



Thanks for submitting your entry for the Spaceport America Cup 2024, we've got it safe and sound.

Good luck!

< Submission



RADIANT

Introduction

Title

Project RADIANT



Short description

An actively-controlled-dynamics solid propellant rocket aimed to reach as near as 10,000 feet apogee AGL.

APPLICATION INFORMATION:

BEFORE you submit this team application, you must complete the following training - <https://esra-training.thinkific.com/courses/preparing-for-the-2024-spaceport-america-cup-registration-process> Please also check "Submit as a team" and ensure your team's name also includes your school's name. If you don't see this button or you need to change the team's name, go to <https://www.herox.com/SpaceportAmericaCup2024> to create a team or access your existing team to change the name.

Formal University Name

Institute for Technology and Innovation Management, Mahidol University

University City/Province and Country

--- REDACTED ---

Mailing Address for Awards

--- REDACTED ---

Team Name

RADIANT

Organization Type

Club/Group

Rocket/Project Name

Project RADIANT

Social Media Presence

--- REDACTED ---

Primary Student Contact - Name

--- REDACTED ---

Primary Student Contact Phone Number

--- REDACTED ---

Primary Student Contact email

--- REDACTED ---

Alternate Student Contact - Name

--- REDACTED ---

Alternate Student Contact Phone number

--- REDACTED ---

Alternate Student Contact email

--- REDACTED ---

Student Media Contact - Name

--- REDACTED ---

Student Media Contact Phone Number

--- REDACTED ---

Student Media Contact Email

--- REDACTED ---

Faculty Advisor - Name

--- REDACTED ---

Faculty Advisor Phone Number

--- REDACTED ---

Faculty Advisor email

--- REDACTED ---

Alternate Faculty Advisor - Name

--- REDACTED ---

Alternate Faculty Advisor Phone Number

--- REDACTED ---

Alternate Faculty Advisor Email

--- REDACTED ---

Team Mentor(s) - Name, Organization, Cert Level, Email, Phone

--- REDACTED ---

Team Flyer of Record - Name, Organization, Cert Level, Email, Phone

--- REDACTED ---

Special Instructions

--- REDACTED ---

Category

10k - SRAD - Solid Motors

Team Demographic Data

This is all members working with your project including those not attending the event. This will help ESRA and Spaceport America promote the event and get more sponsorships and grants to help the team and improve the event. NOTE: High School Students may NOT participate.

Number of Undergraduate Team Members

--- REDACTED ---

Number of Masters Team Members

--- REDACTED ---

Number of PhD Team Members

--- REDACTED ---

Number of Team Members who Identify as Men

--- REDACTED ---

Number of Team Members who Identify as Women

--- REDACTED ---

Number of Team Members Who Identify as non-binary

--- REDACTED ---

Number of Veterans

--- REDACTED ---

Number of Tripoli, NAR, CAR, UKRA Members and Certification Level

--- REDACTED ---

Rocketry Experience

Team Mentors' experience

--- REDACTED ---: Expert in rocketry in Thailand. Used to study and develop high power rocketry for altitude-based rockets and military rockets. A researcher in composite materials, fuels, propellants and rockets.

--- REDACTED ---: Expert in high power rocketry in scientific and military fields of rocket.

Team Experiences (From past projects with us)

1. Our rocket research project in the past few years: Project Juno VI with target of 1,000 meters AGL (3,280 feet AGL) altitude with self-made Sorbitol + Potassium Nitrate based solid propellant motor (Kronos-I, K1) and propellant. We conducted 3 static tests with this motor and successfully launched 4 rockets with K1 motor to the desired altitude with $\pm 10\%$ variation due different rocket design in each rocket.
2. Local Competition: Thailand CanSat & Rocket Competition for 3 years with 11 successful launches to the altitude of 350 - 400 meters AGL. (3-inch Diameter rockets) The sugar-based solid propellant motor and propellant is provided.
3. Self-Experimental Launches: 6 successful launches to the altitude of 250 - 300 meters AGL. (3-inch Aft Frame with 5 inches Payload Section Frame) The sugar-based solid propellant motor and propellant is provided.

In the past few years, our team has been researching and developing various projects in the aerospace and aeronautical engineering fields with support from our Defense Technology Institute (DTI) in Thailand. DTI is one of the first pioneers in the rocketry field in Thailand. They have been researching and developing different rocket types and powers for more than 10 years.

All these projects and competitions were done under SPACE AC (as mentioned in Section 12: Previous IREC) in the past few years during high school time and have been carried on to the university level by former members, and now our team is under iNT Mahidol (Institute for Technology and Innovation Management, Mahidol University).

In addition, we have already done a physical hot fire test and a static fire test with the present motor, Mana M1 (see more details in Section 6: Propulsion System).

VISA Status for International Teams

Most of our team members have acquired VISAs already, but some have not got VISAs yet. We should be able to acquire VISAs for all team members before the event without any hassle.

STEM Outreach

Describe any activities that your team leads or participates in that helps your local community with Science, Technology, Engineering or Math enrichment.

STEM Outreach Events

Our STEMs

iNT Mahidol (Institute for Technology and Innovation Management, Mahidol University) was established for nearly 6 years. iNT Mahidol is set to drive Mahidol University toward a world-class university through technology and innovation. As a team under iNT Mahidol, we aim to follow the vision of developing and researching technology and innovation in order to publish knowledge for not only Mahidol students but also for the local community in Thailand too.

Also, as a part of main contributors at former SPACE AC Institute, we carry our legacy and contributions to the society and the public in our names. These are projects we, as a part of the team have contributed in the past, including ongoing projects at iNT Mahidol.

Here are some past and ongoing projects:

- Mini-course for engineering and space-related topics, e.g., microcontrollers, programming, electronics course, etc.
- AI hackathon event host for driving projects “from society to society.”
- Agricultural Data Collection and Analysis Methods for minimizing losses and maximizing profits for farmers.
- Remote fire detection system for forest fires

- Aerospace engineering courses and internships for high school students
- A food supply delivery robot operates in a hospital, reducing contact between patients and hospital staff.
- Machine learning AI hand sign language real-time interpreter for mute people
- The weather balloon (Project PASSENGER-I, II, and III) aimed to test the students' scientific projects in the stratosphere.

Rocket Information

Overall rocket parameters FOR ALL NUMERIC FIELDS DO NOT INCLUDE UNITS in the field, use the units identified in the help. All numerical values use a maximum of 2 decimal places.

Project Start Date

2023-08-16

Which rocket components are planned to be commercially purchased?

Rocket Airframe

- Top frame & electronics frame – G12 Fiberglass 6" Airframe
- Aft frame – Carbon-fiber-reinforced polymers (CFRP) 6" Airframe

Air Brake

- Center driving rail – stud (steel grade 8.8, threaded full length)
- Motor – stepper motor

Pneumatic Piston

- Pneumatic Piston – 5-inch pneumatic piston
- Valve sets – Pressure relief valve, etc.
- Gas Source – CO₂ Cartridge

Which rocket components are planned to be student fabricated?

