National Aeronautics
and
Space Administration

Marshall Space Flight Center: Student Launch Initiative Program

Student Launch Initiative 2010
Flight Readiness Review:

Measurement of UV Radiation Changes at Varying Altitudes

The Phelps School

March 17th, 2010

Student Project Leader: Chris D.
Student Project Co-Leader: Sang Yoon L.

March 17th, 2010

Attn: Al Krause
Education Specialist (WTI)
OHC Contract- WILL Technology, Inc.
Academic Affairs Office HS30
NASA Marshall Space Flight Center
Huntsville, AL 35812
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Reference: NASA Student Launch Initiative

Dear Mr. Krause:
The Phelps School is pleased to submit its Flight Readiness Review to the Academic Affairs Office under the NASA Student Launch Initiative in response to the Design, Construction, Test, and Launch of a Reusable Launch Vehicle and Science-Related Payload Project.

If you have any questions regarding this proposal or if any supplemental information may be desired, please direct them to Frederick Kepner, address [The Phelps School, 583 Sugartown Rd., Malvern, PA, 19355], telephone [(484) 888-6551].

Sincerely,

Frederick Kepner
The Phelps School SLI Team Leader

The Phelps School Project Educators and Project Approval

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I. Summary of FRR report

Launch Vehicle Summary

Our rocket is 105 inches long and weighs 17.5 pounds without the motor installed. It employs a dual deploy recovery system utilizing dual Perfectflight MiniAlt K+ flight computers attached to redundant black powder charges. The Skyangle Cert-3 drogue parachute will deploy at apogee and the main Skyangle Classic-2 60 parachute will deploy upon decent at 600 ft. A Big Red Bee GPS and a Big Red Bee 100mW transmitter are housed in the nosecone to help us recover the rocket. We are using the smaller 80/20 rail buttons on our rocket to cut down on drag. The weight and size of our rocket are not great enough to utilize the larger sizes available.

Since the CDR we have changed our motor from a K550W to a K1050W. This change was necessary because our rocket weight 5 more pounds than expected upon completing. If we stayed with the K550 motor, we could only expect to get about 3500 ft. when launched in perfect conditions. Although we have not been able to launch our rocket yet due to extreme weather conditions and 6 scrubbed launch dates, we have calculated that the K1050 should get us between 4800 and 5500 feet. We will be launching our rocket on March 20th and 21st. After these launches we should be better able to dial in our Coefficient of Drag (Cd) value in RockSim. Although the motor change came after the deadline, it was approved due to the excessive bad weather the Northeast United States received this winter.

Payload Summary

The basic premise of our project is to measure the Ultraviolet radiation levels surrounding our rocket as it ascends and descends from 5,280 ft. We will be taking concurrent UV readings a ground level for a control sample. Our research indicates that there may be about a 4% increase in radiation levels for each 1000 ft. of altitude. The samples will be taken by two independent sensor/data loggers in the rocket at a rate of 1 sample per second. Upon completion of the launch we will download the 3 sets of data for comparison and draw a conclusion.

II. Changes Made Since CDR

The biggest change in our rocket is the motor being utilized. As explained earlier the unexpected extra weight of the rocket necessitated changing to a more powerful motor. The K550W motor has approximately 40% less power than the K1050W. Our final weight is 17.5 lbs., which is 5 lbs. more than the expected 12.5 lbs. The extra power of the K1050W will helps us get to the target altitude of exactly 5,280 ft. above ground level.

We also added switches and LEDs to both the flight computers and to the sensor/data logger circuits. The LEDs will only illuminate when the switches are in the on position. The LEDs were wired in parallel so that they would not affect the voltage flowing to the sensors. We tried a couple of different switches from Radio Shack but found that they were low quality and that they could be turned off by pushing past the on position. We found a source for higher quality key switches that are much more stable and secure. We have switched both the payload and avionics bay to these switches. The keys cannot be removed unless the switch is in the closed position. We installed bright red nylon strands on the key chains that say “Remove before flight” to make it difficult for us to forget to turn on any of the switches.

The length of the rocket decreased a couple of inches. The nosecone we had picked was on backorder for a long time and we could not wait any longer. We had to buy a similar nosecone that was 4 inches shorter. We went from an Ogive 6:1 shape to an Ogive 5:1. The resulting length of the rocket is 8 ft. 9 inches (105 inches).
We replaced the stainless steel eyebolts with 5/16 inch stainless steel U-bolts for added strength and durability. We addressed this in the CDR but thought it important to mention again. Additionally we switched to a thicker shock cord. We are now using 1 inch Kevlar which is rated to 1500 lbs. In order to protect the sensors in our payload bay from heat, we are considering installing fire-proof foam aft of the payload and fore of the motor casing. We will be launching our rocket with a thermometer installed in the payload bay to record the maximum experienced temperature. If the heat is not an issue we will be proceeding and launching the rocket with the payload bay on March 21st. If we find the need to install the foam, we will before launching on the 21st.

Several components of our recovery system were upgraded. We moved to a larger main and drogue parachute due to the extra weight of the rocket and acting on recommendations from several very experienced sources. We are now using a Skyangle Cert-3 drogue parachute and a Skyangle Classic-II 60 main parachute. To aid in recovery we purchased Big Red Bee’s 100mW transmitter in addition to the Big Red Bee GPS that we originally proposed. The 100mW transmitter is an upgraded transmitter of the 16mW version. It will easily broadcast an audio beacon over 20 miles line of sight. We purchased a Yagi antenna to use with our transceiver if we have to utilize the redundancy of the transmitter. We will still use the Big Red Bee in conjunction with our transceiver and a handheld GPS unit to locate our rocket. A super-expanding fiberglass foam is being utilized in the nosecone to protect both the GPS and transmitter during flight. The bulkhead with U-bolt is attached to an all-thread rod that is anchored in the nosecone by both the foam and epoxy.

The only other change to mention is our utilization of redundant black powder charges to release both the main and drogue parachutes. We addressed this in the CDR but thought it best to mention it again. Both flight computers will set off charges in both the drogue and main chute compartments. These charges are adequate independently to eject the parachutes and ensure that the parachutes will be deployed.

III. Vehicle Criteria

Testing and Design of Vehicle

We are completely confident in the vehicle's ability to perform the experiment with both accuracy and precision. Our building specifications and construction methods were both concise and accurate and consisting of proper assembly procedures, correct wiring of components including ejection charges, sensor to data logger, power source connections, key engaged power switches to the avionics bay, multiple static tests on various components to avoid failure, and tests on the payload to ensure that we will understand and accurately record our results. The ejection charges have been tested several times using computer software to activate them though our altimeters.

