PRELIMINARY DESIGN REVIEW

Engineering and Technologies Academy
Student Launch Class of 2017-2018

ETA SL Team

Engineering & Technologies Academy at Theodore Roosevelt High School

5110 Walzem Rd., San Antonio, Texas, 78218

Leading Teacher:
Christina Moreno
NAR #101793, Level 1 Certification

Mentor:
David Abmayr
NAR #90215/TRA #13238, Level 3 Certification

Changes Since Proposal

Changes Made to Vehicle Criteria;

We have decided to decrease the size of our fins to reduce drag and to decrease weight in order to increase our altitude and make our rocket more stable. We also changed the material of our motor tube to blue tube for better durability and general safety. We have also removed the aft bulkhead, and will instead be attaching the rear shock cord to the motor mount. We have also adjusted the thickness of our nose cone and payload bulkheads, while moving the rear centering ring to rest against the thrust plate. We have also adjusted our nose cone and parachutes, readjusting the erroneous 100 oz parachute to roughly 12 oz. This sharp decrease in weight meant that with our previous motor, we would now be going up to 9583 ft, so we changed our motor to the Aerotech J800T.

Changes Made to Payload Criteria:

We decided to change our electronics design to better fit the piezo sensors and recorder by simply rearranging our electronics bay.

Changes Made to Project Plan:

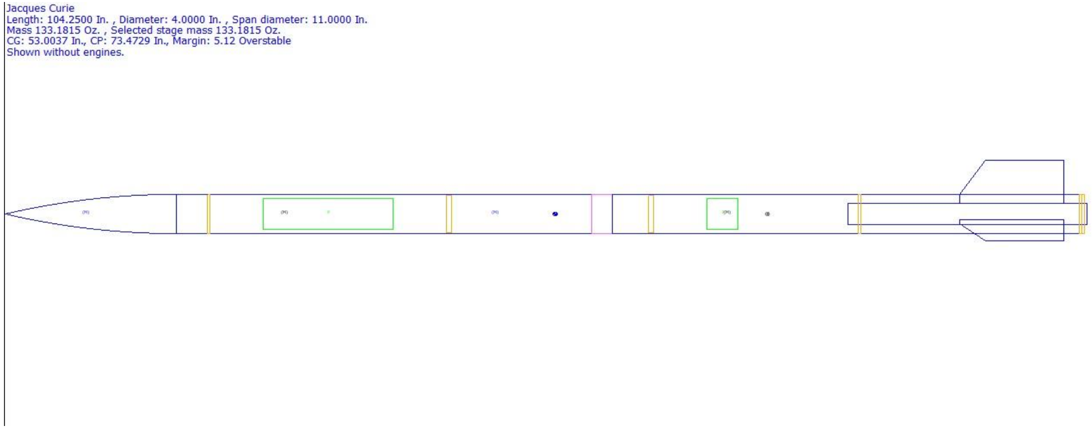
We have increased the amount of fundraiser events we host in order to raise money, as well as increase educational outreach events throughout middle and elementary schools in our area.

Mission Statement

The ETA SL team will launch a mile high in order to measure the energy which can be gained using piezoelectric generators on the ascent and descent, as well as to determine the validity and efficiency of harnessing this electricity on flights. This information could be scaled up and applied to flights by NASA air/spacecraft to harness and generate energy on the flight into space and beyond.

If the ETA Roosevelt SL rocket travels the required height (one mile), is recovered safely, is able to be relaunched and if the team is able to retrieve accurate data then, and only then, can the mission be declared a success.

Vehicle Dimensions Materials and Justifications



CG: 63.3574 in.

CP: 73.4729 in.

Length: 104.25 in.

Mass: 133.1815 oz.