Rocket Fins

- Rocket Fins – CFRP, CNC-cut

Air Brake

- Brake pad – CFRP, CNC-cut
- Frame – Aluminium alloy, CNC-cut
- Actuator Frame – Aluminium alloy CNC-cut

Pneumatic Piston

- Frame – Aluminium alloy, CNC-cut
- Forward piston pad – CFRP, CNC-cut

Nose Cone

- Internal support/structure – high strength, high temperature 3D printed material (ABS or PC)
- Exterior enclosure – fiberglass with resin coat up
- Nose Cone Tip – Aluminium alloy

Coupler

- Coupler – high strength, high temperature 3D printed material (ABS or PC) with stainless steel rod

Total Vehicle Length (inches)

169.29

Airframe Diameter (inches)

6.18

Fin-span (inches)

7.09

Vehicle weight only (pounds)

81.84

Propellent weight (pounds)

34.40

Payload weight (pounds)

11.02

Total Liftoff weight (pounds)

127.26

Number of stages

1

Rocket Information – Additional Comments

Airframe Material Selection

The airframe, fins and air brake of the rocket are constructed from combination of two fiber materials in each section:

Main – Carbon-Fiber-Reinforced Polymers (CFRP)

This material boasts an exceptional strength-to-weight ratio, making it ideal for rocket manufacturing. CFRP is renowned for its lightweight properties, which contribute to improved rocket performance. Additionally, it exhibits high resistance to fatigue, ensuring durability during multiple launches. It is superior to traditional G12 glass fiber (GFRP) in terms of physical strength and weight efficiency.

For parts needing wireless communication or needing a cutout, GFRP will be used in place instead.

Secondary – G12 Fiberglass

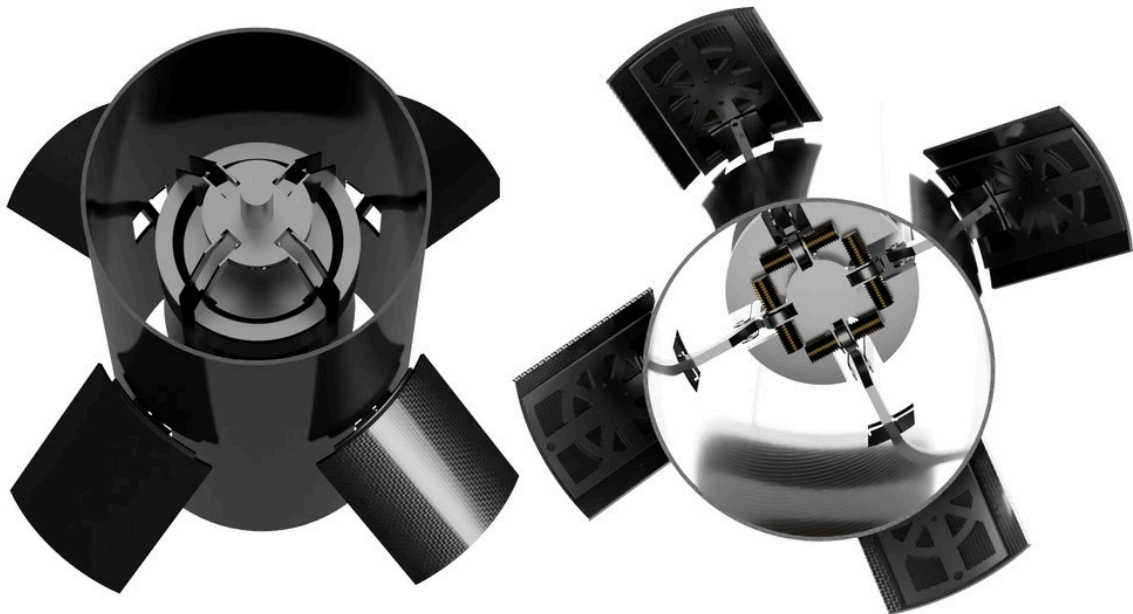
G12 fiberglass is selected for its unique property of not interfering with the wireless signal of the transmission module within the system. While it may be slightly heavier than traditional paper tubes, this weight differential is outweighed by its significantly enhanced strength. G12 fiberglass is a popular choice among rocket enthusiasts due to its robustness and suitability for a wide range of rocket applications.

Rocket Interior Structures and Active Control Mechanical Design

Air brake

In order to achieve an accurate apogee of the rocket, an air brake system is implemented (in conjunction with overshooting the rocket to higher target altitude). The air brake actively changes the vehicle's drag profile on ascent. The air brake mechanism operates by utilizing drag pads that are controlled by a gearing system and an actuator. The pads are calculated to have a size of at least 24 cm^2 (3.72 sq. in.). The brake pads open up from the four side of the rocket's airframe and is actively adjusted to obtain the optimum acceleration for achieving exact apogee using PID control.

Here are some of the proofs of concepts from our mechanism designs.





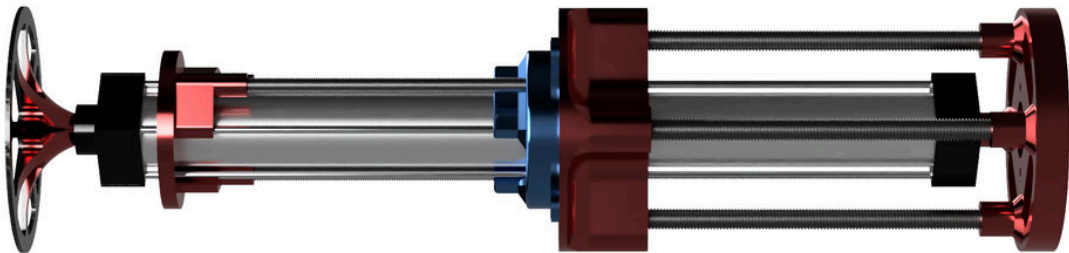
Pneumatic Piston

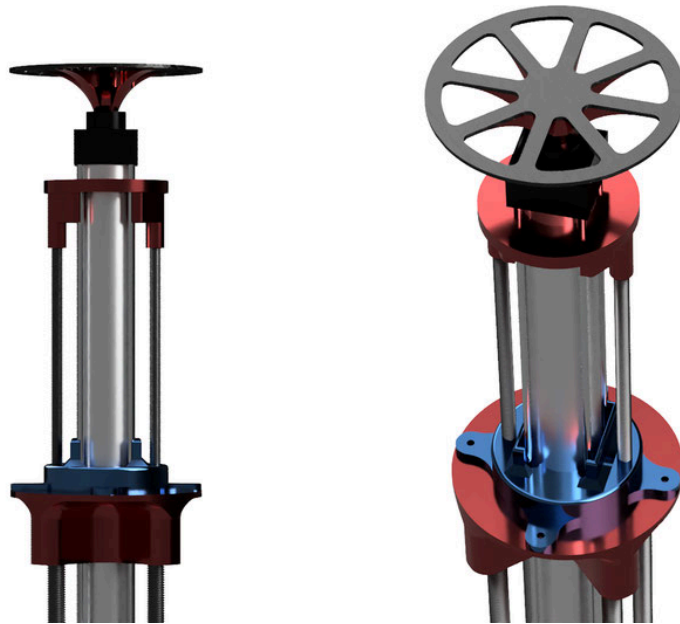
1. A pneumatic piston was chosen to replace traditional direct gas ejection inside the airframe because the pneumatic chamber is airtight, so it has near 100% efficiency without gas leaking anywhere.
2. It has less volume, thus requires less gas for ejection with the same mass and ejection velocity target, thus smaller amount of gas source.
3. The pressure relief valve is implemented to direct the gas towards the outside via side of the airframe, so there is more control and safety into considerations.
4. Although it increases the complexity and the weight of hardware, the additional layer pneumatic piston instead of direct ejection was selected to reduce any risks of airframe damaging.