The Vehicle is constructed of G10 Fiberglass throughout the body, bulkheads, and fins. Each bulkhead holds all the components within both of the bays. The nose cone was filled with a two-part foam mixture that sets hard with an all-thread from the interior tip of the cone to the bulkhead inside the aft end of the nose cone. This all-thread is anchored in place by several washers and epoxy. The foam has hand-cut spaces within it to fit the GPS and transmitter and help protect the GPS transmitter and back-up during flight. The fins are cut and sanded down for enhanced airflow around them.

We are using G10 fiberglass because it has proven in the industry to be able to withstand high stress and heat. Stainless steel is considered the strongest readily available product for our use and is connected to one inch wide Kevlar shock cord that is rated to 1,500 lbs. for strong, reliable connection of the recovery system. Each section of Kevlar shock cord contains two Figure 8 knots, each with a 1200 lb. test quick link attaching the shock cord to the U-bolt.

Our Motor has been changed to the Aerotech K1050W due to increase in final weight due to the protective foam in the nose cone for our delicate electronic components, various pieces of attachment hardware like U-bolts, quick links, all-thread, trays for the components in the payload and avionics bays, larger parachutes, and solid wood motor mounts because of the size of the airframe in order to create a stronger joint. All of these things have contributed to making our vehicle seventeen and a half pounds, which is five pounds more than our computer model that we originally based our motor specifications on.

The weakest attachment component in the vehicle is rated to 1,200 lbs. By securing components that are stronger than the likely experienced stresses, we can ensure that our rocket will not fail due to stress. The motor tube has three 3/8th inch plywood centering rings that have epoxy on the inner and outer sides of the rings and have the three fins attached to the two aft centering rings. Four holes were drilled and filled with two part epoxy to add extra support to the attachment points on the motor mount. On the aft end of the tube there is an AeroPack 54mm motor retaining ring.

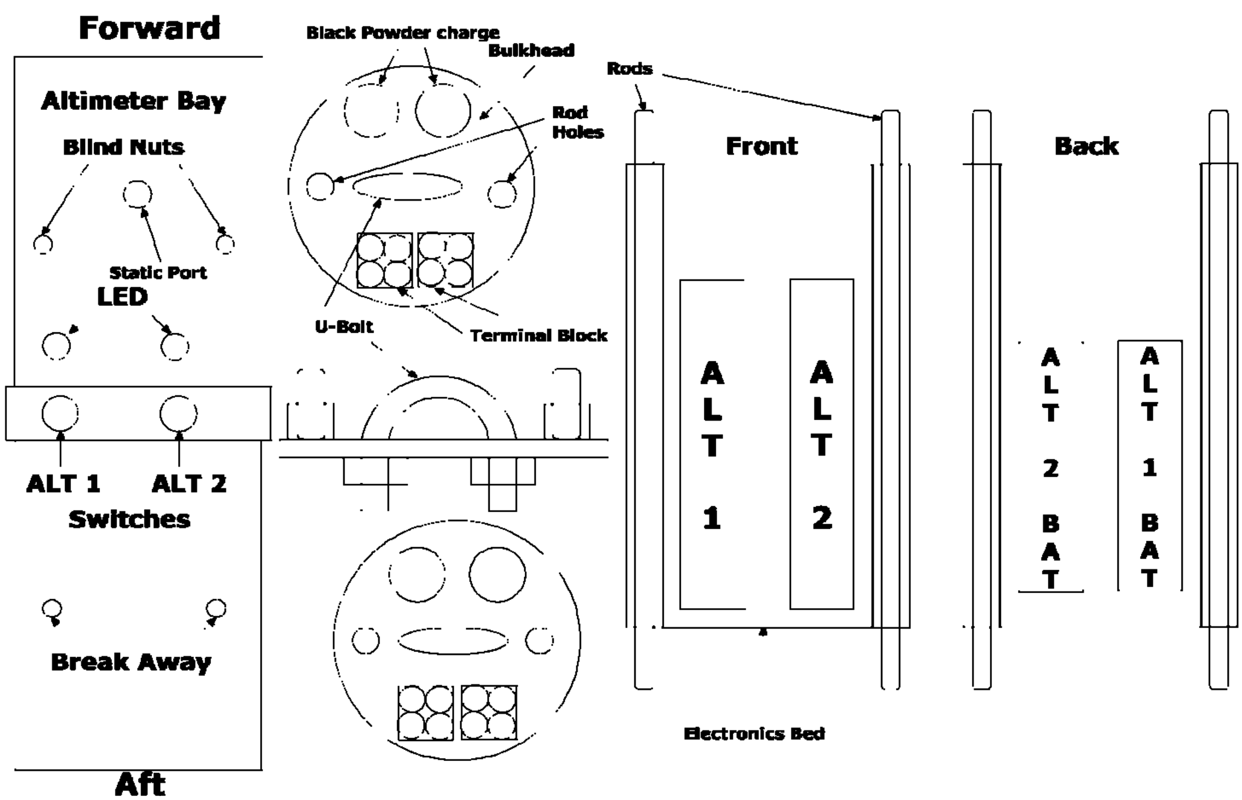
Our center of gravity is 9 inches in front of the center of pressure. This shows that out fins are not too big or too small to provide optimal stability to the vehicle. The very detailed sanding of the nosecone, airframe, fillets, and fins will allow the air to flow across our rocket very smoothly, creating minimal turbulence.

