Operation Helios

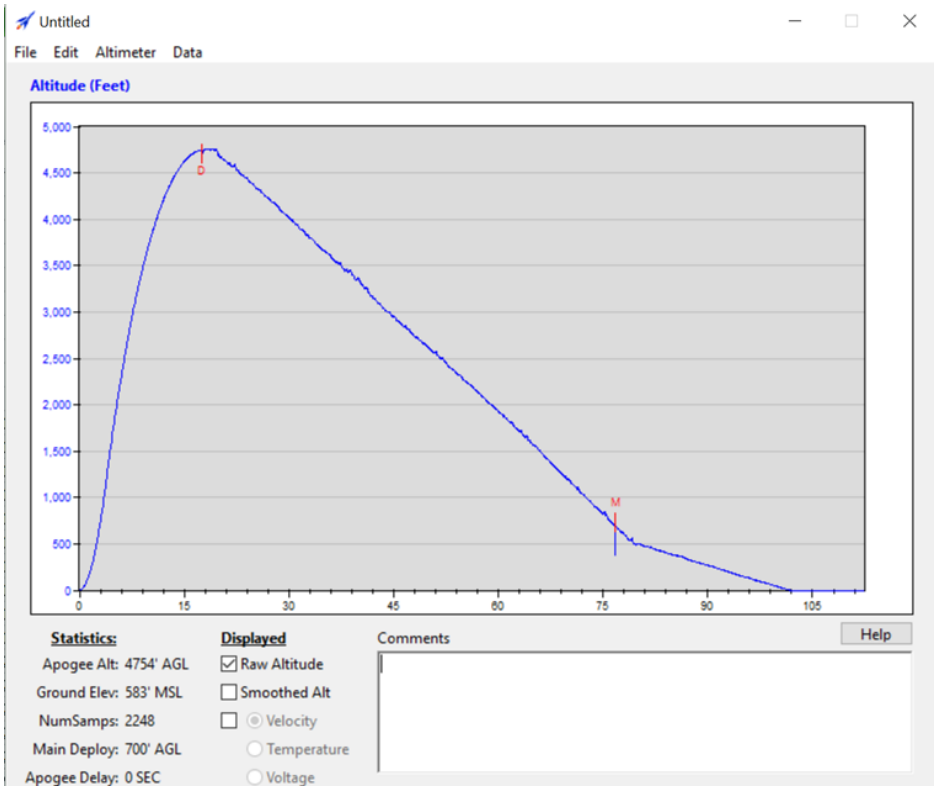
Post-Launch Assessment Review

Cedar Falls High School

1015 Division Street, Cedar Falls, IA, 50613

April 27th, 2018

- Motor Choice
    - The motor that our team used for our launch was the CTI K570. It has a max thrust of 200.7lb, average thrust of 129.0lb, and total impulse of 463.8lb-s
- Brief payload description
    - The payload includes solar panels, a radio transmitter, voltage reader, gyroscope, and two altimeters. The voltage from the solar panel was collected and stored in the voltage reader for analysis after launch.
- Vehicle Dimensions
    - The rocket is 8ft-3.75in. tall and 4.5 in. diameter. The body tube is 6.5 feet long, and the nose cone is 20.75in. Long. The motor retainer stands 1in. past the end of the booster, giving us the total 99.75 inches.
- Altitude reached (Feet)
    - The altimeter used for our official altitude reached gave a reading of 4,754ft. Our backup altimeter ready 4,752 which tells us that our data is reliable and consistent.
- Vehicle Summary
    - The rocket was 8'-3.75" tall with three 14"x4.5" trapezoidal fins for subsonic flight. Fully loaded with motor and all flight equipment, the rocket weighed 21.0lbs. On the outside, four flexible 2"x6" solar panels were put equidistant around the center. These were used for the experiment. Inside the rocket on the electronics bay, there were two altimeters for redundancy of recovery events, as well as a voltage collection microcontroller that stored the voltages collected by the four solar panels. The nose cone housed the gyroscope and the radio transmitter that sent the gyroscope information to our ground station.
- Data analysis & results of vehicle
    - Vertical flight with very little to no spin until apogee. The flight was "textbook" as our mentor told us. It flew very straight and true up to apogee, the apogee ejection charges worked perfect, and the main parachute opened at a great altitude (600ft). We also noticed there was absolutely no damage to the airframe and all of the parachute lines were not tangled. There was just a little bit of red dirt stuck to the airframe because it was so wet and sticky.