The mission of our pneumatic piston is to successfully eject the parachute and nosecone. The pneumatic cylinder piston design is implemented instead of just pure black powder ejection to help prevent damage that can occur to the parachute from sparks caused by the explosion of black powder and to also reduce the amount of black powder used (which makes it a little safer to deal with). It also has the advantage of being a complete assembly, which makes it less complicated to work with. Furthermore, it provides stable performance, high reliability, and strong resistance to extreme environmental conditions such as shock, vibration, and temperature, making it a very sound choice. In the pneumatic piston, CO2 gas cartridge is chosen to be the gas supply. A small amount of black powder will be used to propel a puncture plug which then puncture a hole in the cartridge allowing CO2 gas to pass through into the pneumatic piston. This puncture method ensures a hole large enough for CO2 gas to burst through with sufficient speed.

To summarize, Small BP Charge → CO2 gas → Piston pushes forward.

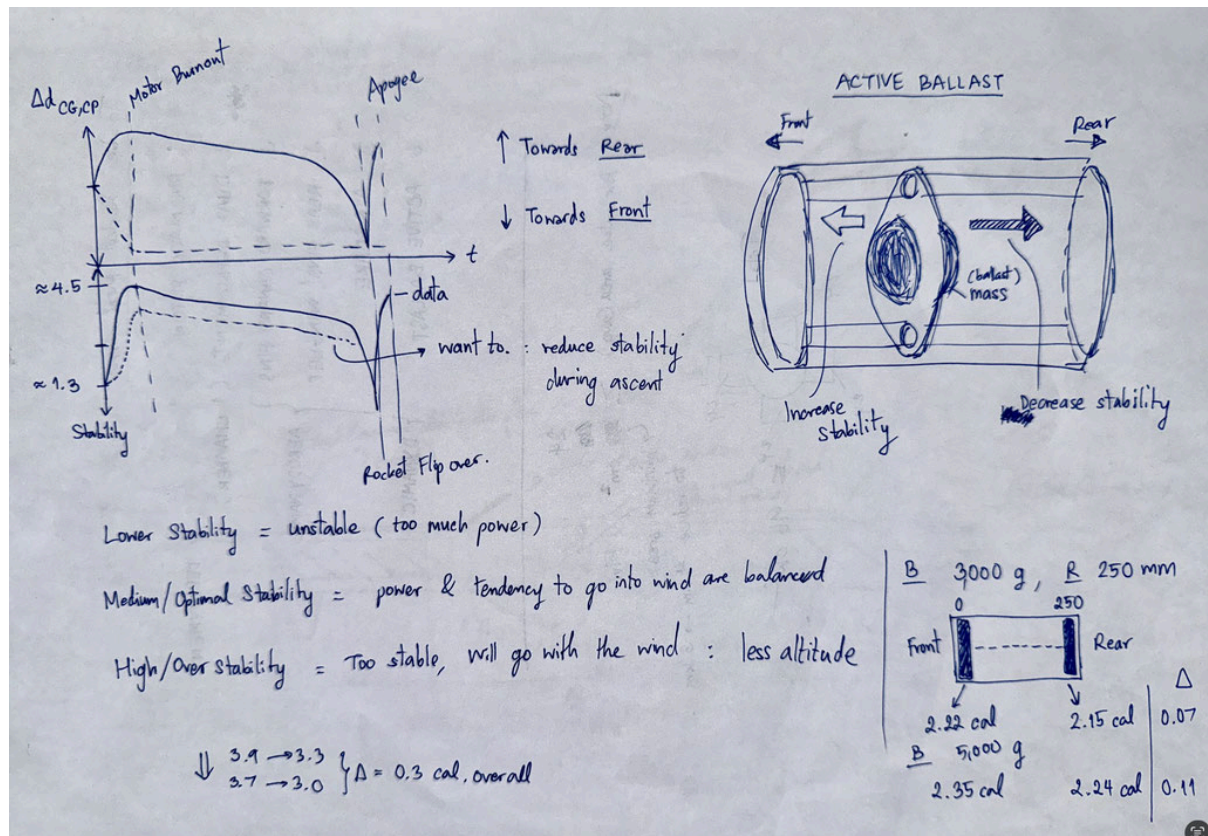
Here are some of the overall proofs of concepts from our pneumatic piston.





Active Ballast

To improve the vehicle's dynamics, i.e., over-stability control, we introduce a device which can shift the center of gravity (CG) point backwards to decrease the static margin during ascent. As the rocket is ascending, the CG shifts to the front as the propellant is ejected to the rear, causing the static margin to increase and the rocket to steer with the wind direction. To reduce the effect, an actively controlled mass ballast is implemented to shift the CG point backward dynamically. Here's a handwritten diagram of the design.



The OpenRocket simulation showed that the ballast can shift the “static margin” value by approximately 0.11 calibers as seen on the bottom right of the sketch (10 lbs ballast shifting by 25 cm in one direction).

Propulsion System

Propulsion Type

Solid

Propulsion Manufacturer

Student-built

Propulsion Systems: (Stage: Manufacturer, Motor, Letter Class, Total Impulse)

1st Stage: SRAD Solid, 34.4 lbs. of 65:35 Potassium Nitrate – Sorbitol (KNSB), N Class, 18452 Ns

Total Impulse of all Motors (Ns)

18452

Propulsion System Discussion

I. Propellant

For non-polymer propellants like APCP, sugar rocket propellant, specifically KNSU (Sucrose), has been a standard for high-power rocketry applications for a very long time. KNSB (Sorbitol) is also in various experiments lately, so we chose KNSB to be our main propellant due to its ease of casting as the melting temperature of sorbitol (230 degrees F) is significantly lower than sucrose.

Also, APCP was not chosen because it was not transportable from Thailand to the USA, so we chose something that we can make with easily accessible tools.

In the future, we would definitely consider developing a propellant grain with higher specific impulse to replace KNSB for more efficiency.

As a result, the handling and casting safety also increases. The grain is lined within PVC tube of 5.20 by 6.89 inches with 3-inch-diameter BATES core. Its density is around 1.75 g/cm^3 . We have experienced some performance drawbacks of sorbitol compared to sucrose as follows.

1. 10% overall total impulse loss due to its lower density, so we have to increase the total volume of propellant to match the target mass.
2. In our test, the initial surface ignition is lower than expected. The thrust curve looks like a mountain instead of flat rectangle of BATES grain. Nakka rocketry also experienced this in their test. We have to coat every surface with black powder paste. We also have to increase distance between grains to 20 mm each. From our chemical computation, the theoretical O:F ratio of KNSB should be 67.5:32.5, but to simplify manufacturing process, 65:35 ratio was and will be used.

II. Propellant Production

To make the KNSB, first we prepare grains, then we mix both grains in the V blender machine. Next, we pour our mixture into a stainless-steel saucepan heated to 230 degrees Fahrenheit. After the stir and the propellant was well mixed, we cast the mixture into our BATES mould. We use a rubber hammer to hit outside of the cylinder to remove air bubbles while the propellant hasn't hardened. As a result, there are some minimal cracks and air bubbles.

III. Ignition and Pyrogen

We used self-made black powder to ignite the chamber, raising the chamber's initial pressure to average burning pressure of approximately 850 psi (120 grams of BP). The igniter is placed at the bulkhead end, firing forward to the nozzle end. Our past tests showed that this configuration was deemed the most effective way to ignite the motor.

Chamber Pressure calculation

$V_{ic} =$	8.387 in ³	Volume of igniter charge	NOTE [1]
$V_c =$	850.48 in ³	Volume of motor chamber, empty	
$V_g =$	574.97 in ³ NOTE [b]	Volume of propellant grain	
$C =$	0.2662 lb _m	Mass of igniter charge	
	= 120.7 grams		
$V =$	275.5 in ³	Motor chamber free volume	
$\lambda =$	70000 ft-lb _f /lb _m	Impetus of charge powder	NOTE [2]
$\Delta =$	0.0009661 lb _m /in ³	Loading density (C/V)	
$P_a =$	14.7 psia	Ambient (atmospheric) pressure	
$G =$	1.00	Fraction of original charge mass consumed [NOTE 3]	
$P =$	852 psia	Pressure in motor chamber	

IV. Motor Specifications

Our M1 motor uses Aluminum Alloy 6061, Phenolic Resin (more explanation in section VII.) and Graphite throat for both bulkhead and nozzle which is a standard "aerospace-grade" combination with optimal weight instead of steel.