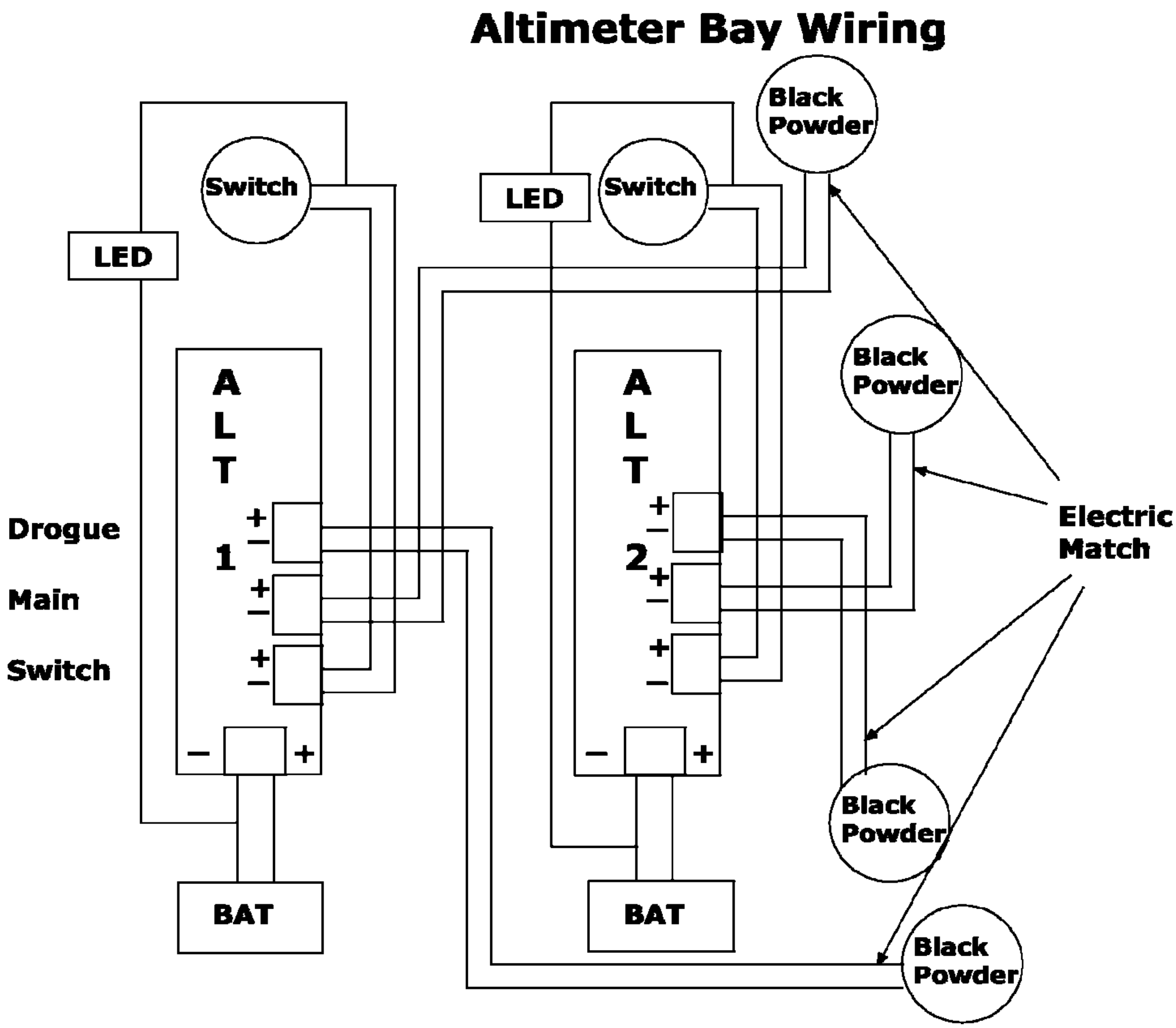
Due to the extreme weather conditions that the northeast has received recently there have been six scheduled launches that were postponed to the following weekend over and over again. We will be launching our scale and full size vehicles on March 20th and 21st with and without our payload

Possible Failure:	Cause:	Effect:	Risk Mitigations:
Motor fails to fire	Improper position of ignition wires	Motor does not launch	Follow proper safety guidelines for time till approach and motor safety
Pre-Mature separation	Change in pressure expands,	Parachutes come out early and reduce max height	Break-always are used, vent holes drill to handle the change in pressure, and proper setup of altimeter malfunction
No Parachutes eject-Lawn Dart	Altimeter fails, rocket does not separate	Total annihilation of vehicle	Use minimal diameter breakaways
Delayed separation	Black powder charge was not sufficient enough to completely separate the rocket	The rocket could hit the ground with velocity that expected	Perform static tests to make sure that the vehicle separates at the time that that event should occur

Recovery Subsystem

Our rocket will contain a 24 inch Skyangle CERT-3 drogue (6.3 sq. ft.) as the drogue parachute and a Skyangle Classic-II 60 (39.3 sq. ft.) parachute as our main cute. Each flight computer is connected to both the drogue and the main parachutes. A single electronic charge will be sent from each computer to an independent black powder charge to eject each parachute. Each charge will have 4grams of black powder. Both computers are connected to a black powder crucible on both parachutes for redundancy in case of malfunction (4 crucibles in total). We no longer are using a piston due to concerns about the piston binding in the airframe and prohibiting the ejection of the parachutes. We based this decision on advice from several very experienced individuals. We have added more and larger Nomex sleeves to protect our rocket; we feel it will be sufficient. Additionally, our team has acquired an amateur radio certification (call sign KF3FRK). This allows our team to find our rocket using the Big Red Bee GPS which utilizes VHF radio frequencies that transmit the rockets current GPS coordinates. We have a Yaesu Vx-8R handheld transceiver with GPS antenna to receive the transmissions. We also have a backup transmitter. This sends an audio beacon that we can track with a Yagi antenna which attaches to our transceiver. Although we have a redundant system and both parachutes should eject, we will establish a 200 ft. safety perimeter. If one of the parachutes does not eject and the rocket begins to free fall towards Earth, we will quickly escort all spectators to an area away from the probable landing location to ensure that no one is hit by our rocket.



