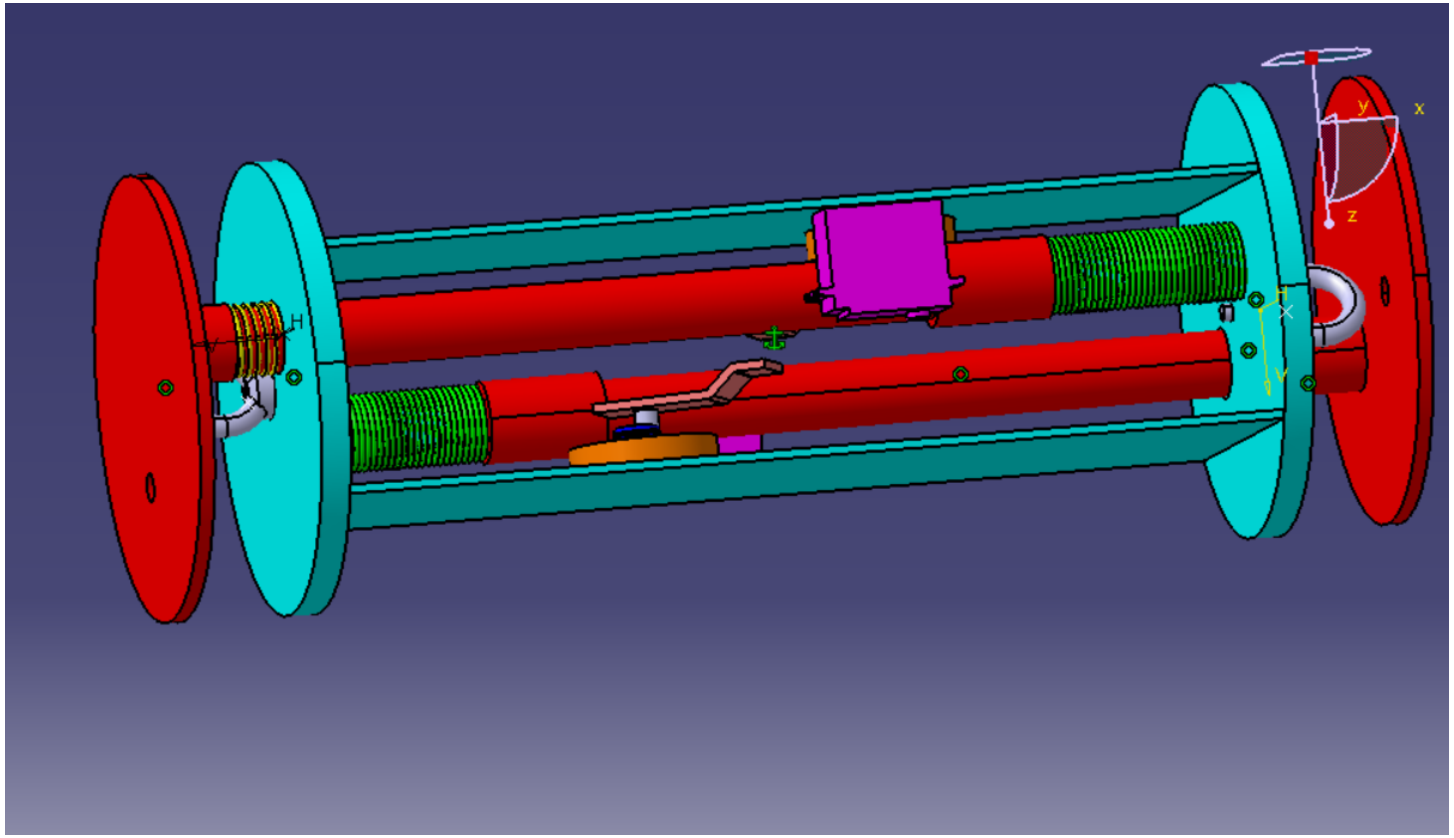
The production of the nose cone will be done by turning process. It is planned to manufacture the nose cone by turning and hand processing the polyamide billet to be supplied. It is planned to supply a 160 mm polyamide slab for the production of the nose cone. The production process is planned to take place in July.

The nose cone has been subjected to strength tests. As a result of the test performed using the CAD program SolidWorks in the computer environment, it was determined that the nose cone we designed was suitable for use.

Recovery System

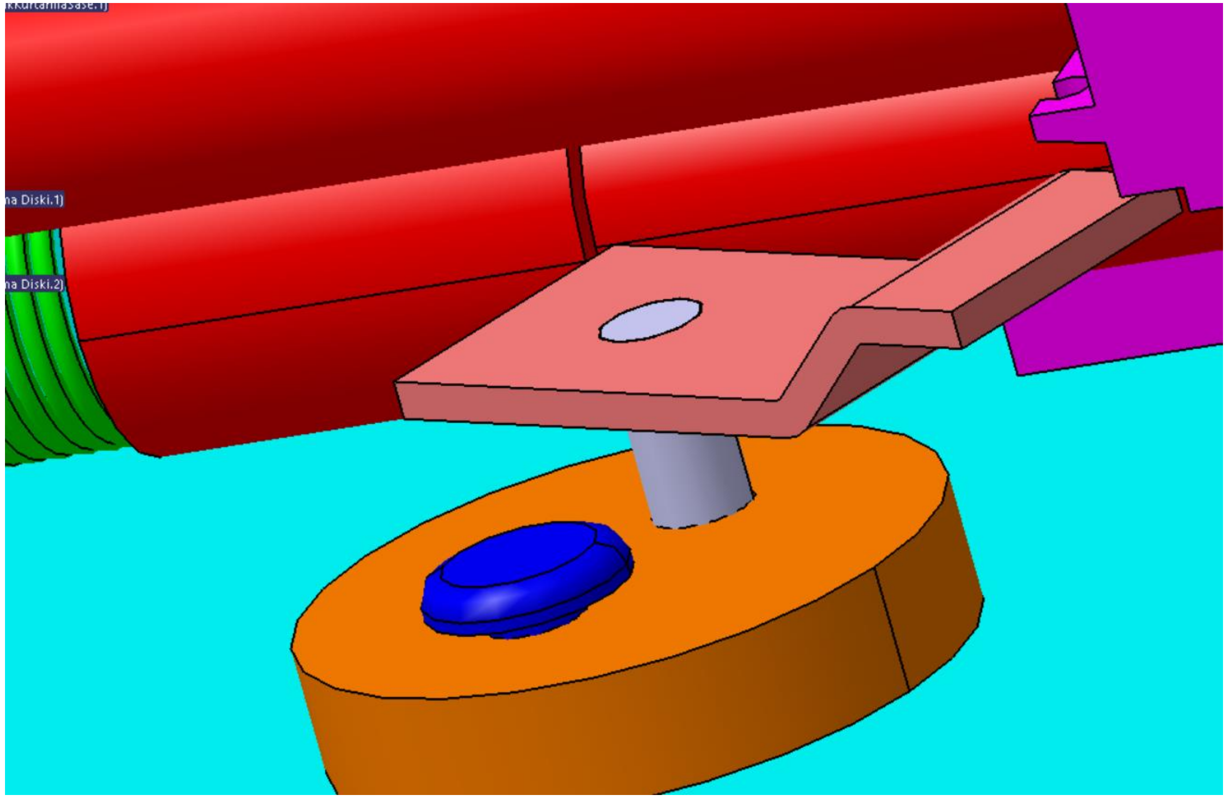
The recovery system takes advantage of the mechanical energy of the springs to eject the pistons and accordingly the pistons.It was designed on the basis of throwing elements such as payload, nose cone, parachute on the road.The recovery system has two pistons facing two opposite directions. Bushing at both ends of piston rodsexists. While the one in contact with the piston head functions to form a plane for the spring seating, the otherAlthough the bush at the end functions to form a plane for the spring seating, the locking mechanism will hold and locking.It forms the surface on which the process will take place. Piston rods will be hollow. The space inside them has a rectangular geometry. These cavities will be supported by rectangular shafts fixed to the chassis. The purpose of the square shafts is to prevent the piston from rotating around the shaft axis. After the pistons sit on the shaft and compress the spring, they will be locked with a locking mechanism. This locking mechanism includes a housing, a locking element, two shafts and a tension spring. The locking element is positioned to sit on the bushing surface. Then the shaft is passed through the hole of the element and fastened with the nut. The other shaft is positioned for the tension spring to fit. The tension spring will hold on to both the shaft and the locking element and will provide the necessary force for the locking process. This locking mechanism will be triggered by servo motors at determined altitudes and thus the launch process will be completed successfully. It will be ensured with the help of sensors that the servo motors will find the right timing to operate for the purpose of propulsion. When the sensors detect the predetermined altitude, the servo motors will operate and the servo motors will drive the system. A wire will be connected to the end of the servo motors and the other end of this wire will be connected to the end of the lock element. When the servo motor rotates, it will pull the wire and trigger the system by moving the lock mechanism.