For casing, 6061 alloy is preferred for reloadable usages and 6063 alloy is for "single use only" as per NFPA1125 7.4.5. As 6063 alloy is non-ferrous ductile as per IREC DTEG 5.5.1 and we have done static firing test (peak pressure was twice the simulation) and to do a hydrostatic pressure test before dynamic testing. Therefore, 6063 alloy will be our main casing material unless the upcoming hydrostatic pressure test shows the safety as per IREC DTEG 6.19.6.1.

The bulkhead and the nozzle can be reused. The M1 motor is 6 inches in diameter and 4.3 feet in total length. The casing thickness is 6 mm. The nozzle has 45-15 CD angles with 31 mm throat. The motor casing is rated to withstand up to 1,220 psi design pressure with 3,102 psi burst pressure (Ratio of 2.54 with initial safety factor of 2) as per IREC DTEG 6.19.4.1. Note: 6063 alloy material has yield and ultimate

strength of 31 and 35 ksi. Every part is sealed and connected by High Temp RTV Silicone to prevent any leakages.

Ref. tools: Nakka rocketry.

Casing Dimensions and Design Factors

$D_o =$	6	in. (mm)	Diameter, outside
$t =$	0.23622	in. (mm)	wall thickness
$S_D =$	2		Design Safety factor

Material Properties

$F_{ty} =$	31	ksi (MPa)	Yield Strength
$F_{tu} =$	35	ksi (MPa)	Ultimate Strength
$E =$	9.9	Msi (MPa)	Modulus of Elasticity
$\nu =$	0.33		Poisson Ratio
$\beta =$	0.886		F_{ty}/F_{tu}
$B =$	1.271		Burst factor

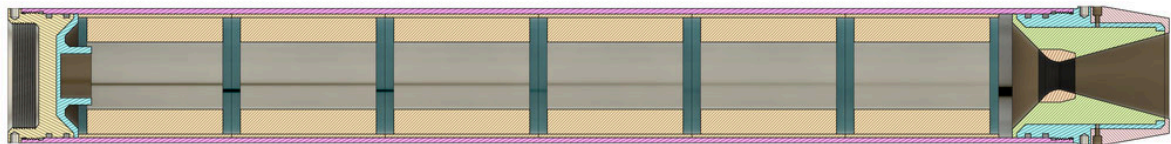
Design and Burst Pressures

$P_D =$	1220	psi (kPa)	Design pressure
$P_U =$	3102	psi (kPa)	Burst pressure
$S_U =$	2.54		Burst Safety Factor

Elastic Deformation under Pressure *

$\Delta D =$	0.00784	in. (m.)	Change in casing diameter, at P_D
$\Delta c =$	0.02464	in. (m.)	Change in casing circumference, at P_D

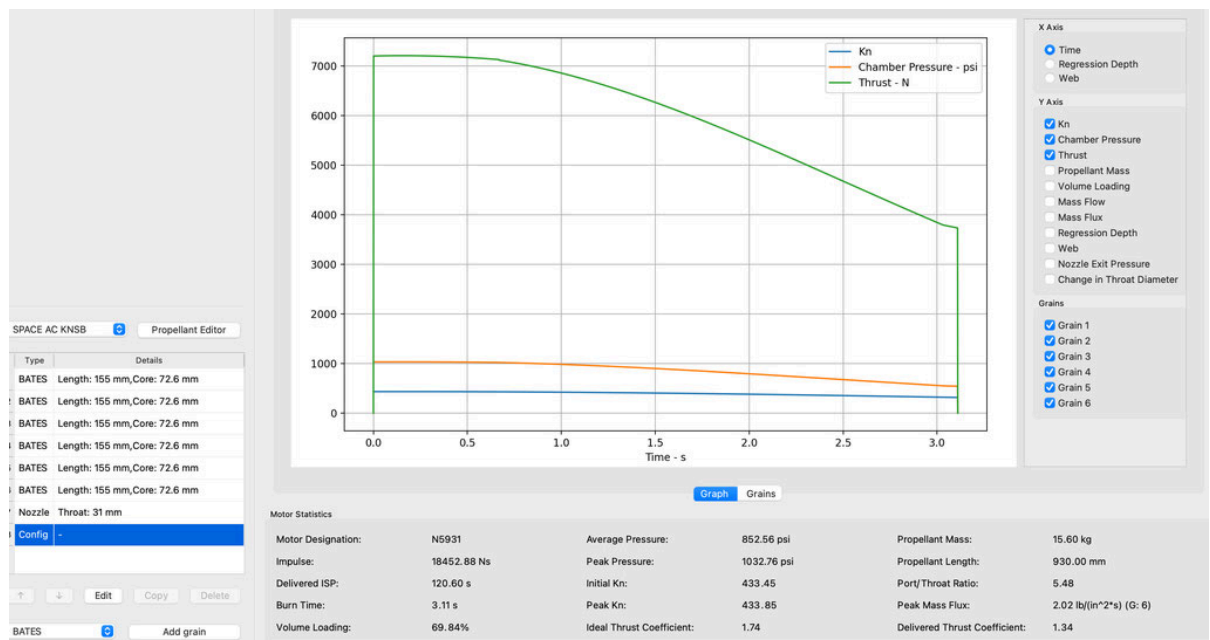
Rev.6 (to-be) Sectional 3D model:



V. Internal Ballistics Calculation & Simulation

Internal ballistics are simulated via "OpenMotor," which is an open-source software used for calculating motor's performance. As we have simulated and static-firing tested, the theoretical-real-world errors are acceptable.

These are some important values regarding M1 (Rev.6)



VI. Static Firing Test Results

As of now, we have tested the M1 motor (Rev.5) for 2 tests. One physical firing test and one static firing test with thrust and chamber pressure measurement. The test was conducted in September 2023 and was the first tests on this motor. The Rev.5 hasn't fixed the stated slow ignition problems that will be fixed in the upcoming Rev.6. Also, the Rev.g will have integrated physical heat-insulated boattail structure.

Here are the test results, photos and videos.



Firing & Static Test Photos & Videos

Videos of our first Static Test

--- REDACTED ---

Photos of our work with our mentors at the Static Test

--- REDACTED ---

VII. Phenolic Material for Ablative Section

We have two phenolic composite materials in consideration: Linen phenolic (in the static test) and Silica phenolic (what we will consider implementing in the flight version due to its superiority in ablative properties). Lathe-machined linen phenolic rod was used in our first firing tests.

Predicted/Simulated Flight Data and Analysis

The following stats should be calculated using rocket trajectory software (OpenRocket, Rocksim, RasAero...) or by hand. Pro Tip: Reference the Barrowman Equations, know what they are, and how to use them.