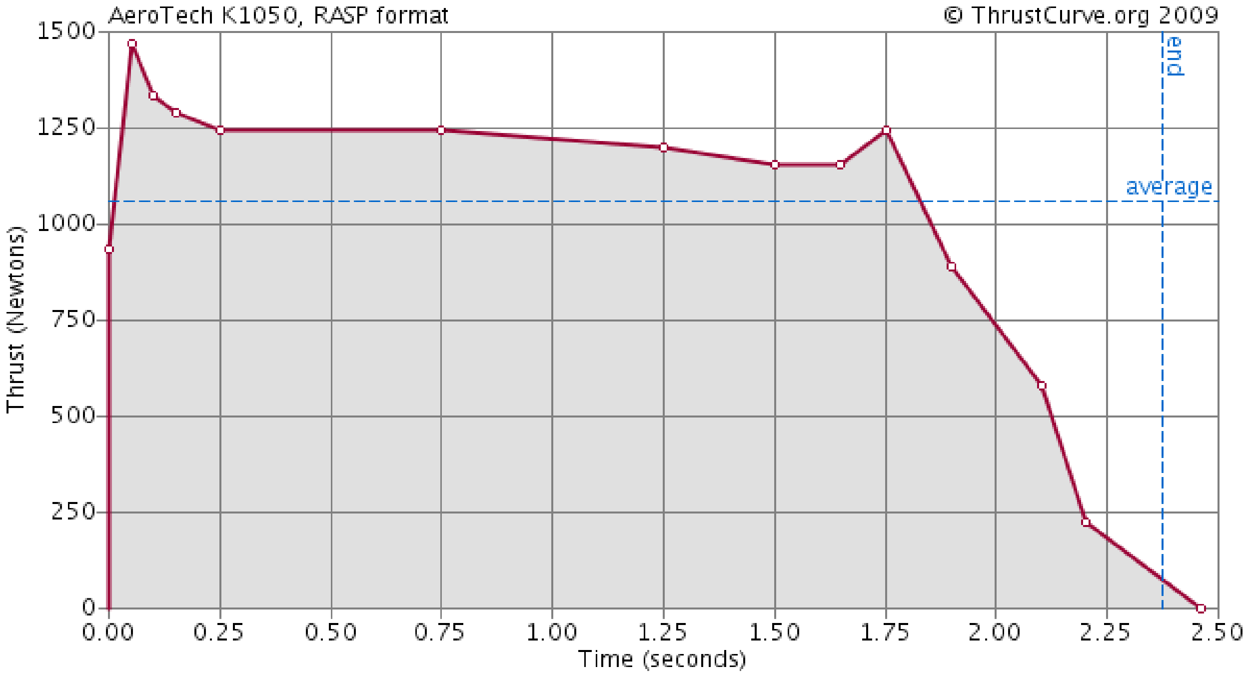


Mission Performance Predictions

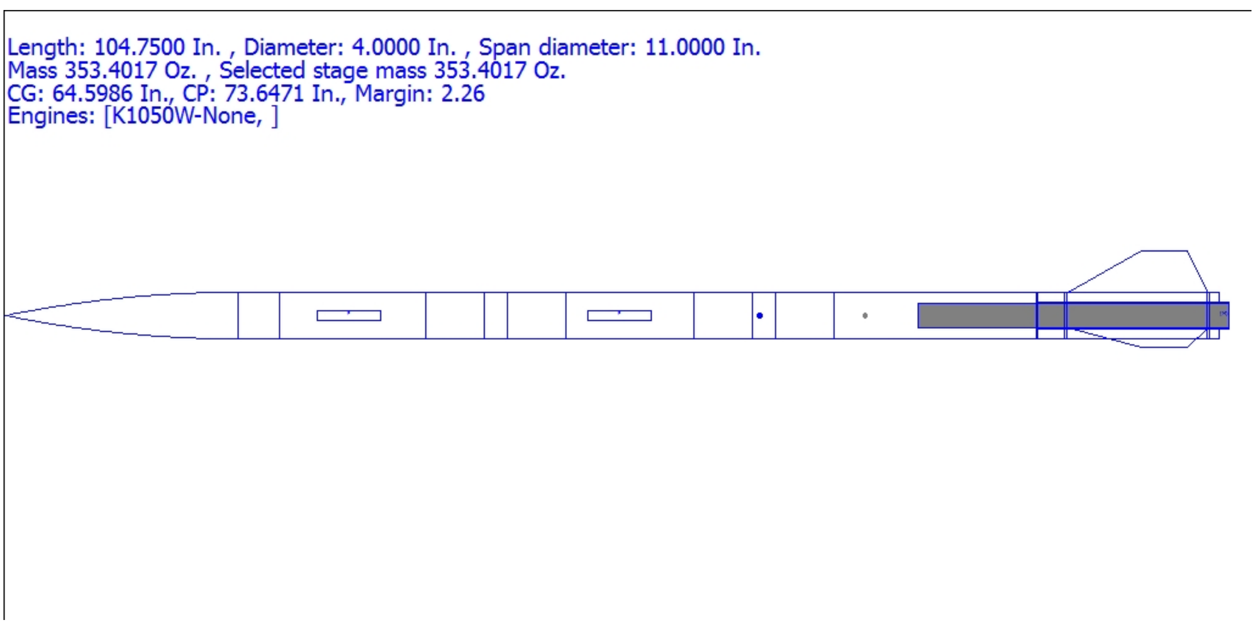
We will be launching our rocket one mile high in order to measure UVA and UVB radiation waves. During the launch we will be measuring the UV waves and comparing them to the rockets altitude; we will also be taking a control sample at ground level to compare to the sensors in our rocket. The hypothesis of our project mirrors some scientific research that suggests that as altitude increases, UV levels also increase. One of the major thoughts of the scientific community that leads to our prediction is that as you increase in altitude, the atmosphere thins, especially at very high altitudes. Due to the thinned atmosphere, Ultra Violet waves have fewer molecules that would scatter or block them. Supporting our prediction, NSF Polar Programs Monitoring Network explains more in depth how Ultraviolet Radiation interacts with our atmosphere, and our planet. "The amounts of UV one is exposed to also vary with altitude. As a rule of thumb, UV levels increase about 4% for every 1,000 foot gain in altitude. This increase has nothing to do with being closer to the sun—any elevation you might gain would be minuscule in comparison to the distance from the earth to the sun, and so would have an insignificant outcome on UV levels. Instead, the increase is the result of a thinner atmosphere with a smaller number of molecules being present to absorb or scatter UV. Examples of such molecules are tropospheric ozone (commonly associated with smog) and aerosols, molecules that remain suspended in the air. Aerosols can be a multitude of substances—dust, soot, sulfates, etc. These aerosols absorb and scatter UV rays, and so cut down on the ultimate UV irradiance." Besides successfully collecting data for our scientific experiment, our team's most important goal is safely launching and retrieving our high powered rocket. Mohamed M., our safety officer, while working with other members of our team, has made major changes since our Preliminary Design Review and Critical Design Review to build redundancy into our rocket. Redundancy ensures that if one particular part of the rocket fails, another separate part would carry out the function as a backup. This will ensure that our rocket will achieve the predicted height and will land safely.