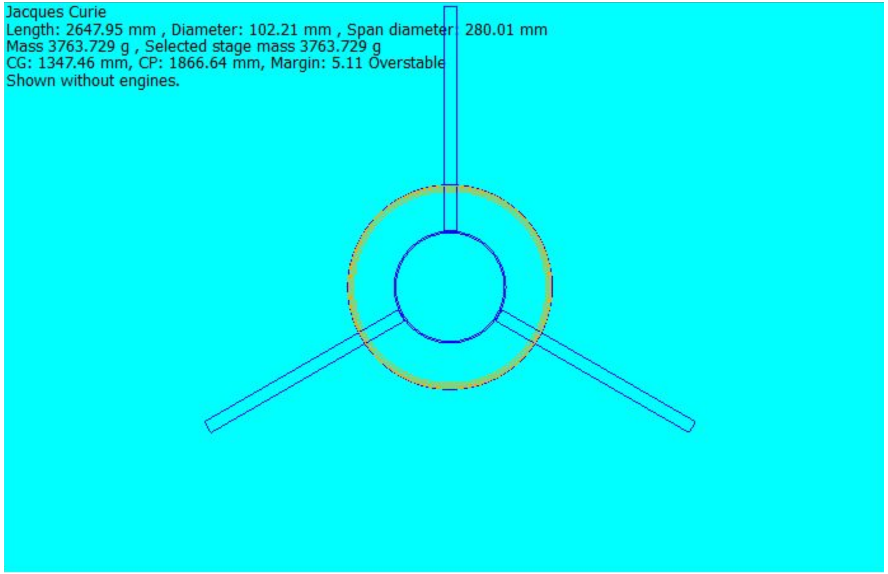
Our airframe will be blue tube because it is strong and light.

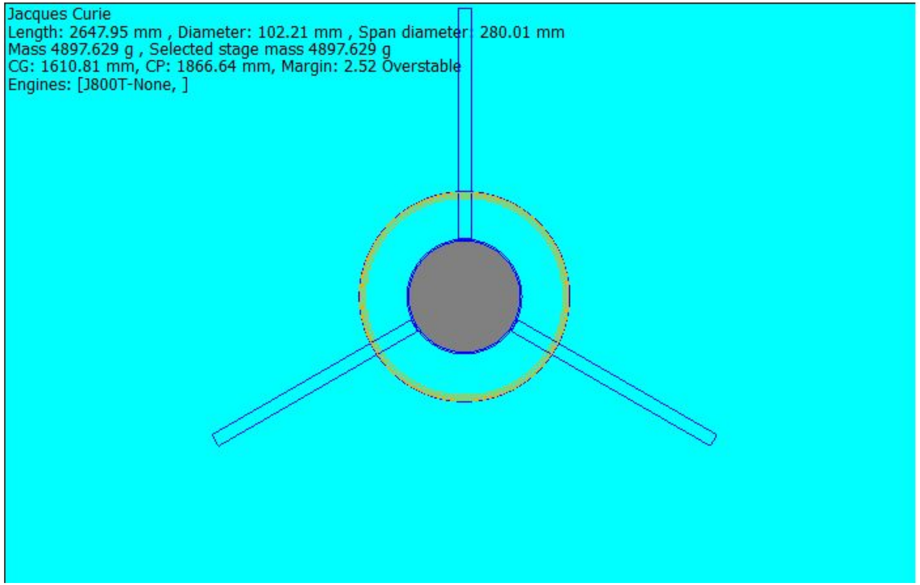
Our nose cone will be polypropylene plastic because it is seamless and sturdy.

Our fins are ¼" birch aircraft plywood because it is light and durable.

Our shockcord is ½" tubular Kevlar because it can easily withstand the force of ejection.

Static Stability Margin





Plan For Vehicle Safety Verification and Testing

Cameron, Fernanda, and Elvis are our safety officers and are responsible for making sure that every team member knows how to safely use all equipment and follow proper safety procedures. Each team member must pass a safety test over the NAR High Powered Rocketry Code and the use of power tools. Safety officers will also brief the students before every launch on safety procedures utilized during each launch.

Christina Moreno, Robert Lozano, and David Abmayr will be the safety mentors and make sure that all safety procedures are followed.

Plan For Vehicle Safety Verification & Testing Cont.

Our safety procedures include:

- At least two team members will be working together at all times.
- Team members will be required to take a mandatory safety test.
- Team members will wear safety gear while building and testing.
- Electronic devices will have multiple switches to prevent accidental firing.
- All black powder and ejection charge preparation will be handled by David Abmayr.
- Students will review safety procedures and checklists multiple times.
- The Safety Officers will make sure to remind the team daily of the safety concerns for each particular task.
- Students will consult the MSDS sheets if unsure about the proper handling of materials and chemicals.

Plan For Vehicle Safety Verification and Testing

All team members must understand and will abide by the following safety regulations:

-There will be a flight readiness review and range safety inspection of each rocket before it flown.

-The team shall comply with the determination of the safety inspection.

-The Senior Safety Officer has the final say on all rocket safety issues.

-The Senior Safety Officer has the right to deny the launch of any rocket for safety reasons.

If ANY member of the team does not comply with the safety requirements, then we will not be allowed to fly.