Recovery System



Overview of the Recovery System

Recovery System



CAD illustration of Lock Mechanism. The locking element is seated on the surface of the 28mm bush and has locked.

Recovery System

Apart from the spring system to be used, a mechanical system based on driving the CO_2 cylinder has also been seen as an alternative. It is envisaged to use a CO_2 cylinder for the mechanical system to be driven by CO_2. It is aimed to benefit from the pressure inside these tubes. In this system, in order for the system to successfully launch, the tube must burst suddenly and give off all the pressure inside it at once. If this does not happen, it will not be able to benefit from the pressure effectively, and the launch operation will not be successful. A separate system should be designed to propel the CO_2 cylinder, in addition, this separate system should be integrated into the designed launch system. Using springs instead makes the job much easier and more economical. The system to be designed to drive the spring will be simpler. Moreover, if the correct spring is used and the locking mechanism works smoothly, the probability of successful implementation of the launch system of the spring system will be much higher than that of the CO_2 system. However, in cases where the system will be used continuously, the spring system will be much more economical than the CO_2 system. In order for the system with CO_2 to work, it will be necessary to buy a new CO_2 cylinder each time, and this will be an economic burden. On the other hand, in spring systems, there is no such thing as buying a new spring every time. Spring system can work thousands of times with a spring.

Recovery System

The rocket has 3 parachutes. Two of them are for the fall of the rocket, and one is for the fall of the payload. The diameter of the parachute for the drop of the payload was determined as 100 cm. The diameters of two separate parachutes to be used for the fall of the rocket were determined as 150cm and 250cm. The color of the parachute is determined as matte red.

When the rocket reaches the apogee point, the servo motors will trigger the spring system and the first launch will take place. In the first launch, it will launch the 150 cm diameter parachute on the piston path, the payload and the 100 cm diameter parachute for the payload. With the help of a 150 cm diameter parachute shock cord, it will hold onto the rocket and the rocket will begin to glide with a parachute. In the meantime, the ejected payload will also begin to float separately. As the altitude reaches 600 meters, the second piston will be triggered by the servo motor and will launch the 250 cm diameter parachute and nose cone on its path. Thus, the rocket will glide more slowly than the first stage. The glide speed of the rocket was determined as 8.42m/s on the Openn Rocket system.

Avionics

The avionics system of the rocket consists of two subsystems, the communication and rescue system. The rescue system ensures that the data from the sensors are instantly transferred to the ground station during the flight, the parachutes are opened when necessary, and the place where the rocket fell after the rocket landed. The communication system will provide communication between the flight computer and the monitor in the ground station throughout the movement of the rocket.

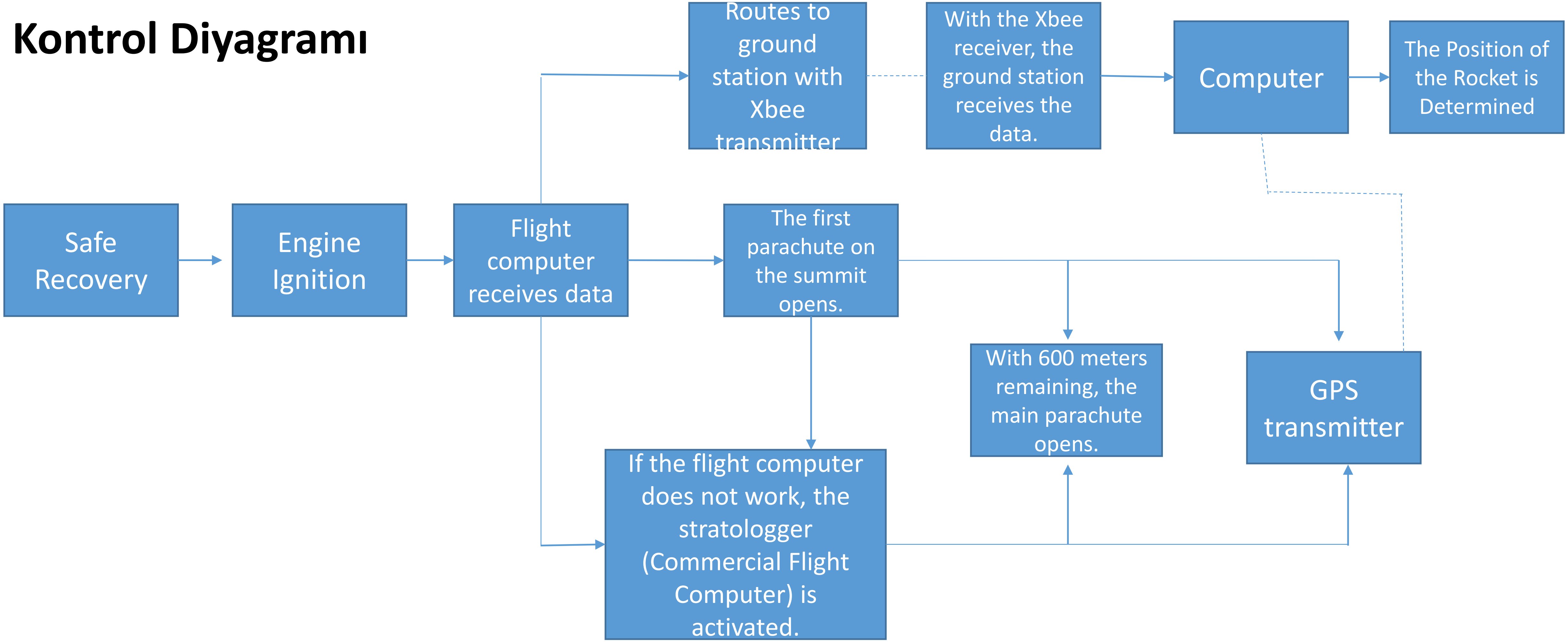
BNO055 and MPU6050 sensors are considered for the accelerometer to be used in the rescue system. It is decided on the BNO055 sensor. In this decision, it was taken into account that the BNO055 sensor contains wider information and has more clear information possibilities. For the pressure gauge to be used, it was decided between the BMP280 sensor and the BMP180 pressure sensor, and the BMP180 sensor was chosen. When the sensors used in the selection were compared in terms of price-performance, it was concluded that the BMP180 sensor was better. For the GPS system, NEO6MV2 GPS Module and Eggfinder LCD-GPS Module were considered and it was deemed appropriate to use NEO6MV2 GPS Module. In this selection, the ease of use of the device and its capacity to give better results were taken into consideration.

The device to be used for communication xBee PRO 900 Mhz and NRF24L01 wireless communication modules are considered. It has been deemed appropriate to use xBee PRO 900 Mhz. In this selection, speed and communication range are taken into consideration.

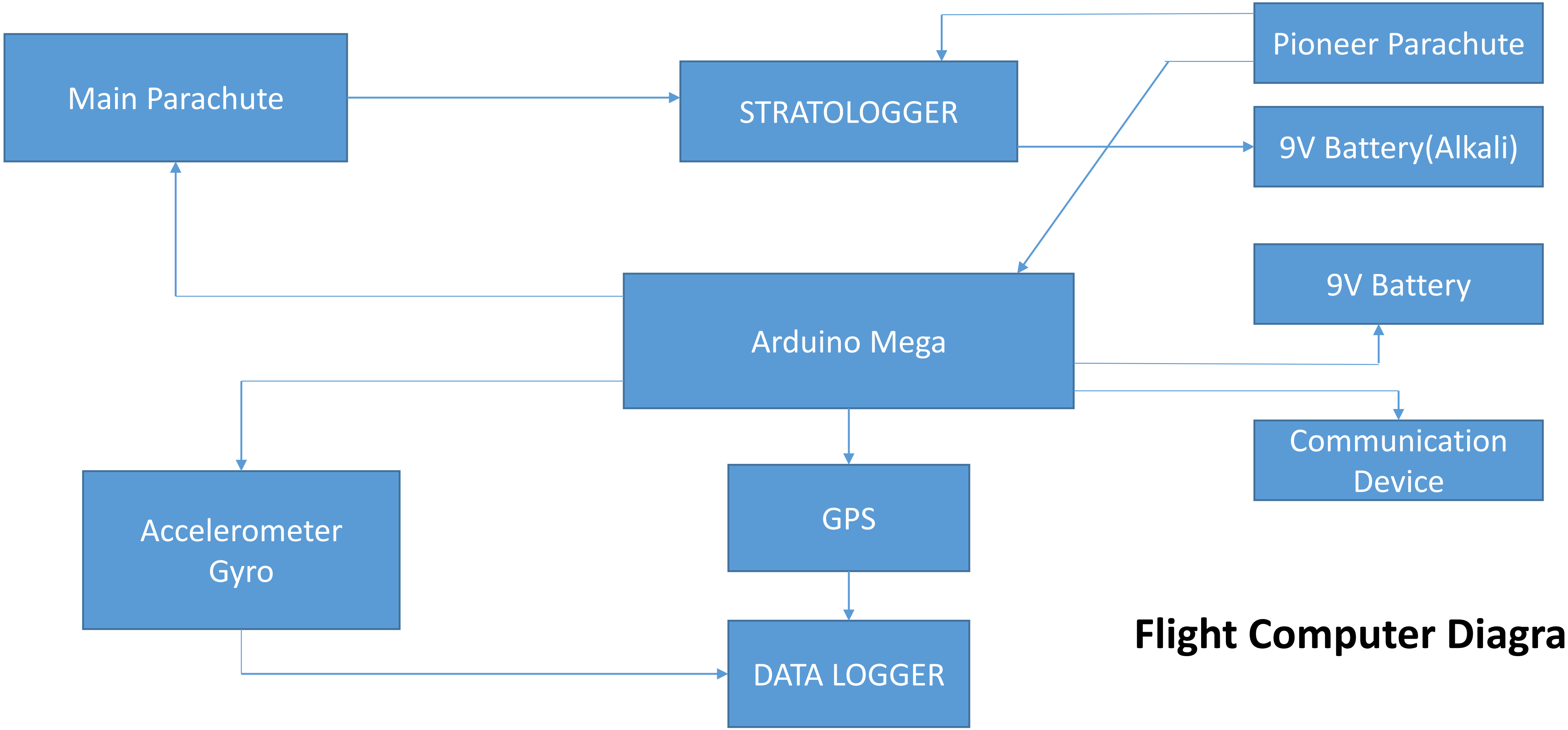
Stratologger ready flight computer is considered as a backup system.