Motor information -
Manufacturer: Aerotech
Entered: Jan 3, 2009
Last Updated: Jan 3, 2009
Mfr. Designation: K1050W-P
Brand Name: K1050W
Common Name: K1050
Motor Type: reload
Diameter: 54.0mm
Length: 62.7cm
Total Weight: 2203g
Prop. Weight: 1265g
Cert. Org.: Tripoli Rocketry Association, Inc. Cert.
Designation: K1132 (89%)
Cert. Date: May 17, 2008
Cert. End: Jun 30, 2013
Average Thrust: 1132.9N
Maximum Thrust: 2172.0N
Total impulse: 2426.4Ns
Burn Time: 2.1s
Case Info: RMS-54/2800
Propellant Info: White Lightning

Thrust Motor Curve -



Our Estimated height is between 4900ft and 5500ft depending on the actual coefficient of drag. We will have a better idea after the March 20th and 21st launches.



Length: 104.75 in.
Diameter: 4 in.
Total Mass: 353.4017 oz.
Center of Gravity: 64.5986 in. from aft
Center of Pressure: 73.6471 in. from aft
Stability Margin: 2.26

Safety and Environment (Vehicle)

- The safety officer for out rocketry team is Mohammed M.
- Some of the problems that may occur while we are building the rocket are:
    - Black powder can spill. In such situations, water will be poured over the black powder to neutralize it then it will be removed and dispensed of properly.
    - Powder may be blown into someone's eye. In such situations an eye rinse will be kept accessible for the person to quickly rinse out his eye.
    - Order a container to handle the black powder without interacting with the powder.
- The different PPE that will be used while handling hazardous material include; protective goggles, latex gloves, hearing protection, as well as dust masks depending on which is required. All persons not involved with handling these hazardous materials will be asked to stay clear of all material as well as keep a minimum of a 15 ft. radius perimeter will be maintained while the material is being handled. This is to insure the maximum amount of safety possible.

IV. Payload Criteria

Experiment Concept

Creativity and Originality
- Testing the UV radiation levels at different altitudes.
- Question for our experiment: Does UV Radiation significantly increases at higher altitudes?

Uniqueness or significance
- Two TOCON sensors and amplifiers mounted 45 degrees facing up in opposite directions.
- For the exposure of sunlight, we drilled holes in the coupler of the payload bay and installed the sensors into the holes so that they protrude from the holes.
- Placed sealed bulk head above the motor mount to prevent from extreme heat (we will be performing a test on our scale model using the thermometer to verify that the temperature is not an issue and then deciding whether to take this action).
- Utilize UV light to determine if our sensors are calibrated.
- Operate a third UV sensor on the ground to find accurate and precise control data for comparison to our experimental data.

Suitable level of challenge
We believe that this was a challenging project because of the following items:
- Finding the sensors that read UVA and UVB wavelengths accurately and precisely was difficult and expensive.

- Our project required several subsystems to work together.
- Building a rocket that will survive these high levels of stress and protect our expensive and sensitive data collection hardware was difficult and required a lot of planning and engineering.

Science Value

Our scientific experiment is one that will display results that many people might actually pay attention to. After our rocket launches it will begin taking radiation samples to test the atmosphere for UVA and UVB radiation. Our hypothesis is that people who spend time or live at higher altitudes than the average person are more likely to acquire ultraviolet radiation related skin disorders or forms of cancer.

In order to obtain these samples of data we have in our payload, two TOCON standard radiation sensors which are capable of reading both types of radiation simultaneously. We also have a data logger which will record the data and allow us to download it directly onto a laptop or palm pilot. This allows us to simply plug the data-logger into a laptop or transfer the data wirelessly via Bluetooth. These radiation sensors will be taking and recording a data point once every second from the point at which it is turned on. The data logger itself has a total of 32,220 data points which will be able to support readings for over 9 hours after activation.

When thought about, it is quite apparent that most of the data entries will occur during the descent of the rocket. So in order to obtain an accurate reading, we have concluded that angling the sensors in the rocket at a 45 degree angle will be the most efficient way to position them without being affected by the parachute. In order to compare our results properly, we will have a control sensor of the same model, on the ground. The control sensor on the ground will be fixed in the same general direction as those in the rocket and will be fixed to an identical data logger. This will show us and allow us to compare the results of the sensors in the rocket to those that are found on the ground so we can therefore conclude how much of a risk of UV exposure there is when living at higher altitudes.

According to the American Cancer Society, the sun is the most common source of Ultraviolet radiation and direct exposure to the sun is the leading cause of skin related cancers. The most common form of skin cancers, Basal Cell and Squamous Cell cancers, are found on parts of the body which are commonly exposed to the sun. On the other hand, Melanoma, a potentially fatal type of skin cancer, does not require as much sun exposure and can also form on any part of the body.

<u>Ultraviolet wave lengths for UVA and UVB</u>
UVA rays are involved in the aging of cells and produce some damage to DNA.
UVB rays are in the wavelength range mainly responsible for direct damage to DNA, and are thought to cause most skin cancers. We do not believe that many people are aware that the altitude they are at may affect their chances being harmed by UV

radiation. Hopefully, if our hypothesis is correct, the data we retrieve will enable us to inform those whom are not aware of their risk and allow them to take appropriate precautions.