Baseline For Motor Selection and Justification

In order to reach a one mile high altitude and our desired velocity, we needed to have an engine that could lift the weight of a rocket and payload. We decided to use an Aerotech J800T engine which would give us enough thrust to reach our altitude. We will be using a grain motor casing. The Jacques Curie will have about 1229.1 N/s of thrust. It will burn for 1.6 seconds. We also had to consider motor availability when choosing our motors. Below is a table with the other motors which we considered using for our rocket.

	Simulation	Results	Engines loaded	Max. altitude Feet	Max. velocity Feet / Sec	Max. acceleration Feet/sec/sec	Time to apogee	Velocity at deploym Feet / Sec	Altitude at deploym Feet
1	0		[J800T-None]	5589.96	797.00	807.90	17.11	3.64	5589.97
2	1		[J415W-None]	5174.38	658.94	331.96	17.46	2.59	5174.36
3	2		[J525-LW-None]	4670.21	671.20	408.67	16.36	1.21	4670.20
4	3		[J460T-None]	3280.22	516.94	383.39	14.04	1.79	3280.22
5	4		[J390HW-TURBO-Nc	5133.76	636.55	364.33	17.37	0.19	5133.76

Thrust To Weight Ratio and Rail Exit Velocity

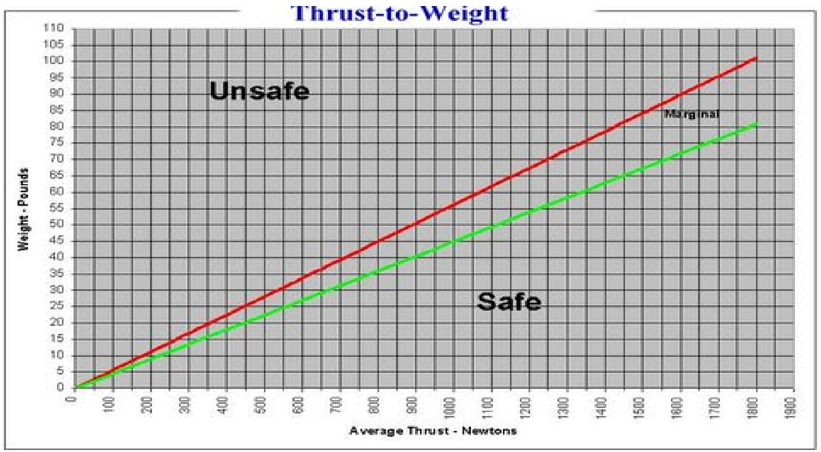
Thrust From Motor: 696.5 N x 1 lb./4.45 N = 156.58 lbs.

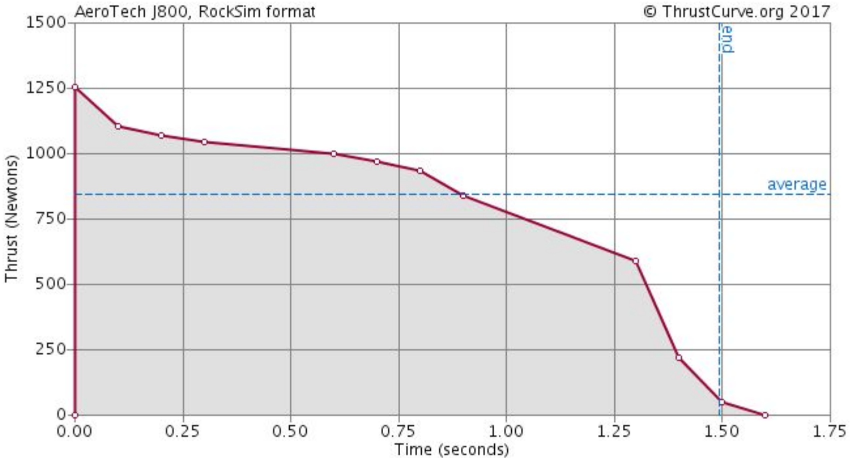
Weight of rocket: 173.12 oz. x 1 lb./16 oz. = 10.82 lbs.

Thrust/Weight ratio: 14.471

Velocity at launch guide departure: 107.8 ft/s

User specified minimum velocity for stable flight: 52 ft/s





Vehicle Verification and Test Plan Overview

Performance targets for the payload and vehicle are:

- The vehicle will be developed to deliver a scientific payload/experiment to a specific altitude of 5,280 feet above ground level (AGL).
- The vehicle will be designed to use a standard launch rail.
- The launch vehicle as well as the scientific payload will be designed to be recovered and reused.
- Preparation of the vehicle on launch day will not exceed 1 hour.
- Data from the scientific payload will be collected, analyzed, and reported by the team following the scientific method.
- The vehicle shall use solid motor propulsion using commercially available ammonium perchlorate composite propellant (APCP) motors.
- A tracking device will be placed on the vehicle allowing the rocket and payload to be recovered after launch (GPS module).