Launch Rail

ESRA Provided Rail

Rail Length (feet)

17

Liftoff Thrust-Weight Ratio

10.47

Launch Rail Departure Velocity (feet/second)

114.83

Minimum Static Margin During Boost

1.61

Maximum Acceleration (G)

12.44

Maximum Velocity (feet/second)

1063

Target Apogee (feet AGL)

10,000 ft

Predicted Apogee (feet AGL)

9544

Simulation/Analysis Comments

Overshoot Design

1. Controlling the manufacturing process of every piece of hardware and propulsion system preciseness is not practical. Some of the factors can be controlled to manufacture to the computed design. But the real-world parameters are not the same as in computer sims, i.e., apogee calculation.
2. A close-loop control of apogee via an air brake device is introduced. To make the air brake works, the rocket must be launched with higher apogee target for the air brake to reduce it as precisely as the flight computer can to the target 10,000 feet apogee.
3. The close-loop control with filters, i.e., Kalman filter and signal cleaning have been in the engineering field for a very long time, and the results have been promising and very accurate if done correctly.

To ensure that our rocket reaches the apogee we are aiming for, we have designed our rocket to have a raw performance that would reach an apogee

exceeding the target by about 30 percent. To reduce the velocity and apogee of the rocket to the target apogee of 10,000 feet, we rely on our precision calculated active control air brake system. The air brake system utilizes PID active control to decrease the velocity of the rocket before the desired altitude. Prior to launch, we will be testing with various safe and suitable PID constants for the air brake to generate sufficient drag to brake the vehicle after burnout while still maintaining stability. The area of the brake will be restricted physically to prevent ANY errors from happening.

(Original Total Drag Coefficient = 0.52; Apogee: 13,100 feet)

Drag Coefficient with Airbrake = 1.06; Apogee: 10,000 feet)

Rocket Trajectory Simulation

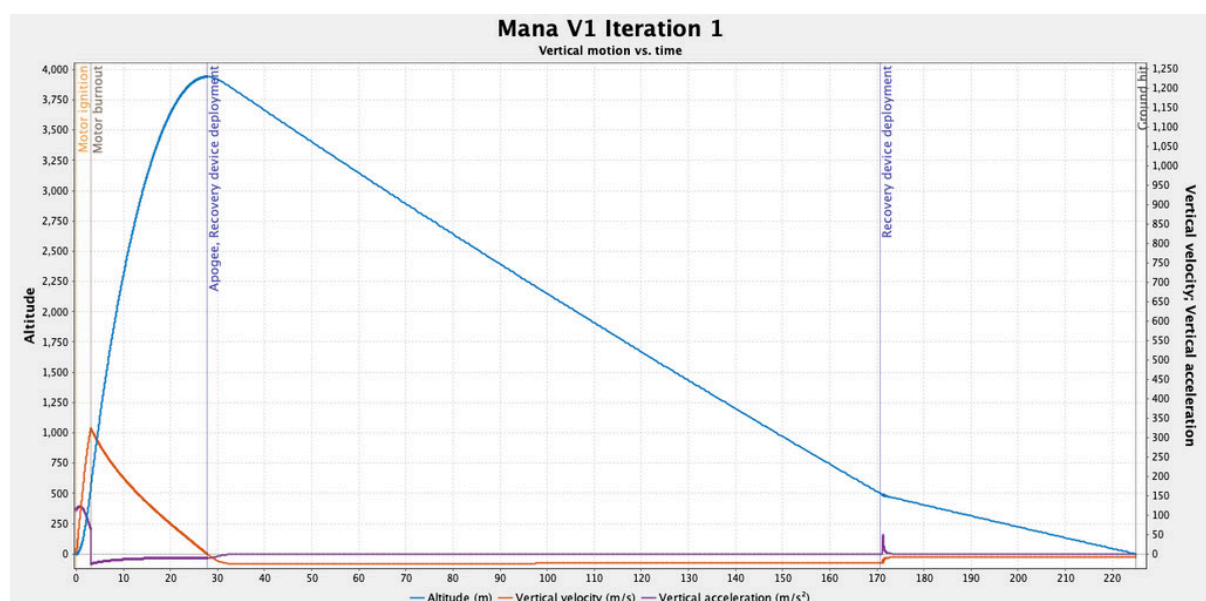
We simulated the trajectory and flight of the rocket in OpenRocket in two configurations: with opened air brake pads (pseudo brake) and raw performance without air brake.

Apogee of rocket with open air brake: 2909 m (9,544 feet)

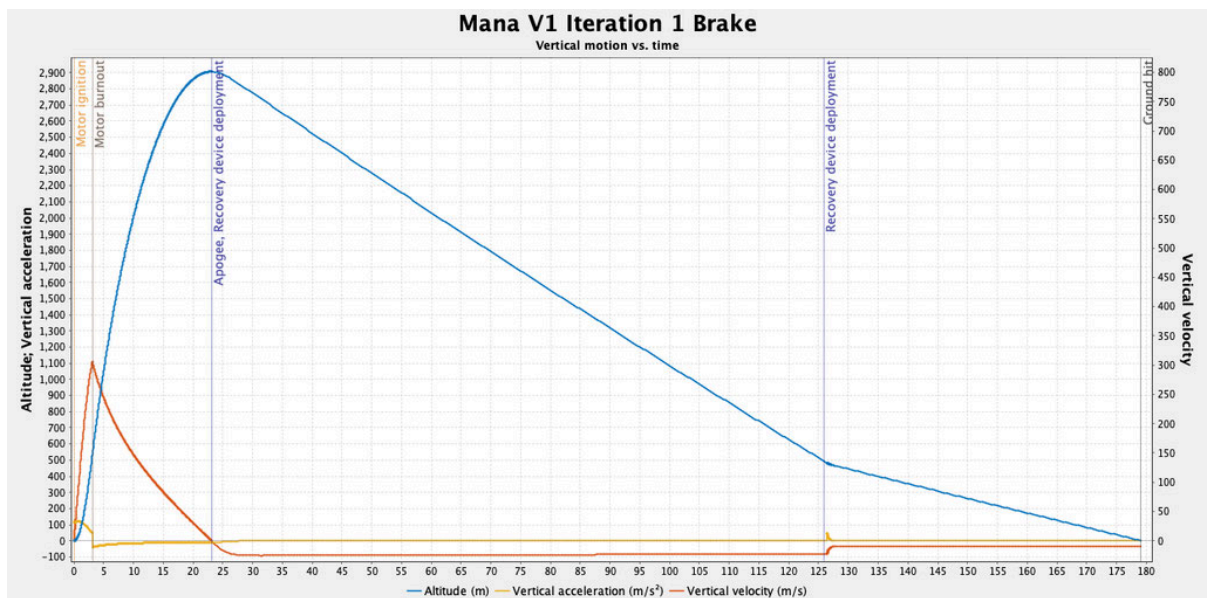
Apogee of rocket without air brake: 3946 m (12,946 feet)

**Pseudo brake is a virtually added drag coefficient to create similar characteristics and effect to that of the real air brake which will be implemented.*

As per OpenRocket's official technical documentation, most of the software's calculation uses Barrowman's formulas, empirical formulas, approximations, including CG and CP position. The assumption of Barrowman's formulas can still be applied to our rocket even with some slight errors. Additionally, from previous rockets that we have launched and simulated with OpenRocket, we found that the error is only approximately 5 percent. Thus, we found OpenRocket to be a suitable simulation application.