Experiment Design of Payload

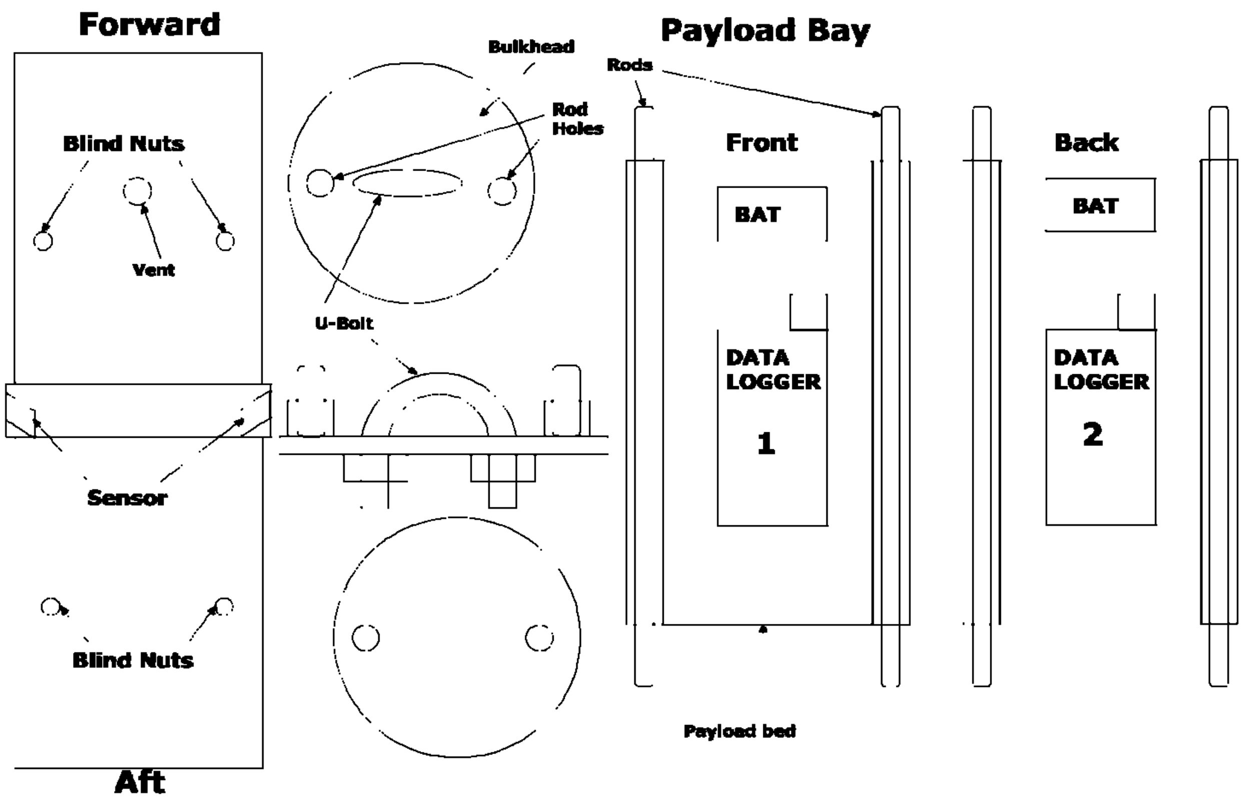
The scientific payload is constructed of 12 inch long, 3.9 inch diameter fiberglass tubing. The scientific payload, along with the avionics bay, are coupling payloads which means that a strip of 4 inch diameter tubing is glued onto payload leaving it exposed when the two pieces of airframe are put together. In order to protect instruments inside of the payload, two fiberglass bulkheads that consist of a circular piece of fiberglass that is 3.9 inches in diameter, glued to a second disc with a slightly less diameter will lock in place and provide a snug fit. To ensure the quality of the seal, and to add to the ease of accessibility, we have JB-welded the aft bulkhead permanently in place. Along with sealing the bulkhead, we have also used Loctite on the bolts holding the two all-thread rods in place in the aft bulkhead. The two all-threads are very important in the design of our payload. They serve as a track for a removable electronics bed and once the fore bulkhead is put in place, a washer and wing nut will go over the rods and hold the payload together. While collecting information for our scientific experiment, our payload will act as an attachment point for our recovery harness. We have mounted a 5/16 inch stainless steel U-bolt on the fore bulkhead by putting Loctite on the threads and bolts, then applying JB-weld to every point of contact between the U-bolt and bulkhead. This procedure is followed for each U-bolt that will attach to the recovery harness.

Inside of the payload we have provided a medium for our instruments to be mounted on that is easily accessible, but once secured, able to move during flight. This medium is a precisely cut rectangular sheet of fiberglass that fits the width and length of the bay. On one side of the sheet we have epoxied two ten-inch lengths of PVC piping to align with the all-thread rods. The electronics bed is fabricated to fit directly in the center of the payload, requiring the track to be slightly above or below the fiberglass bed. This forced us to place the all-thread rods off-center and to one side of the fiberglass bed. With the PVC piping attached to the fiberglass bed, we have created a flat surface to mount the required materials on that is removable. Although not every instrument will be removable, the ability to remove this bed helped with the installation process and gives us the ability to do a thorough pre-flight inspection.

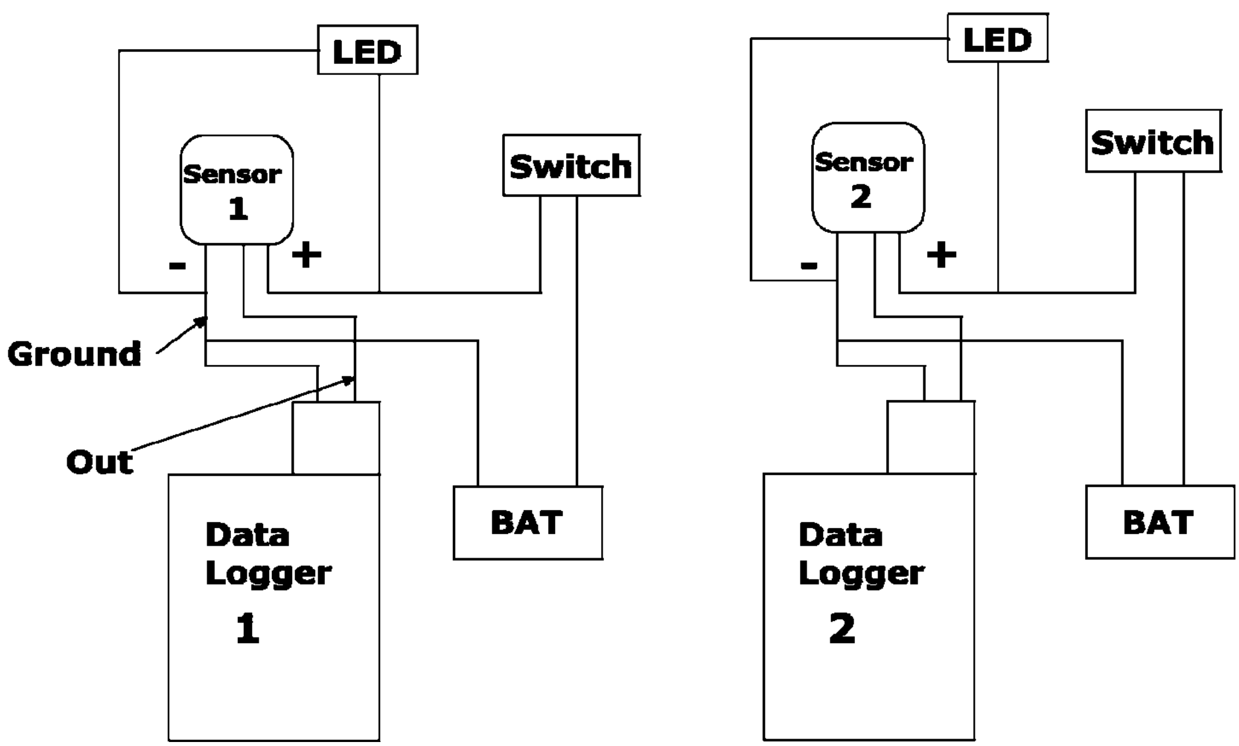
The two-inch coupling band of the payload has also been an effective medium for mounting required hardware. On the band we have our two TOCON UV sensors along with independent switches, LED lights to indicate activation, and female headphone jacks that connect to each data logger. As stated in our previous reports, our goal was to mount each sensor 180 degrees apart at an upward angle of 45 degrees. With the new design we were unable to position the sensors exactly 180 degrees apart but did manage to get the two holes for the sensors drilled at a 45-degree angle. The sensors are about 165 degrees apart. Each sensor is held in place by a layer of epoxy, and then covered with epoxy putty. The epoxy does not cover the surface of the sensor that is used to take readings. After beginning the installation of the sensors, we found that each sensor will slightly protrude from the airframe but should not affect the flight aspects of the rocket more than an external bolt or rail button. Each sensor is independently wired to its own switch, LED light, data logger, and power source. The LED lights will be wired in a parallel circuit for the purpose of guaranteeing that both the LED light and the sensor will receive the required three volts of Direct Current. The data loggers and AA battery packs are mounted on the removable fiberglass bed with enough wire to completely remove the bed without disrupting any of the connections. The data loggers are fastened to the fiberglass pullout by industrial strength Velcro and reinforced with zip ties. This will give us the ability to easily remove the data loggers and connect them to computer if necessary. The AA battery packs will be screwed into place horizontally to eliminate the possibility of the acceleration compressing the spring and breaking the connection of the battery.