Vehicle Verification and Test Plan Overview

<u>Evaluation and Verification Matrices:</u>

<u>Motor:</u>

- Ignites / Does not ignite
- Appropriate burn rate / Inappropriate burn rate
- Rocket will achieve desired altitude / Rocket does not achieve desired altitude

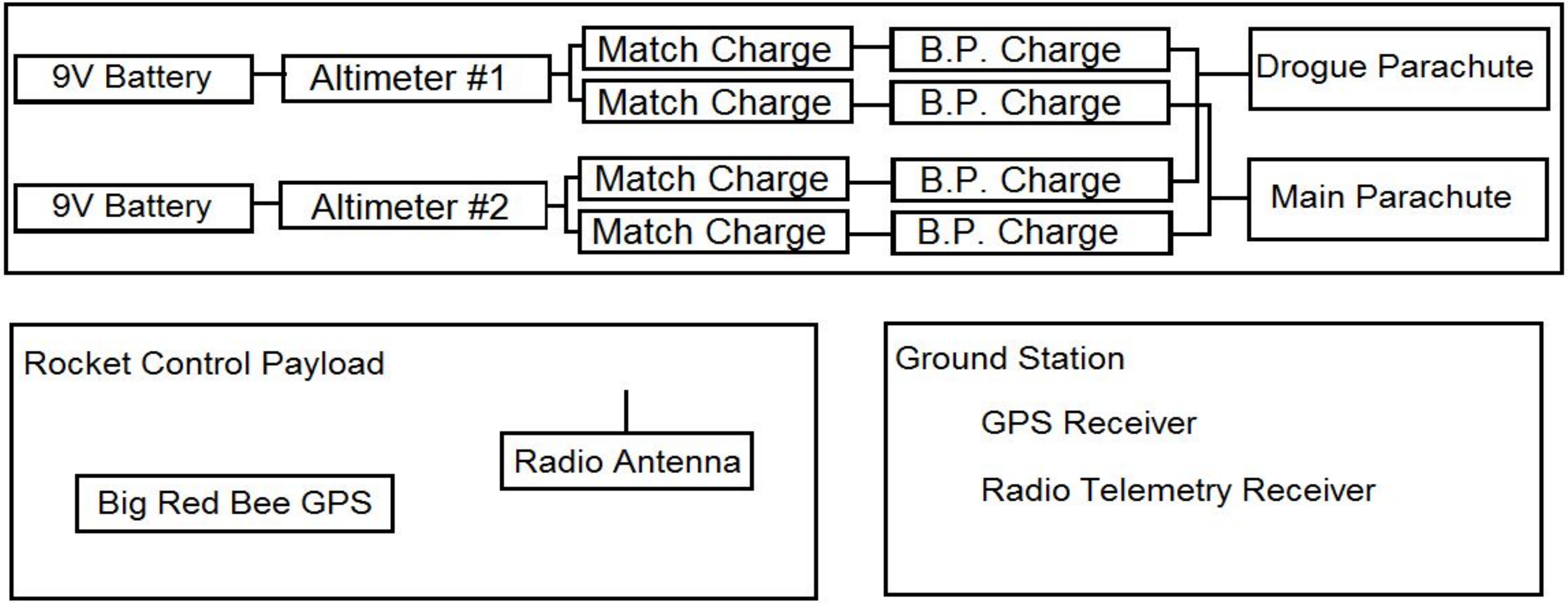
<u>Payload:</u>

- Altimeter deploys chute / Altimeter does not deploy chute
- GPS signal is transmitted / GPS signal is not transmitted
- Telemetry is transmitted / Telemetry is not transmitted
- Filter parachute is reefed / Filter parachute is not reefed
- Filter collects particles / Filter does not collect particles

<u>Recovery:</u>

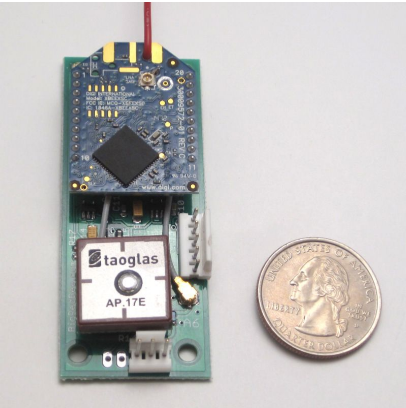
- Ejection charge fires / Ejection charge does not fire
- Drogue chute is deployed / Drogue chute is not deployed
- Main chute is deployed / Main chute is not deployed

Major Component - Recovery Subsystem



Major Component - Recovery Subsystem Tracking

We will be using the Big Red Bee 900 as our recovery tracking system. Our recovery team, JR and Madeline, will be familiar in its workings before the launch at Alabama in order to decrease recovery time. Our GPS will be located in the payload section.