The image above is the position graph captured from the DataLogger program that gives data from the altimeter.

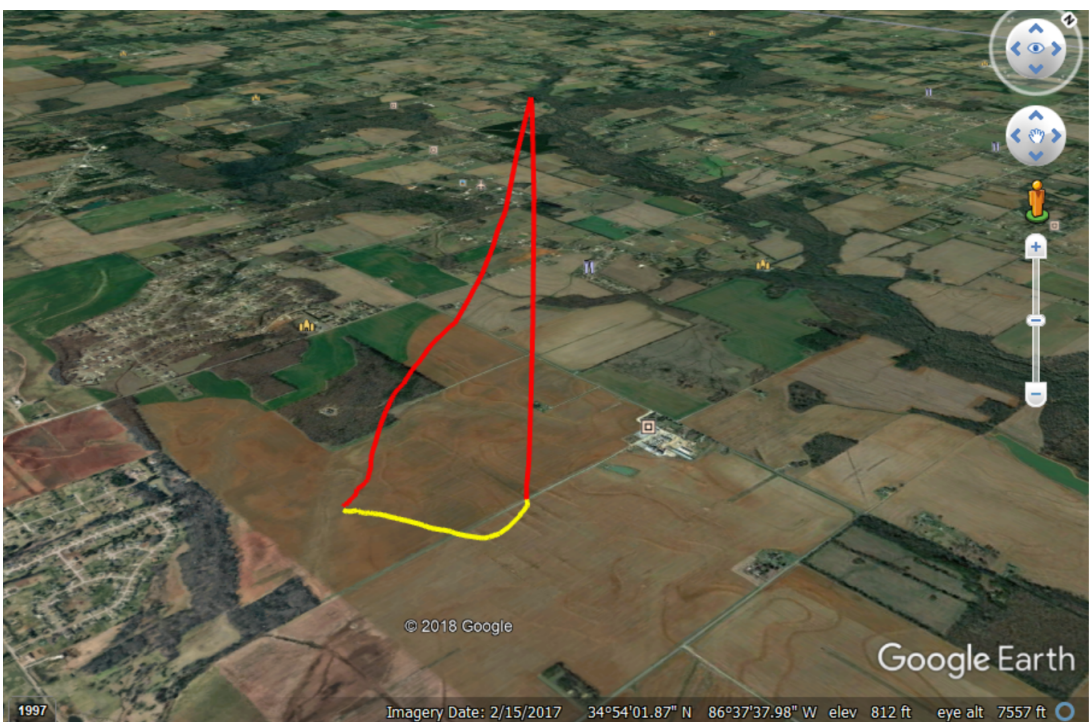


Fig. 2: The image above is a screenshot of the 3D “Google Earth” KML file that we received from our GPS tracker (AIM XTRA). It shows the very straight ascent and smooth descent.