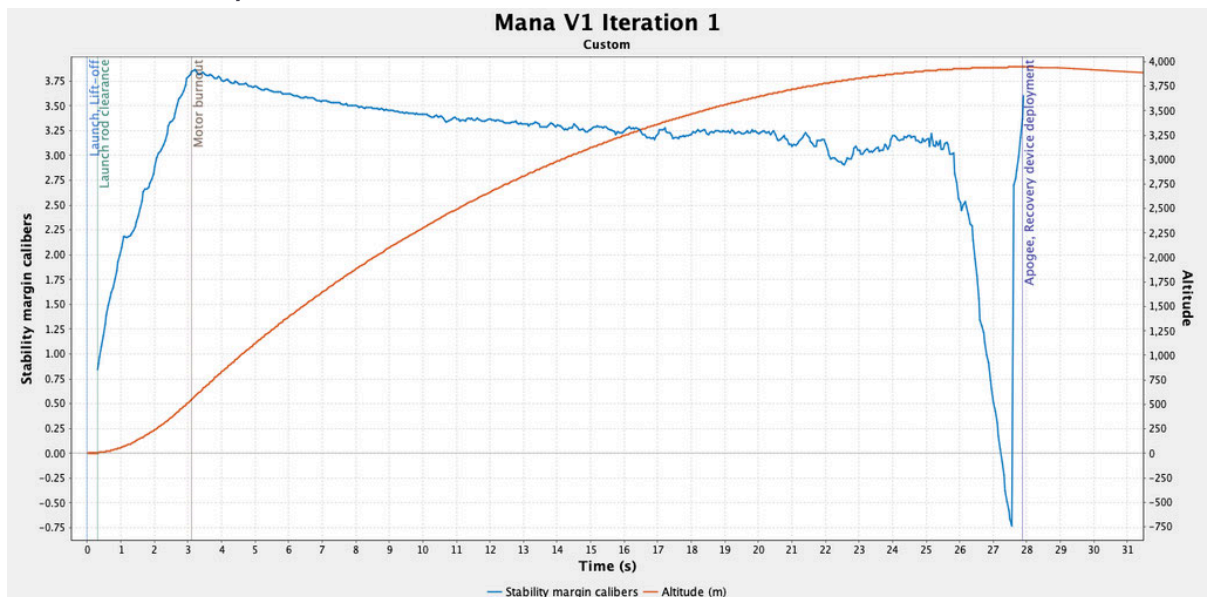
Without virtual airbrake



With virtual airbrake

Rocket Stability Analysis

We have simulated the rocket stability during its flight and at launch rod clearance. The rocket stability (blue line) can be seen to remain under 5 and above 1.5 calibres at all time during flight ensuring a stable ascent until apogee. The sudden and rapid drop in stability during $t+25s$ to $t+28s$ is due to the fact that the rocket is turning downward toward Earth during that time which is a common effect of "Gravity Turn".



Team Provided Launch Systems

Are you bringing your own launch system?

--- REDACTED ---

Payload Information

NOTE: To compete in the SDL Payload Challenge, you **MUST** follow the instructions on the **Spaceport America Cup Documents and Forms Page**. The information provided here is for ESRA purposes only. See <http://www.soundingrocket.org/sa-cup-documents--forms.html>

Payload Description

Important Note that the 3U CubeSat will NOT be deployed from the rocket at any time due to suggestions of this year's payload deployment guidelines.

Our mission is to conduct research on a system of multiple CubeSats. This system configuration includes multiple CubeSat nodes in the sky, collecting scientific data. The data collected will be relayed to a single CubeSat, which will handle all the telemetry workload, including downlinking all the data to a ground station.

The payload consists of three main CubeSats (Total of 3U): two 1U-sized CubeSats are for exploration and data gathering, while one 1U-sized CubeSat is for telecommunication purposes. All mentioned CubeSats also comply with the CubeSat form factor of 10cm x 10cm x 10cm.

Exploring CubeSat

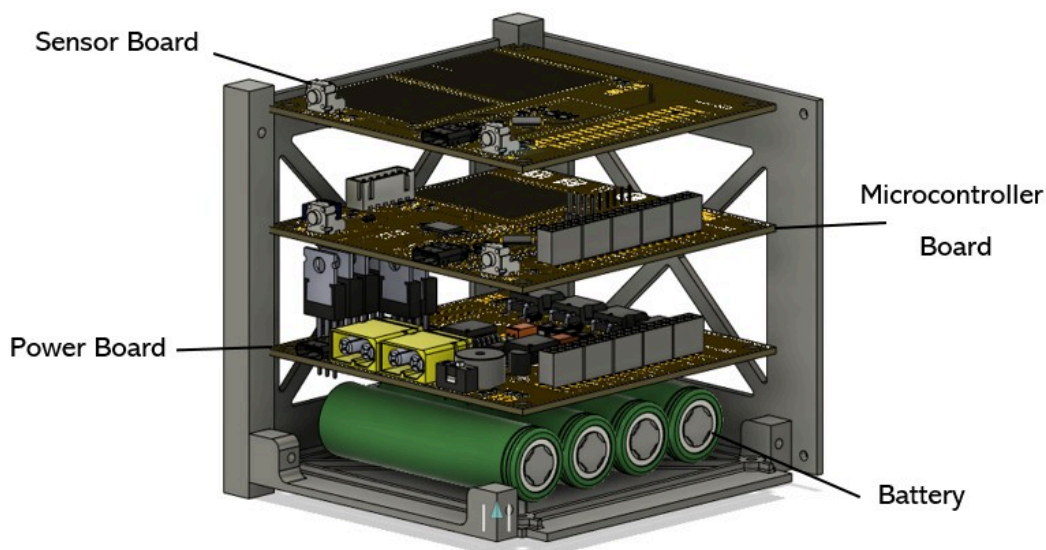


Fig 1. Our previous student research and development CubeSats.

Two 1U-sized CubeSats are designed for exploration and data gathering purposes. Their primary function is to acquire all the vital data through sensors and other

essential visual modules. This data will be sent to a CubeSat designed specifically for telecommunications.