Avionics

Kontrol Diyagramı



Avionics



Flight Computer Diagram

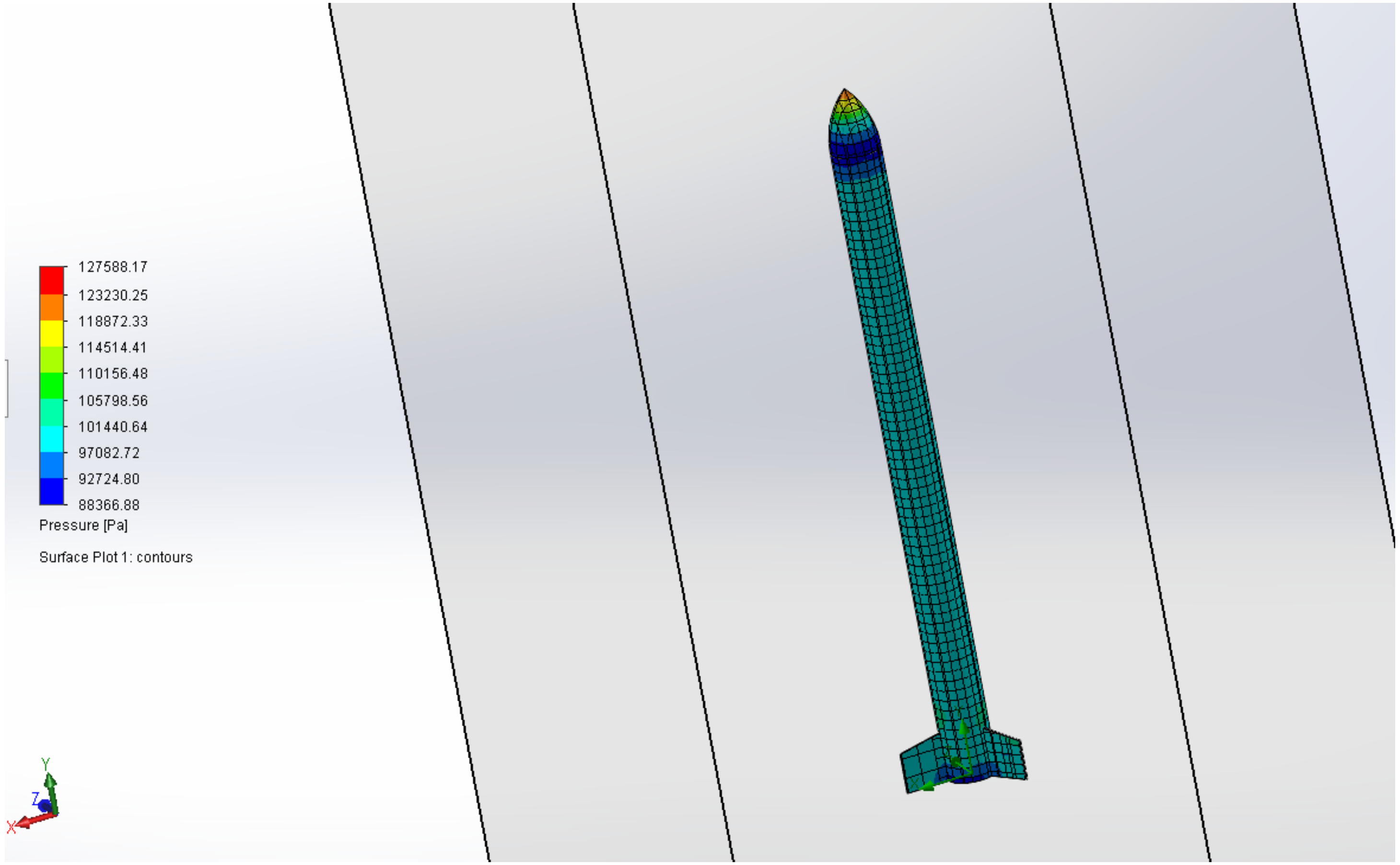
Structural – Body/Inside Structural Supports

PVC pipe was chosen as the main material of the body. PVC pipes are elastic and durable. They are resistant to abrasion. The tensile strength of PVC-U waste water pipes to be used in rocket manufacturing has been specified by the manufacturers as 52N/mm2. The density of PVC-U waste water pipes was determined as 1.41 g/cm3. They are light materials. They are resistant to high temperatures.

The material decided on the main body is PVC-U pipe. One of the reasons for this is that PVC-U pipe is cheaper compared to its alternatives. Composites such as glass fiber and carbon fiber are expensive. Moreover, while we can supply ready-made PVC-U pipes, it is difficult to obtain ready-made pipes in sizes designed from materials such as carbon fiber and glass fiber. Various manufacturing processes must be applied to prepare pipes from the mentioned composite materials. This means both time and economic loss. Although the PVC-U waste water pipe is inferior in strength to other alternatives, it is a material that is strong enough to withstand the pressure that the rocket will be exposed to. In summary, with the selection of the PVC-U pipe, a material that is economically free from a load and that can exceed the loads that the rocket will be exposed to has been selected. Considering the variables, it will be seen that an ideal choice has been made.

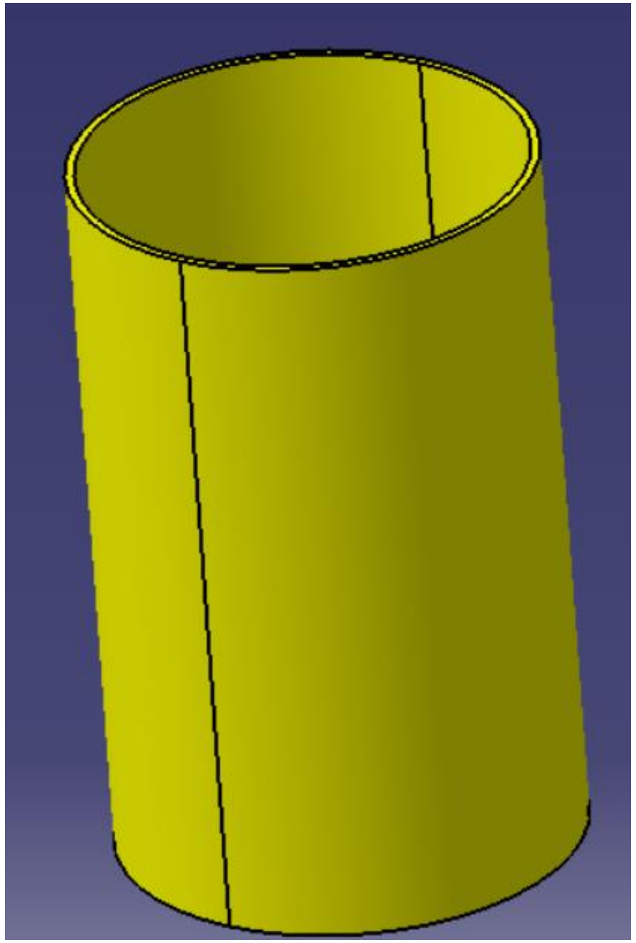
The hull will not be original production. PVC-U pipes produced in accordance with the standards will be supplied ready.

Structural – Body/Inside Structural Supports



The following data were obtained as a result of fluid analyzes on the rocket body. As can be seen from the data, a pressure of about 101,440 KPa acts on the main body of the rocket, as can be seen from the colors. In the light of the tests carried out and the strength values written in the product catalog, it is seen that the body of the rocket can operate comfortably under this pressure. No deformation will be seen.