Before constructing the payload, we wired all three sensors to a data logger, battery pack, and a switch to test the calibration of the sensors. We wanted to ensure that during our testing each sensor was exposed to the same amount of light to properly test the calibration. The easiest way to do this was by building a small wooden rig to hold each sensor at the same plane. During our testing we used several different types of lights to test the calibration and range of view. An example of one of our tests is taking a black light and running it over the sensors at a distance of a half-inch. Then, we would proceed by passing the light over all three sensors at receding distances. From this we could gather its optimal reading range, discrepancy between sensors, or any flaws with activating and deactivating the data loggers. After our testing we compared our data on the software provided by Omega and found that each sensor was operating properly and little variation between each reading.

Unfortunately at this point we have not had the ability to run a test a flight for our full size or scale rocket. We have had six previous launch dates cancelled due to foul weather conditions. On March 20th and 21st, we have launches available to us in two different locations. On these launches we will be flying our rocket with the payload to collect our first set of data. Preparing the scientific payload for flight is actually extremely easy. All that is required is initiating the two data loggers with our palm pilot and flipping the switches to allow power to the sensors. Although this sounds very easy we will also be doing a thorough inspection of the wiring connections and the quality of mounting of each installed part.



Payload Bay Wiring



<u>Assembly</u>

1. Fold and roll main & drogue parachutes.
2. Insert 2 24in Nomex sleeves around parachutes.
3. Connect quick links to U-bolts to connect shock cord.
4. Insert GPS and transmitter into nose cone and seal the compartment.
5. Insert main parachute into the top section of the rocket.
6. Attach nose cone using 2 break away screws.
7. Put in screws to fore part of the avionics bay section.
8. Screw fore part of the avionics bay into the body tube.
9. Insert drogue parachute into the main section of the rocket.
10. Screw fore portions of the payload bay to the middle section of the rocket.
11. Pack engine into motor casing.
12. Insert motor casing into aft bay of the rocket without inserting the igniter.
13. Screw aft portion of payload bay to the bottom end of the rocket.
14. Attach top part of rocket to the rest of rocket using break away screws.
15. Attach rocket to the launch rod and install the igniter.

<u>Integration and compatibility simplicity</u>

All of our rocket components are designed to be compatible with one another.

<u>Structural integrity for flight</u>

We have tested the structural design of our rocket using RockSim. We have determined that we have a suitable thrust to weight ratio, verified that the speed of the rocket is within a safe range, and that the shock cords are of adequate strength to support the rocket components during descent. The parachutes have been correctly sized and are the proper material needed so they will withstand the forces they will be subjected to. All bulkheads are reinforced and all mounting hardware has been properly sized. We utilize an Aeropack motor retainer mounted to the fiberglass engine tube with J-B weld to hold the motor casing in position during flight.

<u>Quality of Construction</u>

We used quality materials and installed them in approved methods according to the manufacturer's recommendation and followed all applicable codes that are required for High Power Rocket construction. We took great care to ensure that all surfaces are smooth and that all joints are strong so the rocked does not fail during flight.

Safety and Environment (Payload)

- The safety officer for our rocketry team is Mohammed M.
- There are several errors that may occur with us while attempting to launch the rocket:
  - The rocket may not launch, in such cases we will wait two minutes until approaching the rocket.

  - The engine may explode; a 200 ft. perimeter is taken to insure that no harm is done to anyone watching.
  - The parachute may not eject, causing the rocket to free fall and pick up large amount of speed; if this occurs we will relocate all spectators to an area where they are clear of any danger.
- Personal hazards are to be avoided by both wearing the proper equipment (gloves) while dealing with hazardous material such as black powder as well as keeping a safe distance for all persons not involved in the payload.
- We must be careful while launching, due to the high powered motors that may light fire if it is launched in an improper environment. We also must launch the rocket off a relatively flat base due to the fact that an overly tilted surface will cause the rocket to launch in an unpredictable direction which may unfortunately cause harm to others.

V. Launch Operations Procedures

Checklist

Final assembly and launch procedures:

- Set up launch pad, examine rocket for any loose or missing parts.
- Roll and pack both drogue and main parachutes and load them into the rocket.
- Set rocket up on launch rod.
- Activate the GPS unit and backup transmitter.
- Activate payload sensors/data loggers and ground sensor/data logger simultaneously.

Recovery operation:

- Activate flight computers.
- Check Flight computer settings. The drogue will be set for apogee and the main charge will be set for 600 ft.
- Check that parachutes and shock cords are not tangled and will eject freely.
- Load appropriate amount of black powder into the crucibles.

Motor preparation:

- We will be using Aerotech's official motor preparation instructions.

Igniter installation:

- We will be using Aerotech's official igniter installation instructions. Igniter will be installed on when the rocket is attached to the launch rail and aimed in the air.