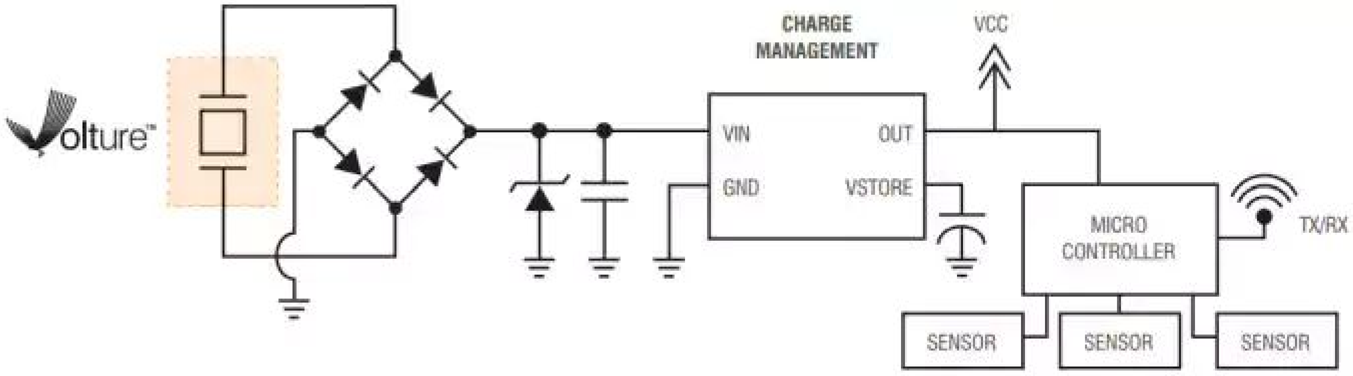


Electrical Payload Design

The Piezoelectric Sensors will be place on a predetermined location based on practice flights along the inner airframe the rocket. As we have Two different sensors, our Piezo vibration sensors will be tested in different sections of the inner tubing and from the data retrieved we will be Able to analyze the activity during flight in order to determine the area that will yield the most energy for the energy harvesting sensors.

Electrical Payload Design

Below is the schematic for the piezoelectric sensors.



Electronics Design

We have chosen this experiment in order to explore the possible modes of harvesting energy that would otherwise be wasted. Through the flight there is a considerable amount of vibration that occurs especially on a larger real world application of rocketry. In order to achieve this we have chosen piezoelectric sensors specifically to acquire energy during flight that is readily available. The goal is that on a real world flight this method could be used in order to have a backup supply or even as a method to utilize all possible sources of energy and utilize it to aid in some other aspect of the project.The ETA SL team will launch a mile high in order to measure the energy which can be gained using piezoelectric generators on the ascent and descent, as well as to determine the validity and efficiency of harnessing this electricity on flights. This information could be scaled up and applied to flights by NASA air/spacecraft to harness and generate energy on the flight into space and beyond.

Payload Verification and Test Plan Overview

Verification Plan:

1. Perform analysis of altimeters and GPS using Original Equipment Manufacturer (OEM) provided dimensions to ensure mounting.
2. Once the payload tray is constructed, perform a fit check to verify placement.
3. Verify payload is secure on the payload section of the rocket.
4. Make sure altimeters are mounted using shock cord mounts to avoid stress.

Preliminary Integration Plan:

The preliminary integration plan of the scientific payload will consist primarily of a layout using the dimensions provided by the OEM. Once payload parts are received and the tray is constructed, a fit check will be performed to ensure the feasibility of the mounting design.

Instrumentation, Repeatability of Measurement and Recovery System:

Testing of the scientific payload is planned prior to launch. Primary tests include accuracy and repeatability tests in a controlled environment.

Conclusion

Currently, we have ordered our parts and are waiting for them to arrive. We are meeting with our mentor once a month to go over design and building. We are on budget as we have received grants and donations as well as completed fundraisers. We have also reached out to schools within our district and are planning educational engagements.

We are excited about this unique opportunity and look forward to working with you!