- Payload summary
    - Our payload was testing the intensity of the sun as we increase in altitude. We had solar panels on the outside of our rocket and they were storing their voltage data on an SD card. There was also a ground station model of the rocket. The ground station mimicked the rockets yaw, pitch, and roll during flight. The gyroscope in the rocket was transmitting the rockets orientation to the ground station as it flew. The solar panels on the rocket and on the ground station were compared after the launch was over.
- Data analysis & results of payload
    - The ground station rocket was set to only mimic the orientation of the rocket in flight during ascent so that the ground station wasn't overloaded with extreme position changes with the rocket during descent. Since the rocket has such a straight and smooth flight to apogee, there was little to no movement within the ground station. It was a blessing and a curse. The blessing was that the rocket in flight had an amazing and true ascent, but the curse is that we weren't able to see the ground station put to a full "test" of its ability. We know that it worked and that both the in-flight and ground station rockets collected data.
    - From the information received by our solar panels, there was not a very significant difference in voltage from the sun at 4,754 feet above the ground as compared to the voltage on the ground using the tools available to us. On average, the voltages seemed to have less than one volt less recorded by the ground station than was recorded by the rocket in flight during apogee The ground station voltage read a pretty consistent. At the same point in each graph, there is large dip in the voltage readings, which we assume to be a considerably dense cloud passing over the sun. This dip in the graph shows that both the ground station and the rocket give reliable readings. In the future, we would like to test higher altitudes with more precise solar panels to see what different measures of voltage we could receive. The four panels on the rocket in flight can be seen as having different voltages from each other since each one was getting a different amount of sun since they were wrapped in a circle around the rocket. You can even see that two of the panels received similar data to each other, but high voltage than the other two. We assume that these were the two that were facing the sun the most directly during flight.
    - The other piece of data, which we found the most interesting, was that the voltage on the rocket in flight did have a pretty distinct "sinusoidal" pattern to it. What we think is happening is that we are seeing the voltages of each panel going up and down as the rocket spun around during ascent. As each panel was turned into the sun we can see the voltage rise (even though it was slight), and as that same panel turned away from the sun you can see the voltage decrease (again slight but noticeable). This was everyone's favorite part of the whole data analysis session! It isn't as evident in the ground station voltage graph for some reason, but we are very excited to see that the voltages did in fact react to the orientation towards the sun.

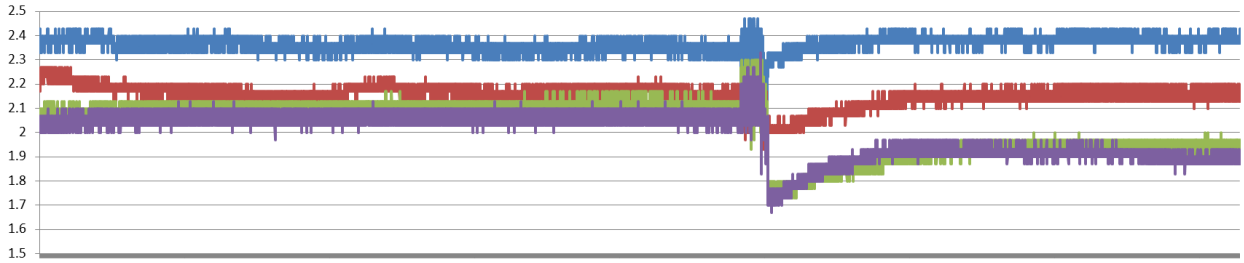


Fig. 3: Voltage data from the rocket in flight

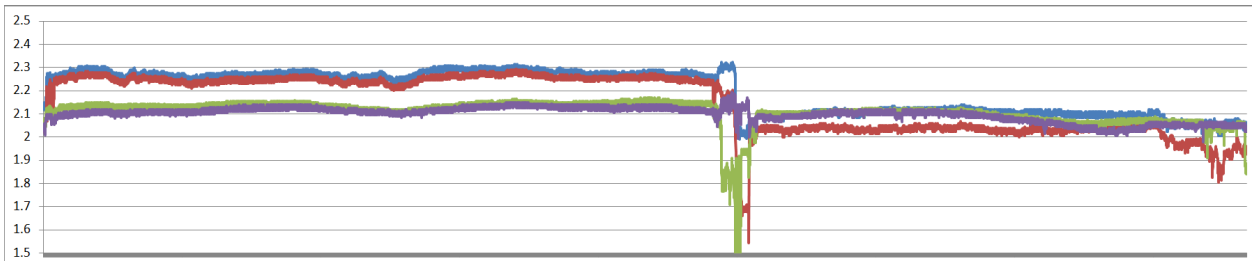


Fig. 4: Voltage data from the ground station

- Scientific value
    - The findings are important to companies that may be looking into investing in renewable solar energy. When trying to find the best place to put their solar panels, they may consider putting them at higher altitudes in the hopes that they will get higher voltage input from the sun. Our experiment shows that the higher altitude does give more voltage even though our results had minimal increases with altitude. We believe that if this data was extrapolated and the solar panels used were more sophisticated and more sensitive the results would be magnified and the voltage differences would be greater.
- Visual data observed
    - Very little movement of ground station due to the fact that the rocket launched extremely straight and the vehicle had no spin. There were clear skies for launch so the entirety of the launch was visible from the ground.