Structural – Body/Inside Structural Supports



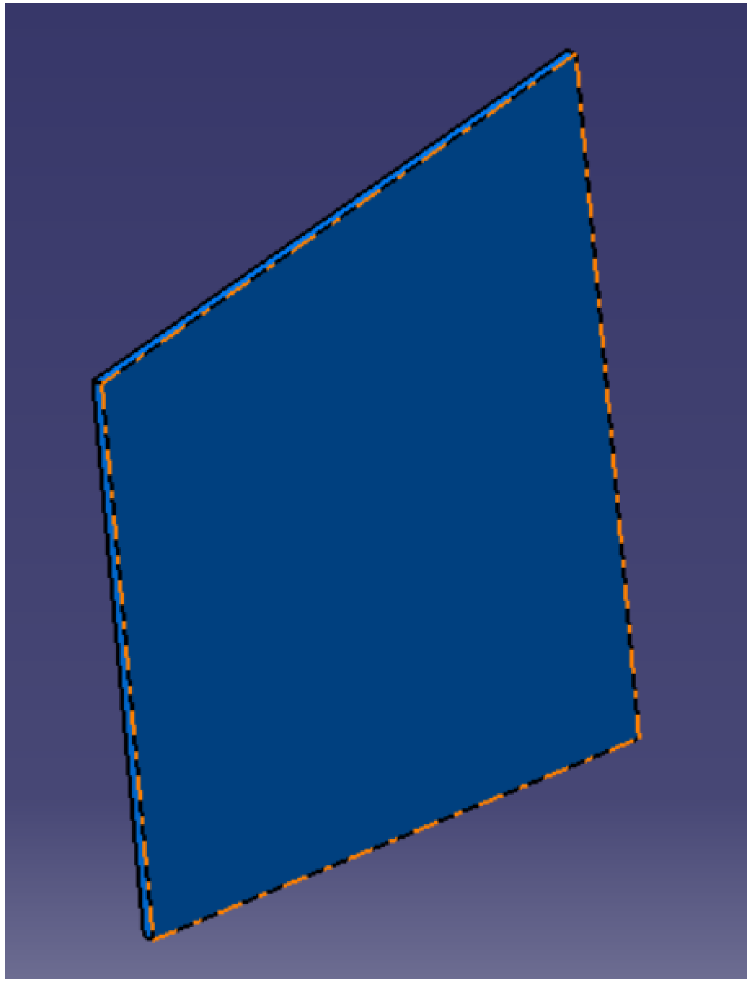
The integration body is the element that will connect the two separate pipes that will form the main body of the rocket. Although PVC was first considered for the integration body, this idea was abandoned as there was no suitable PVC pipe with standard dimensions suitable for the dimensions of the integration body. It was decided to manufacture the integration body from polyamide in order to ensure that the pipe is robust, compatible and manufacturable. Polyamide billet will be procured and processed on the lathe and the integration body will be produced in the designed dimensions.

Structural - Fin

Balsa, acrylic and polyamide materials are considered for manufacturing the fin piece. Balsa is a material with low density. It is light. Moreover, balsa is a very easy material to shape. Polyamide is a lightweight polymer. Although it is a solid, durable and hard material, it is a material with high machining feature. Acrylic is a plastic-plastic composite. It is a transparent material and has good processing properties.

Among the specified materials, polyamide was chosen. Polyamide is a more durable material than balsa. Although the ability of balsa to be shaped is better than polyamide, polyamide outweighs balsa since the main criterion here is the ability of the material to withstand the force it will be exposed to. They are materials close to polyamide in terms of acrylic properties, but acrylic material is more difficult to find than polyamide, but polyamide material is more economical than acrylic material. For this reason, polyamide material was chosen among the materials.

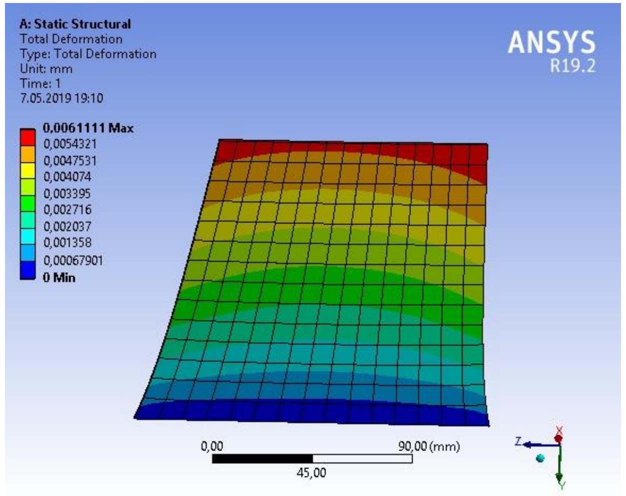
Structural - Fin

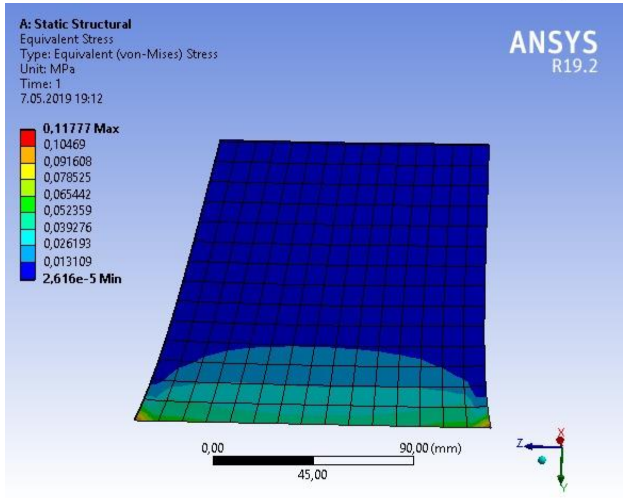


The CAD image of the fin design is shown in the side picture. As can be seen from the picture, the geometry of the material is determined as trapezoidal geometry. One end of the trapezoidal geometry was determined as 160mm and the other end was determined as 130mm. The length of the trapezoidal geometry was determined as 140 mm. In addition, the wall thickness of the fin was determined as 3 mm.

The fin production will be original production. Polyamide plates larger than 3mm and the closest size to 3mm will be supplied and 3 pieces of blades will be produced by cutting the polyamide plates in the form of blades by laser.

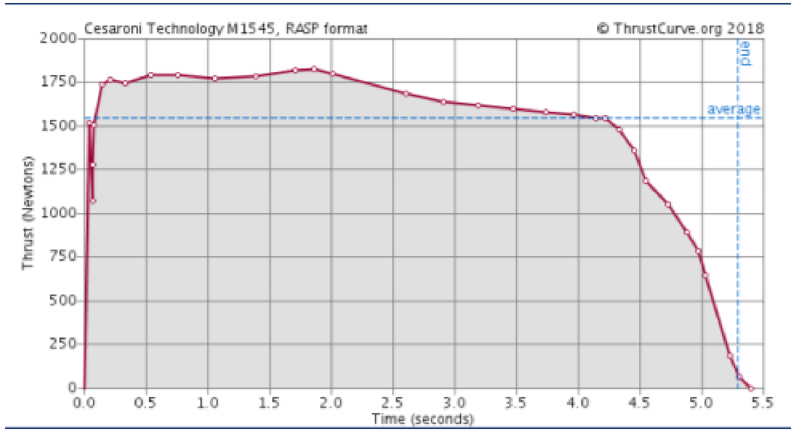
Structural - Fin



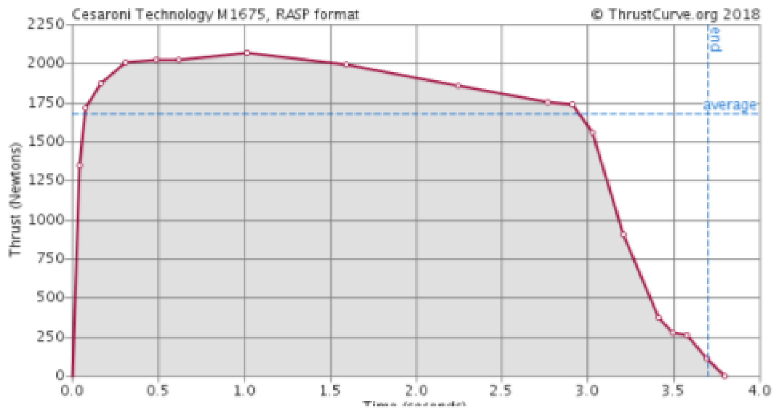


Necessary analyzes were made for the fin geometries and the maximum stresses they could be subjected to were obtained by fluid analysis. Although it is actually impossible, it is thought that the maximum load that will affect the fins will act when the rocket will fly horizontally with the fin pointing up, and the maximum pressure that will act, although it is actually impossible, has been determined as approximately 140 KPa with this analysis. In line with the determined pressure values, the analysis was carried out using the determined values on the fins. The screenshot of the static analyzes made is given on the side. As a result of these analyzes, it has been proven that the fins made of polyamide can withstand more than the actual pressure they will be exposed to without any problems.