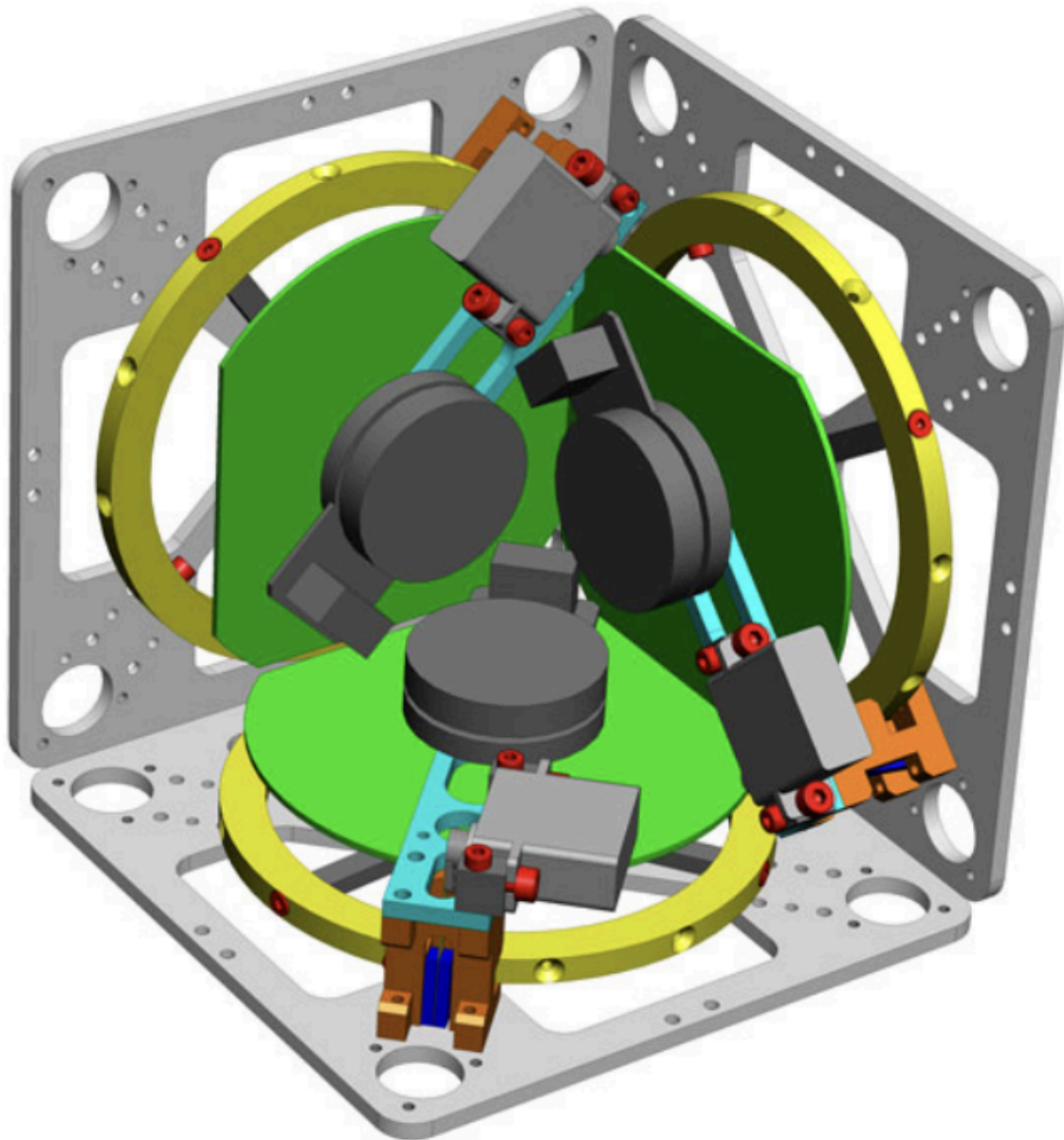


Fig 2. Cubli, example of on earth operational 3-axis reaction wheel.

One 1U-sized CubeSat is specifically designed for telecommunication, operating as a data relay node for the other two 1U-sized CubeSats. Received data is then sent back to the ground station via an onboard directional antenna attached to the CubeSat. 3-axis reaction wheels are utilized to control the CubeSat's orientation, thus also effectively controlling the pointing direction of the directional antenna — for example, a Yagi-Uda or circularly polarized antenna — to maximize the received signal strength for the ground station downlink.

The Mbed RTOS scheduler will be implemented in the software framework for its prioritized multitasking functionalities provided by a scheduler.

This CubeSat configuration offers economic benefits in deployment costs by eliminating the need to equip all deployed CubeSats with high-performance RF systems. This also free up the limited space inside the CubeSats for other demanding applications.

Electronics

Electronics Description

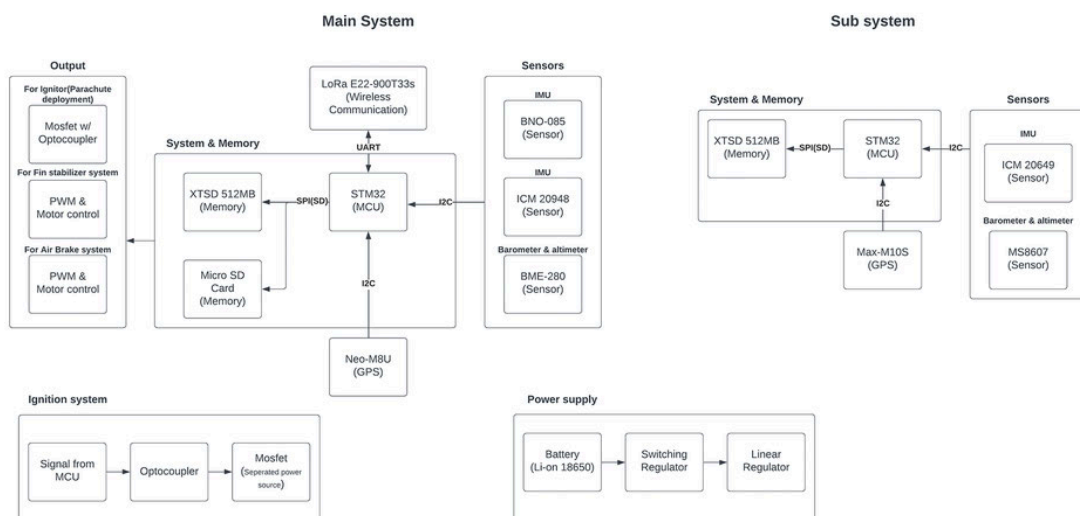
COTS Avionics & Recovery Electronics

Our COTS flight computer is the “Featherweight Blue Raven” to serve as both primary and backup parachute deployment system flight computer. This flight computer also acts as official altitude logging system specified in Section 2.5 of the IREC Rules.

COTS GPS Tracker

Our COTS GPS tracker is the “Featherweight GPS Tracker” operated at 900 MHz frequency. Amateur Radio Operator’s license doesn’t require at this operating frequency.

SRAD Avionics & Recovery Electronics



Package Description

Controllers and sensors (barometric pressure, temperature, humidity, gyroscope, accelerometer, magnetometer, etc.) will be soldered and packed onto a printed circuit board (PCB), which will be physically mounted in the electronics bay section of the rocket. The system will both store telemetry data in its memory and transmit it to the ground station. Additionally, it will manage the air brake and fin stabilizer systems. A redundancy system is also implemented to ensure the rocket's successful operation in case of any malfunction in the main system.

The package consists of the main controller, subsystem controllers, and sensors as follows:

Main System

The main avionics system is the rocket's central control unit. It collects important data, sends it back to the ground station, and also manages the rocket's air brake and fin stabilizer systems. This system is vital for monitoring and controlling the rocket's flight.

- STM32-F411CEU6
 - Microcontroller
- Adafruit SPI Flash – XTSD 512 MB
 - Memory access
- Micro SD card
 - Memory access
- LoRa E22-900T33S
 - Communication Module
- Ignition System (Parachute deployment)
 - Optocoupler
 - MOSFET with an ignitor
- BN0-085
 - Accelerometer, Magnetometer & Gyroscope sensors
- Motor control (Air brake and fin Stabilizer)
 - Motor driver
 - PWM output
- ICM 20948
 - Accelerometer, Magnetometer & Gyroscope sensors
- BME-280
 - Barometric pressure sensor & altimeter sensors
- Neo-M8U – GNSS receiver
 - Manufacturer: SparkFun
 - Model: Neo-M8U
 - Required HAM license: No

Subsystem

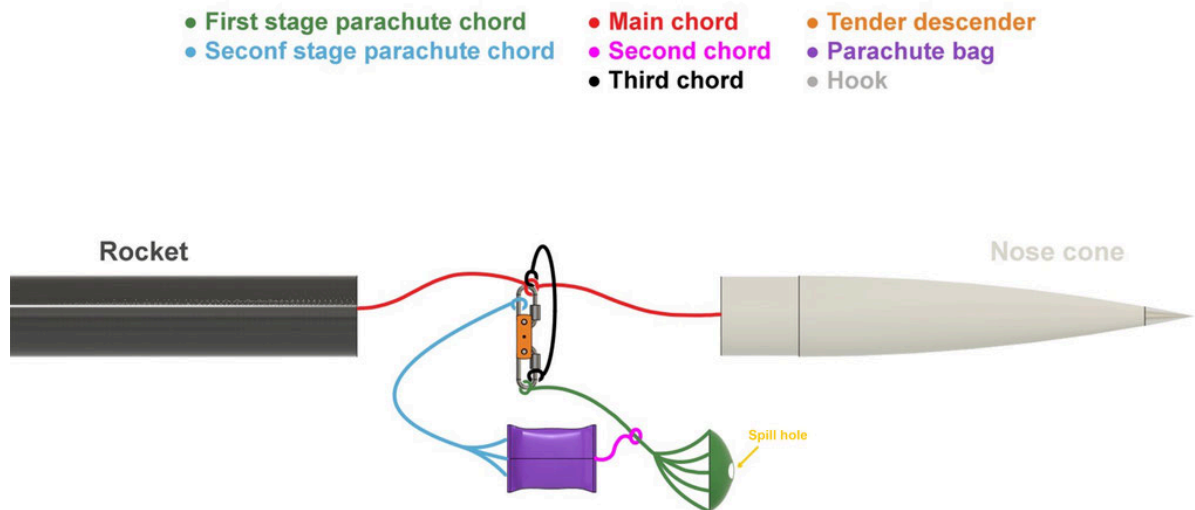
The design includes a redundancy system for rocket control to function in the event of any malfunction in the main system. It is designed to have an identical type of sensor and controller, each capable of controlling the rocket independently. The subsystem must be able to perform all the functions of the main system while also storing all the telemetry data for future failure diagnostics.