Setup on launch pad

- Load rocket on launch rail.
- Activate all of the switches to power on all computers, sensors, and data loggers.
- Connect the launch controller and check for continuity.
- Remove all personnel and flammable materials from the 200 ft. safety zone.
- Receive permission to launch from Range Safety Officer.
- Initiate launch countdown.

Troubleshooting

What if altimeter does not power up?

- Check battery and/or replace battery.

If motor does not activate?

- Check/replace igniter.
- Check connection to launch battery and controller.

What if rocket is bound up on the launch rail?

- Examine rail and rail buttons for irregularities.

What if black powder charges do not activate?

- Replace electronic matches.
- Check for wet black powder.

What if GPS does not activate?

- Check/replace battery.

What if Data loggers do not power up?

- Check and charge internal batteries.

Post flight inspection:

- examining data collected from sensors on rocket,
- compare to ground sensors to check for a difference,
- check for frayed shock cord, damaged fins, melted parachutes, altimeter failure, unaligned or damaged sensors on both rocket and ground

Safety and Quality Assurance

Following the Launch Operations Procedures checklist will help our rocket fly safely and mitigate the chances of a bystander being injured by a rouge rocket or rocket piece. The whole team will be helping to prepare the rocket and inspect for any problems but Mohammed M. will be overseeing that all safety precautions taken. We will be abiding by all Tripoli and NAR high power regulations. We will launch only when our rocket has passed the Range Inspector and we have been cleared to launch by the Range Safety Officer. By following all regulations, we will minimize the chance of any injuries to spectators, the environment, or ourselves.

VI. Activity Plan

Status of Activities and Schedule

Budget				
Payload				
UV Sensors	TOCON Standard	3	164	492
Data loggers	Omega	3	199	597
Software	Omega	1	119	119
Shipping		1	28	28
Subtotal				1236
Scale model				
Barrel Swivels	1000 lb. test	2	6	12
Aeropack Retainer Assembly	38 mm	1	29	29
Small Rail Buttons		1	5	5
Shock Cord (per yd.)	1/8 inch Kevlar	7	1.25	8.75
Drogue Shoot	LP-14	1	10.45	10.45
Redline 'J' engine	Aerotech J420R	1	49.99	49.99
Engine Casing	38-720	1	119	119
Main Parachute	Classic II 28	1	33	33
Shipping		1	64	64
Modified Little Dog Kit		1	85	85
Various Hardware (epoxy, etc.)		1	130	130
subtotal				546.19
Full scale rocket				
Nosecone		1	38	38

Airframe tubes	4 inch	3	80	240
Fin sheets	3/16 inch	3	28	84
Motor tube	54 mm	1	28	28
Centering rings	4 inch to 54mm	4	7	28
Aeropack ring	54mm	1	34.99	34.99
Shock cord (per yard)		12	1.5	18
Main parachute	Classic II 52	1	85.5	85.5
Drogue parachute	15 inch Nylon	1	11.5	11.5
Large rail buttons	80/20	2	5	10
Payload/avionics bays	BRD-50 Loc Prec.	2	32	64
Various Hardware		1	125	125
GPS unit	Big Red Bee	1	299	299
Flight Computers	Mini Alt WD+	2	0	0
RockSim	Apogee	1	164	164
Barrel swivels	1000 lb. test	2	6	12
Shipping		1	150	150
Wood Bulkhead		5	3.5	17.5
Pistons		2	24	48
Motor casing	54-1706	1	179	179
Motors	K550W	1	104.99	104.99
Motors	K1050W	4	159.99	209.98
Motor casing	K1050W	1	159.99	209.98
SS quick links		8	4	209.98
Subtotal				2372.42
Travel				
Airfare		11	297	3267
Hotel		15	100	1500
Rental vehicle		0	0	0
Meals		198	10	1980
Gas		0	0	0
Subtotal				6342

Total Cost of Project				10900.61

Timeline

Third Week:

- Review FRR final draft and prepare for FRR presentation.
- Finalize Flight Readiness Review (FRR) due March 17th.
- Update our current status in production.

March 20th and 21st

- Several launches of Scale model and Full size rocket.

April:

Get ready for SLI Trip.

First Week:

- Modify payload or avionics if necessary.
- FRR Presentation (tentative).
- Update our current status in production.
- Long weekend 4/1/10-4/4/10 Easter break.

Second Week:

- Travel to Huntsville.
- Rocket fair/hardware and safety check.
- Update our current status in production.

Third Week:

- Develop final launch procedures and test fly rocket.
- Update our current status in production.
- Results from flight and make modifications to payload or avionics if necessary.

Fourth week:

- Work on final report.
- Update our current status in production.

May:

All month:

- Work on and finish Post-launch Assessment Review (PLAR) Due May 21st

Educational Engagement

We will be travelling to several local schools to give a presentation about the Phelps Rocketry program. Three team members and our Technical Adviser will be giving the presentation. We will begin by showing a Power Point presentation that utilizes NASA footage of the Apollo 11 launch and moon landing as well as a night launch of the Space Shuttle, and the Ares I test launch. Following the presentation, we will speak about the

Team America Rocket Competition and the Student Launch Initiative. We will then show the students several of our rockets and explain the key components and features of the rockets. Additionally we will be discussing rocket and launch site procedures before we take the students outside and launch a sample Estes Beta rocket flying on an Estes A8-3 motor. We chose to only fly this small rocket due to the small flight area and liability concerns.

We currently have 4 schools signed up for presentations. We will be visiting the following:
Strafford Friends School – 38 students
Lower Merion School District – 57 students
Malvern Preparatory School – 45 students
Centerville School District – 42 students

We are continuing to contact several other schools and hope to visit a few additional schools. We currently will be presenting to 182 students and expect to be around 300 by the end of the project.

VII. Conclusion

We have been dealt a difficult hand by Mother Nature. We've had, as of the date of this report, 6 launches cancelled due to snow storms, torrential downpours, or mud. The frustration that we've felt has been enormous. We have continually readied our rocket for launch weekends and not been able to complete the launches. We are very certain that we will be able to launch on at least one of the days this upcoming weekend, March 20th to 21st.

We have altered the design of our rocket and motor to better our chances of launching a rocket that will successfully launch our scientific payload exactly 1 mile above ground level and record the UV levels at a rate of 1 sample per second on the way up and down. We feel that the current configuration of our rocket represents the best possible configuration to achieve our goals. We look forward to attending SLI in April and showing off our rocket and experiment. In addition, this experiment may prove to be extremely useful in helping people avoid skin cancer and other UV related diseases.