Engine

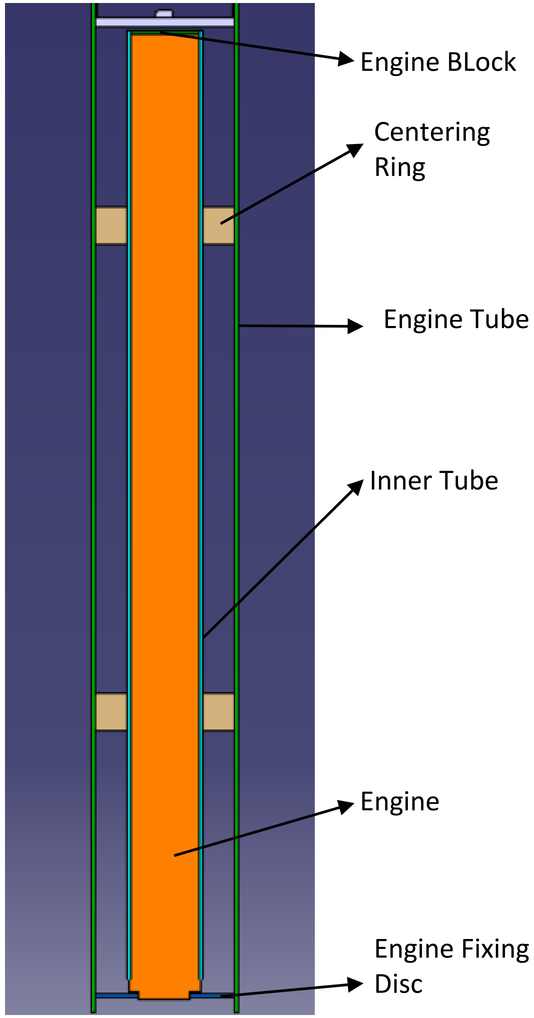


The graph in the upper left is the thrust-time graph of the Cesaroni M1545 rocket engine. The envisaged designs were simulated with the engines in the list to be given for the competition, and as a result of these simulations, it was decided that the Cesaroni M1545 was the most suitable engine for the target altitude and other values for the competition.



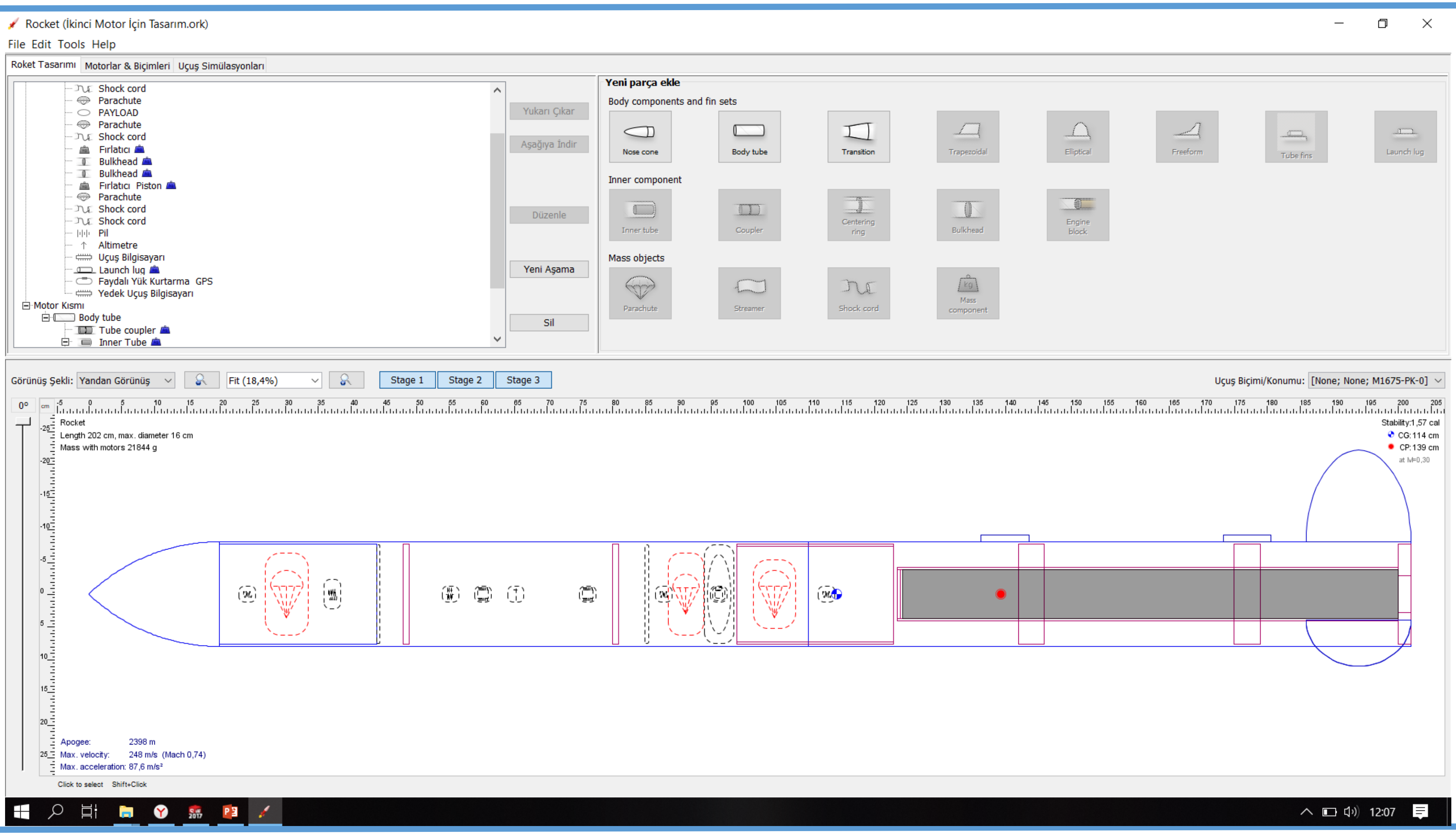
The graph in the lower left is the thrust-time graph of the Cesaroni M1675 engine. After Cesaroni M1545, the most suitable engine was determined as Cesaroni M1675 in order to reach the target altitude for the competition and to meet other conditions.