- STM32-F411CEU6
 - Microcontroller
- ICM 20649
 - Accelerometer, Magnetometer & Gyroscope sensors
- MS8607
 - Barometric pressure sensor & altimeter sensors

- MAX-M10S – GNSS receiver
 - Manufacturer: SparkFun
 - Model: MAX-M10S
 - Required HAM license: No

Recovery

Recovery Description



The recovery system is primarily used to decrease the descent rate of the rocket after it reaches apogee and deploys everything, ensuring that the rocket, avionics, properties, and lives are not damaged when the vehicle hits the ground. Moreover, dual parachute deployment will be implemented to ensure that the vehicle doesn't exit the recovery area/range and slows down sufficiently for a safe landing. All recovery system parts will be secured at the top of the rocket (above the payload section).

Regarding the shock cord and other component connections, the main shock cord will connect the airframe to the nose cone at both ends. At the middle of the cord, the tender descender and the second-stage parachute cord are connected. The first parachute cord connects to another end of the tender descender.

Additionally, the second-stage parachute is secured in the parachute bag so that it remains intact until it reaches the altitude required for its deployment, as shown.

The process starts at apogee, detected using our electronic apogee detection algorithm. The first (drogue) parachute and the payload will be deployed simultaneously using a pneumatic piston. The drogue chute will set the initial descent rate of the rocket to 35 m/s to reduce the risk of the drifting effect due to high-altitude strong winds. The second parachute will further decrease the descent rate to 9 m/s at an altitude of 500 meters to prevent any damage upon impact. During the second deployment event, the avionics command the tender descender to ignite electronically.

List of recovery system components

1. First stage parachute – Circular parachute with 102 cm diameter and 20 cm spill hole.
2. Second stage parachute – Circular parachute with 306 cm diameter and 61 cm spill hole.
3. First stage parachute cord – 1.5 m
4. Second stage parachute cord – 3.5 m
5. Main shock cord – 10 m
6. Second shock cord – 50 cm
7. Third shock cord – 50 cm
8. Tender descender with hook
9. Parachute bag

Design Criteria Tradeoffs

A tender descender was chosen due to its simplicity. Another design would be a double piston action on two sides of the rocket which was very complex in designing and assembly, and significantly increases the length and weight of the airframe.

It only requires single piston action on one end. The drogue chute will pull the main parachute out by separating the tender descender with small black powder (controlled electronically by COTS controller). It is also safer to handle and assemble.

Also, an alternative to the COTS tender descender can be student fabricated (SRAD) with similar core concepts of the design. For instances, we would consider designing a SRAD black-powder-powered cable cutter to release the main parachute. This would increase our engineering capability in this project to create a DIY mechanism.

Planned Tests

COMPLETED TEST

September 2023

- MANA M1 Static Test

TO BE COMPLETED TEST

November 2023

Subsystem Test

- Air Brake Prototype Test
- Pneumatic Piston Deployment Prototype Test
- MANA M1 Static Test
- MANA M1 Hydrostatic Test
- Telecommunication CubeSat Test
- Exploring and Data Gathering CubeSats Test

December 2023 (1st Update)

Subsystem Test

- Air Brake Final Design Test
- Pneumatic Piston Deployment Final Design Test
- Parachute Drop Test
- Tender Descender Test

Integration Test

- Flight Data Simulation Test
- Payload Operation Test

January 2024

Subsystem Test

- Air Brake Wind Tunnel Test
- Pneumatic Piston Deployment Test with Airframe
- Recovery System Drop Test

Integration Test

- MANA V1 Dynamic Test without Subsystem
- Payload Full Operation Test

February 2024 (2nd Update)

Subsystem Test

- Air Brake Dynamic Test

Integration Test

- MANA V1 Dynamic Test with Full Subsystem Operation and Payload

March 2024

Integration Test

- MANA V1 Dynamic Test with Full Subsystem Operation and Payload
- Full Operation Test

April 2024 (3rd Update)

Field Drills

- Operation Field Drills
- Safety Drills
- Emergency Drills

Post your team Logo



Are your Team Leads logging into and following HeroX?

Yes

Any other pertinent information

Dear Spaceport America Cup 2024 Competition,

We are team RADIANT from iNT Mahidol (Institute for Technology and Innovation Management, Mahidol University). Our team has different people good at different things. Some of us are great at programming, others at CAD design or electronic design, and some have other special skills. Many of us have been in local rocket competitions, and a few even got trophies in big competitions like the USA CanSat Competition. But all of us really love aerospace and aeronautics and have been super excited about it, even back in our high school days.

Our team has been researching and developing various technologies with a main focus on suborbital nanosatellites in the past few years: CanSat, CubeSat, and high-altitude balloons. While we are developing these technologies, we face an inevitable problem, which is payload transportation. Our country, Thailand, has almost no local rocket community, and most knowledge is kept in the military sector, so this is when we decided to start research and develop high-power rocketry (more details of rocketry experience in Section 3). After we have been through many experiments and completed almost all rocket competitions in Thailand, we know we are ready for another step toward rocketry fields participating in the Spaceport America Cup 2024 Competition.

By joining this competition, we're not just looking forward to building more cool innovations but also sharing what we learn with people back home. We want to

show everyone in Thailand that space and rockets aren't just dreams, they're something we can really do!

So, we hope you'll let us join this competition. It's a big chance for us to take another step in aerospace and aeronautics, not just for us but for our country too.

Thanks a lot,

Team RADIANT and iNT Mahidol

Previous IREC/ Spaceport America Cups

Has your team applied for past competitions?

Yes

Previous Results/Outcomes

Most of our team members are former members of the SPACE AC XT team, which submitted to last year's competition (Spaceport America Cups 2023) but was not selected. This year, most of our SPACE AC XT team members are currently studying at the undergraduate level. This led us to gather former team members and new members that currently study at Mahidol University to form a new team under iNT Mahidol (Institute for Technology and Innovation Management, Mahidol University). That includes continuing the relations with our rocketry mentors and experts at DTI Thailand.

ABOUT HEROX

[About Us](#)

[Press Kit](#)

[Partner With Us](#)

[Partners](#)

[Careers](#)

[Privacy](#)

[Terms](#)

[Cookie Policy](#)

COMMUNITY

[Blog](#)

[Organizations Involved](#)

[Events & Webinars](#)

[Community](#)

[General Forums](#)

SUPPORT

[Contact Us](#)

[How HeroX Works](#)

[Knowledge Base](#)

[FAQ](#)

[Innovation Resources](#)



© Copyright HeroX 2024

Was this page helpful?

☐ Yes

☐ No