- Lessons learned
    - Over the course of the project our team learned many things beyond the workings of our rocket and payload. A major lesson was that of time management. The proposal for this project was written in one week, illustrating how poor our time management skills were to start out. Due to that intense burst of stress, we decided we would start out PDR much sooner when that rolled around. However, we procrastinated *very* much on that, which caused even more stress than the proposal. Our CDR and FRR were spaced out much better, as was our practices for our presentation. From those failures and successes, we

learned that spacing out our work and having a schedule for what needs to be done benefitted us greatly.
    - Another important skill we learned from this project was how to present effectively. We had a lot of practice from our teleconferences with NASA and the presentations we made for potential donors. We now know what it means to present effectively through pertinent information and confident speaking. Over the course of the project we truly grasped an understanding of what it is to be a strong speaker, a skill that will no doubt be highly valuable later in life.
    - We also learned a HUGE lesson that we never gave much thought to before: Safety First. Our safety guys thought we had a pretty extensive safety document when we first submitted out PDR due to that fact that it was a much longer list than we had ever seen and it had things on it that we never even thought about. But to quote NASA during our PDR presentation, “It barely scratches the surface of the tip of the iceberg.” That was quite the shock to us. We were so confident in our safety that we thought it would be the last thing commented on. It was only then that we realized just how important safety was and just how prepared you really have to be to work with things that could seriously harm others.
- Summary of overall experience (what you attempted to do versus the results; how valuable you felt the experience was)
    - Overall, we felt as though our project was successful. The voltage was recorded from the solar panels on both the ground station and on the rocket. It was found that altitude made a very minor difference in the voltage recorded by the solar panels due to our equipment precision and quality. In the end, the ground station hardly moved during the flight, which was good and bad as discussed earlier in our report. Our experiment went as planned, and our hypothesis was proven true which felt great. Being able to finally launch and complete the project with no launch complications was really a great experience.
    - This experience was extremely valuable to each member involved. As stated above, it taught us many things such as time management, presentation skills, and the importance of safety in a project such as this. We felt so good watching our rocket fly down in Huntsville, because the stress and exhaustion of 8 months of work finally paid off to have a picture perfect flight. None of us had ever tackled a project this extensive and this huge, and we now know just how good it feels to work so hard for something and have it end up so amazing. It ignited our passion for STEM more than any class ever could, and it will hopefully launch us into future careers. We loved the process, and we are so happy to have worked with NASA.
- Educational Engagement summary
    - The outreach requirement was met by doing multiple outreach events, but the largest contributors to our numbers were two different STEM fairs that the team attended as presenters. Each fair consisted of a large amount of fields under the STEM category, which our club fell under. We enjoyed our educational engagement opportunities due to the ability to reach a large amount or different

groups of people. We met different types of clubs, such as robotics teams and companies like John Deere. Plus the ability to interest children in STEM activities, and possibly making them future prospects for the team.

- Budget Summary
    - Last year as a team we competed in TARC, which was quite a step down from what we did this year. That includes the budget that we had. Since it was a small rocketry competition parts were readily accessible and cheap. But for our NASA project rocket we would need “heavily” priced items such as the electronics we used. Then there is also the motor and it’s casing, plus the rockets body itself. The total materials budget ended up being over $4,200. We had been careful in the purchasing of our materials, tools, etc. throughout the subscale and the full-scale builds, which allowed us to be under our proposed budget of $4,200. Because of this we were able to afford an extremely nice automotive paint job to top of our great rocket building experience. Our travel expenses also ended up being almost exactly what we had proposed. The only two significant changes we made were that we had planned to drive two separate vans donated by our school to drive to Huntsville, but instead we rented one large van that fit everyone. Instead of paying for the gas for two schools vans, we were able to take the money we would have used for the second van and put it towards the price of renting the bigger van. We had also been well under budget for travel during our test launches and the driving to each of those that we were able to book a few extra hotel rooms in Huntsville so that we could comfortably stay in Alabama instead of sleeping 4 students per room. In the end our $5,550 budget for travel was right on the mark. Each category far outmatched what we had to fundraise for our previous competition, but we were able to connect with a great amount of individuals and companies who helped fund our project.