Engine

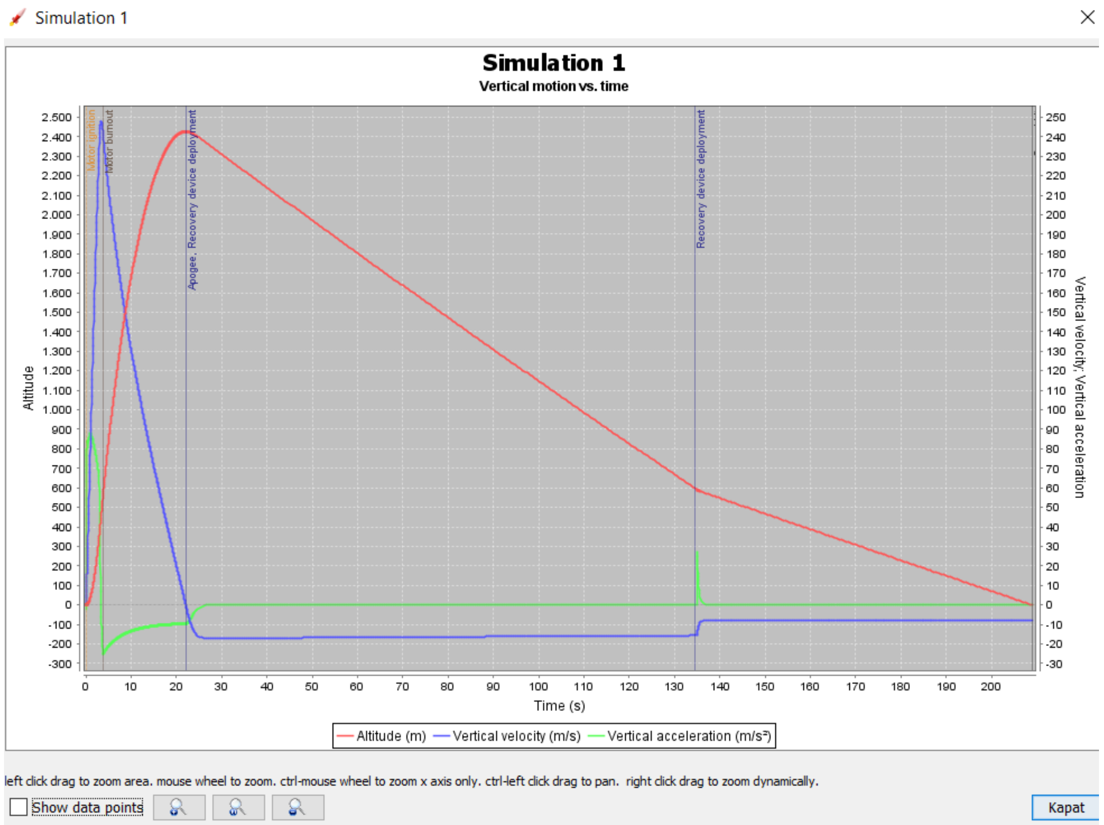


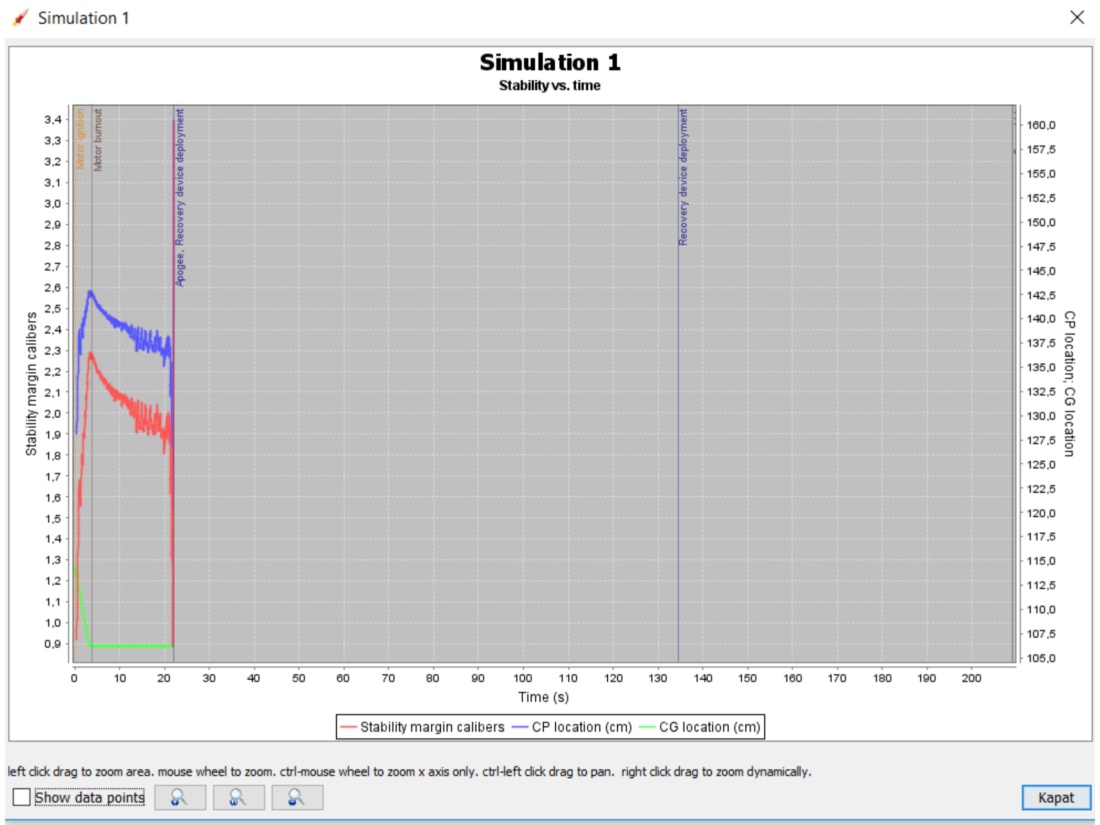
In order to fix the engine, the other elements will be fixed first. First of all, the centering rings will be mounted on the inner tube where the motor will be placed, from the outside of the inner tube. The engine block will then be mounted at the end of the inner tube so that one direction of the engine within the tube is blocked. Then the centering ring, inner tube and engine block assembled together will be placed and fixed on the engine main tab tube. Fixing these three elements to the engine hop tube will be done by screwing the centering rings to the tube from the outside. After these processes, the bed where the motor will be placed is prepared. After this stage, the engine will be placed. The engine will be pushed until it contacts the engine block. When the engine touches the engine block, it means that the movement of the engine from one end is blocked. Then the movement of the other end of the motor will be blocked. This movement will be inhibited by a disc. The inner diameter of this disc will fit on the protrusion at the end of the motor, and the outer diameter will touch the motor hop tube. Then this disc will be connected to the motor tab pipe from the outside with a screw. Thus, the movement of the other end of the motor will be prevented and the motor will be completely fixed.

Second Engine Selection



Second Engine Selection





The graphs given above are velocity-time and stability-time graphs of the rocket design for the second engine.

Second Engine Selection

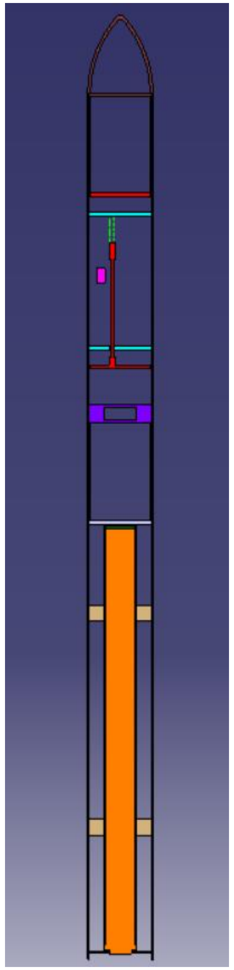
Various changes were made in the design for the second engine in order to comply with the determined altitude and values. The length of the inner tube was determined as 76.5 cm. The length of the engine hop tube is set at 92 cm. On the other hand, a shortening of 3 cm occurred in the length of the middle-rebound tube. The geometry of the fins changed and became elliptical. While the root cord was 16 cm, the width was determined as 14 cm. However, the weight of the payload was determined as 4 kg in order to approach the target altitude.

Name	Configuration	Velocity off rod	Apogee	Velocity at de...	Optimum delay	Max. velocity	Max. acceler...	Time to apogee	Flight time	Ground hit ve...
Simulation 1	[None; None; M16...	32 m/s	2426 m	15,7 m/s	18,3 s	248 m/s	88 m/s²	22 s	209 s	7,84 m/s

The data given above belong to the rocket design made for the second engine and is the proof that the ramp-up speed is provided.

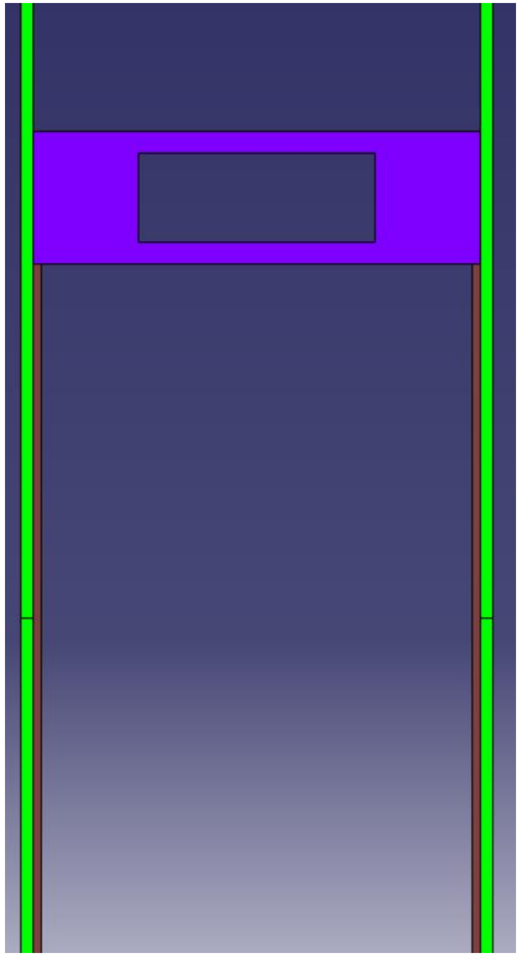
Rocket Integration and Tests

Rocket Integration Strategy



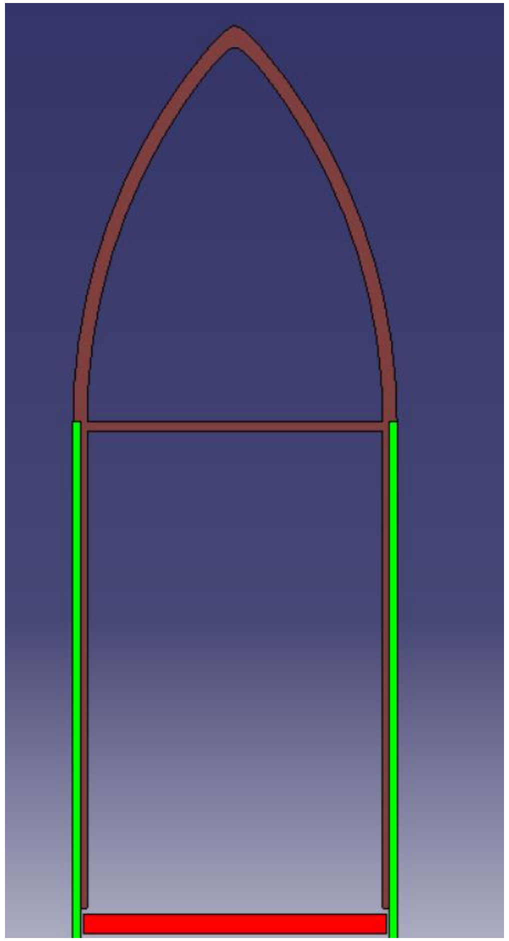
As can be seen from the general section picture of the rocket on the right, the rocket consists of various subsystems. Here the main elements in the name of the assembly are the nose cone, the middle hop tube and the engine hop tube. The reason why these three elements are considered as the main elements for assembly is that all of the sub-systems will be mounted on these three elements after the assembly of the other sub-systems is completed. These three main elements mentioned will be separated from each other during the rescue process, but they will be connected to each other by shock cords. After the assembly of the tube of the motor tab is completed (it is mentioned before the motor is installed), the integration body will be mounted on the upper part of the motor tube. Half the length of the integration body will be located so that it enters the motor hop tube. The part of the integration body inside the engine tab pipe will be mounted on the engine tab pipe by screwing it from the outside.The middle part is the part that contains the pipe recovery system and other elements. The recovery system will be mounted on the middle tab pipe. Screw holes will be drilled on the sides of the circular plates on the chassis of the rescue system and the rescue system will be screwed to the middle tab pipe at the specified location from the outside. Thus, it will be ensured that the rescue system is also installed. The avionic systems to be used in the rocket will be fixed on the flat plates located between the two circular plates in the rescue system. The GPS to be used for the payload will be put into the slot opened in the payload, and the slot will be covered with a thin sheet to prevent the GPS from falling while the payload is floating after the recovery.

Rocket Integration Strategy



After the installation of the middle hop pipe itself is completed, the middle hop pipe will be mounted on the motor hop pipe through the integration body. Although the integration body is screwed with the motor tab, it will be connected with the middle tab pipe by snapping. The integration body will engage the middle hop pipe with a payload at the top. The reason why the integration body is snap-connected to the middle hop pipe is that the middle hop pipe will be separated from the engine hop pipe during the recovery process. In the recovery operation, the piston payload will push the payload integration body and the integration body, which is screwed to the motor tab, will be separated from the middle tab together with the engine tab.

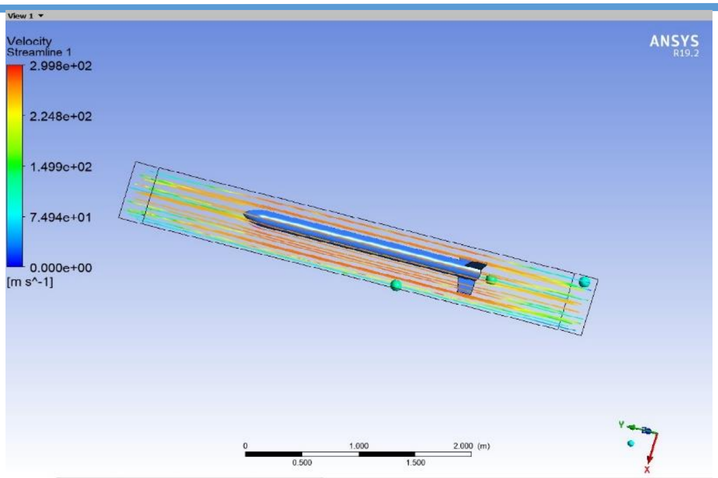
Rocket Integration Strategy

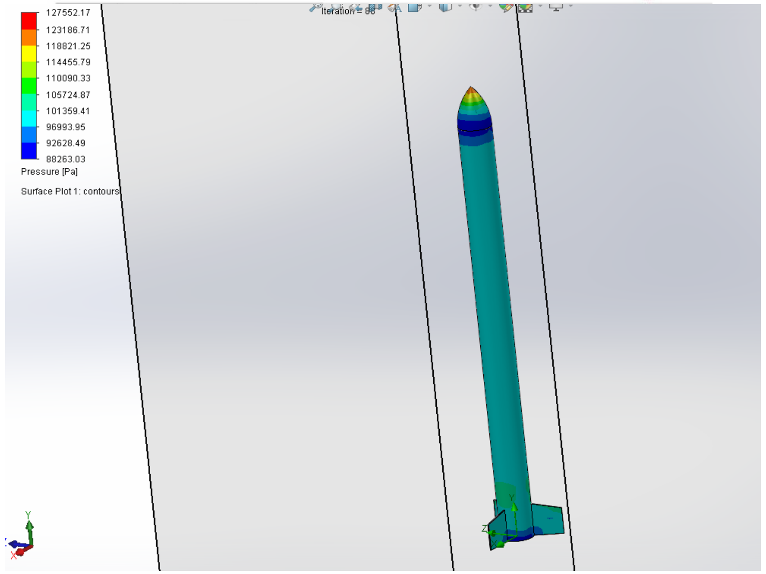


The nose cone is the part that will be located at the top of the rocket. It has a disc in the nose cone structure. Although the purpose of this disc is to make eyebolt connection, this disc will be attached to the nose cone from the outside with a screw. The nose cone will be mounted by snapping into the upper part of the middle tab tube. It will snap because the nose cone will pop out during the rescue operation. The nose cone will pop out but the lash tie will fall off with the middle ricochet with the help of the shock cord.

In order to fix the altimeter two, a slot will be designed for the eyebolt retaining disc in the nose cone and the altimeter two device will be fixed there. It can be easily taken from the nest after the flight.

Tests





The necessary strength tests of the rocket were carried out. As a result of the analysis, the pressures acting on the rocket body were determined. Based on these determined pressures, the experiment was carried out on the sample obtained. This experiment can be accessed from the link https://www.youtube.com/watch?v=AvTvSKYBM38&t=3s .

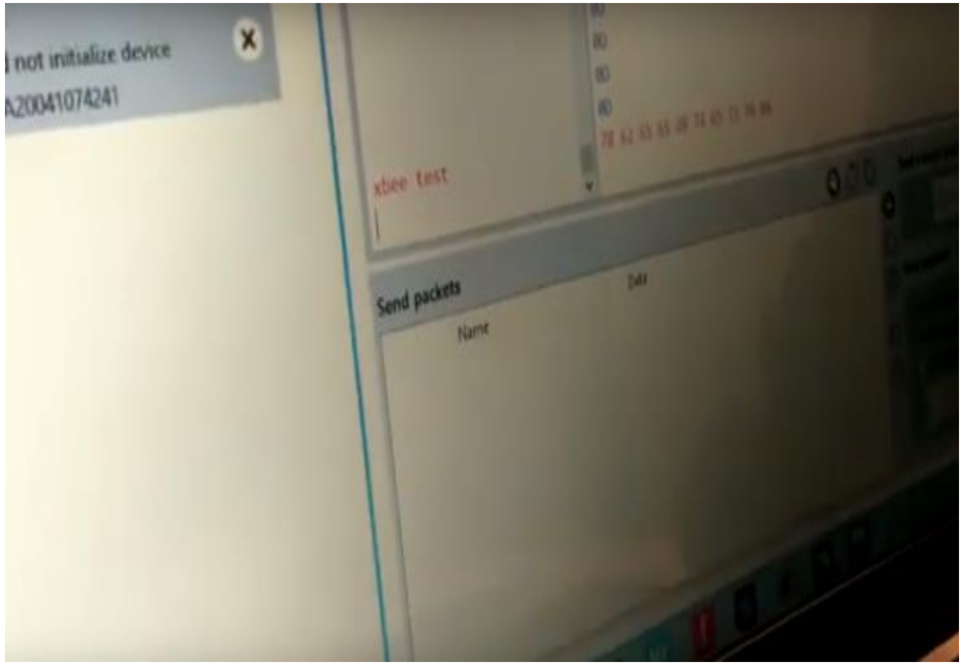
The test sample is not in exact measurements, but the experiments on the sample were made based on the sample measurements and the sample was subjected to the pressure values obtained as a result of the analysis.

Tests

A prototype was prepared in line with the rescue system design. The prototype is made of iron, not aluminum, the material to be used. The fact that the prototype was not produced from the original material designed caused the prototype to be much heavier than expected. In order to prevent problems that may occur in this context, changes have been made in the design by methods such as reducing the wall thickness of some elements. Prototype was produced and tested. The test video of the produced prototype can be accessed from the link ‘ https://www.youtube.com/watch?v=17AIeRWi9D4 '. The prototype has been successfully tested. Investigations were made on the produced prototype and necessary changes were considered for the system to work better and applied to the design of the system. The changes made will be considered in the construction of the actual recovery system. On the left are photographs of the prototype of the rescue system.

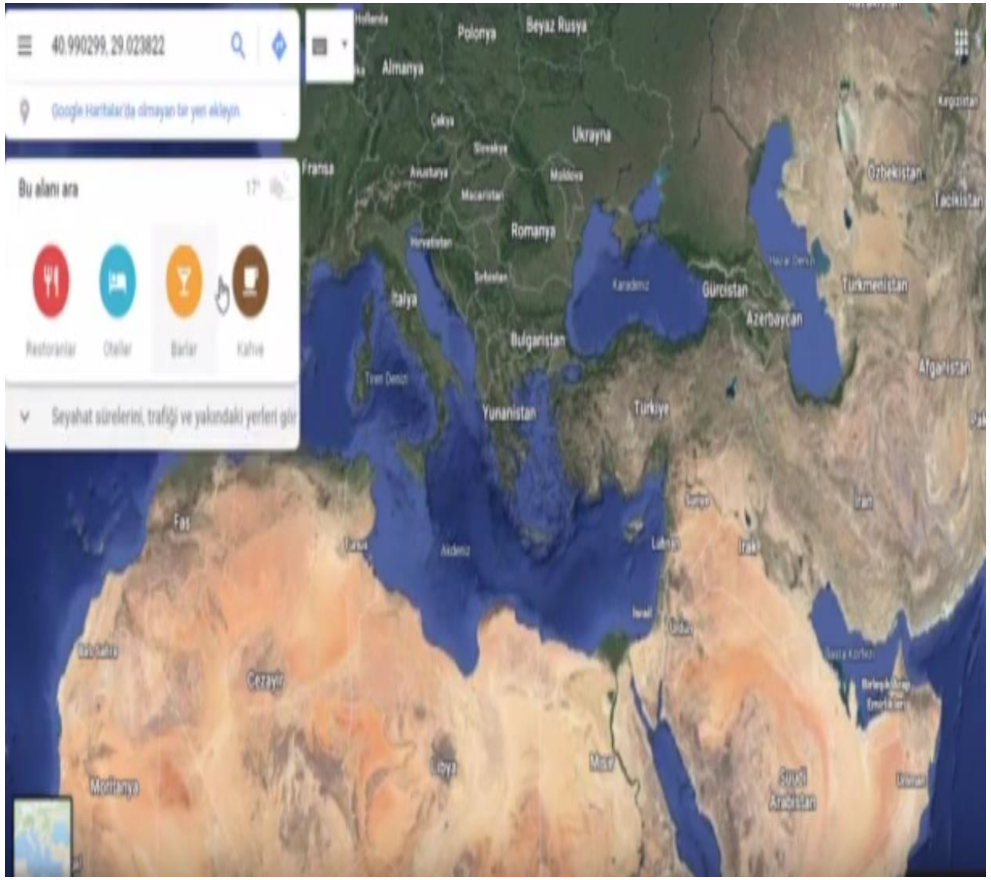
Tests

- Telemetry Test
- While conducting telemetry tests, 2 xBee communication modules and 2 xBee Explorers were used. One of the XBee modules is connected to the computer and the other to the Arduino Mega. The data to be transferred has been sent to the computer from the Arduino serial screen. As a result of the test, it was determined that there was no problem in sending the data.
- The test video can be accessed using the link https://www.youtube.com/watch?v=HmLBbGOk4HI .



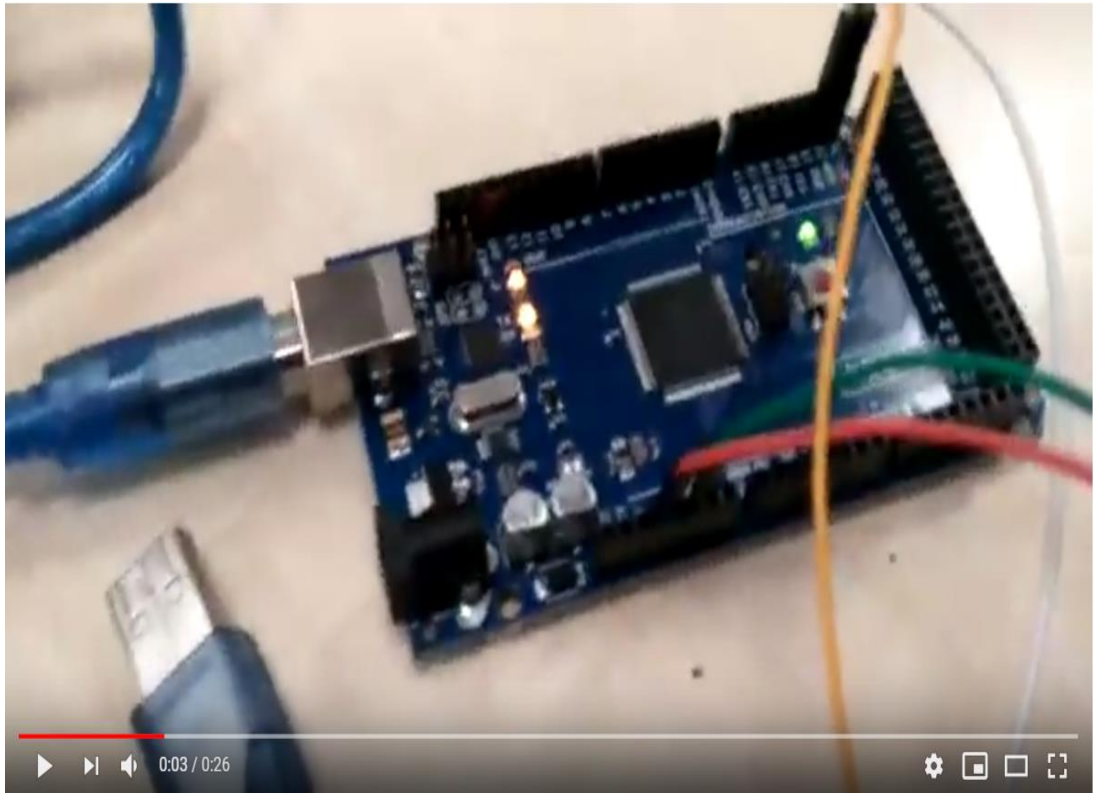
Tests

- GPS Test
- NEO6V2 GPS module was used for GPS tests. The test was carried out in the open air with the aim of getting data more easily for the GPS module. The latitude-longitude information obtained from the GPS module has been confirmed using Google maps. The result obtained from the GPS module has been found to be correct.
- The test video can be accessed using the link https://www.youtube.com/watch?v=2HnrWhGdDus .



Tests

- Pressure Test
- BMP180 pressure-temperature module was used while performing the pressure test. It was carried out indoors in order to prevent the test results from being affected by the wind. The first value that appears on the Serial screen shows the pressure value of the environment. By taking this value as a reference, height determination is made with the help of the pressure information that changes from the up and down movements of the module.
- The test video can be accessed using the link https://www.youtube.com/watch?v=ij_6ZKVdsvQ .



Schedule

	MAY	JUNE	JULY	AUGUST
Procurement of body materials	X			
Supply of polyamide logs		X		
Supply of materials for the rescue system	X	X		
Manufacturing of parts from polyamide logs		X	X	
Assembling the recovery system		X		
Manufacture of fins from polyamide plate		X	X	
Integration of avionics and electronic systems into the rescue system			X	
Procurement and testing of parachute and shock cords			X	
Beginning rocket assembly processes		X	X	X
General testing			X	X

Budget

Part No	Component	Number	Cost	Supply Way
1	PVC-U pipe (2m)	3	67 TL + KDV/number	Industry
2	160x1000mm polyamide log	1	943.8 TL + KDV	https://metalavm.com/pa-cubuk-poliamid-160-mm
3	90x1200mm polyamide log	1	370.89 TL + KDV	https://metalavm.com/pa-cubuk-poliamid-90-mm
4	250x500x15mm polyamide plate	1	91.08 TL + KDV	https://metalavm.com/pa-6g-levha-dokum-poliamid
5	Cast iron for payload	1	50 TL	Industry
6	Aluminum Plate (70x70cm)	1	411.52TL + KDV	https://metalavm.com/aluminyum-plaka-10-mm
7	Aluminum Rod 28mm diameter	1	91 TL + KDV	https://metalavm.com/aluminyum-cubuk-30-mm
8	Spring	6		Industry
9	Eyebolt	4		Industry
10	Parachute	3	80 TL/number	https://www.apogeerockets.com/Building_Supplies/Parachutes_Recovery_Equipment/Parachutes/Low_Power/12in_Nylon_Parachute
11	Shock Chord	4		Industry

Budget

Part No	Component	Number	Cost	Supply Way
1	Arduino Mega	1	65 TL	Industry
2	Xbee	2	300 TL/number	Internet/Abroad
3	Xbee Explorer	2	55 TL/number	Internet/Abroad
4	GPS-NEO6MV2	2	60 TL/number	Internet
5	BMP180	1	15 Tl/number	Internet
6	Stratologger	1	55 Dolar	Internet/Abroad
7	BNO055	1	332 TL	Internet
8	Servo Motor	2	48.14 TL/number	Industry