National Aeronautics
and
Space Administration

Marshall Space Flight Center: Student Launch Initiative Program

Student Launch Initiative 2010 Preliminary Design Review:

Measurement of UV Radiation Changes at Varying Altitudes

The Phelps School

December 4th, 2009

Student Project Leader: Chris D.

Student Project Co-Leader: Sang Yoon L.

December 5th, 2009

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Reference: NASA Student Launch Initiative

Dear Mrs. Clift and Mr. Krause:
The Phelps School is pleased to submit its Preliminary Design 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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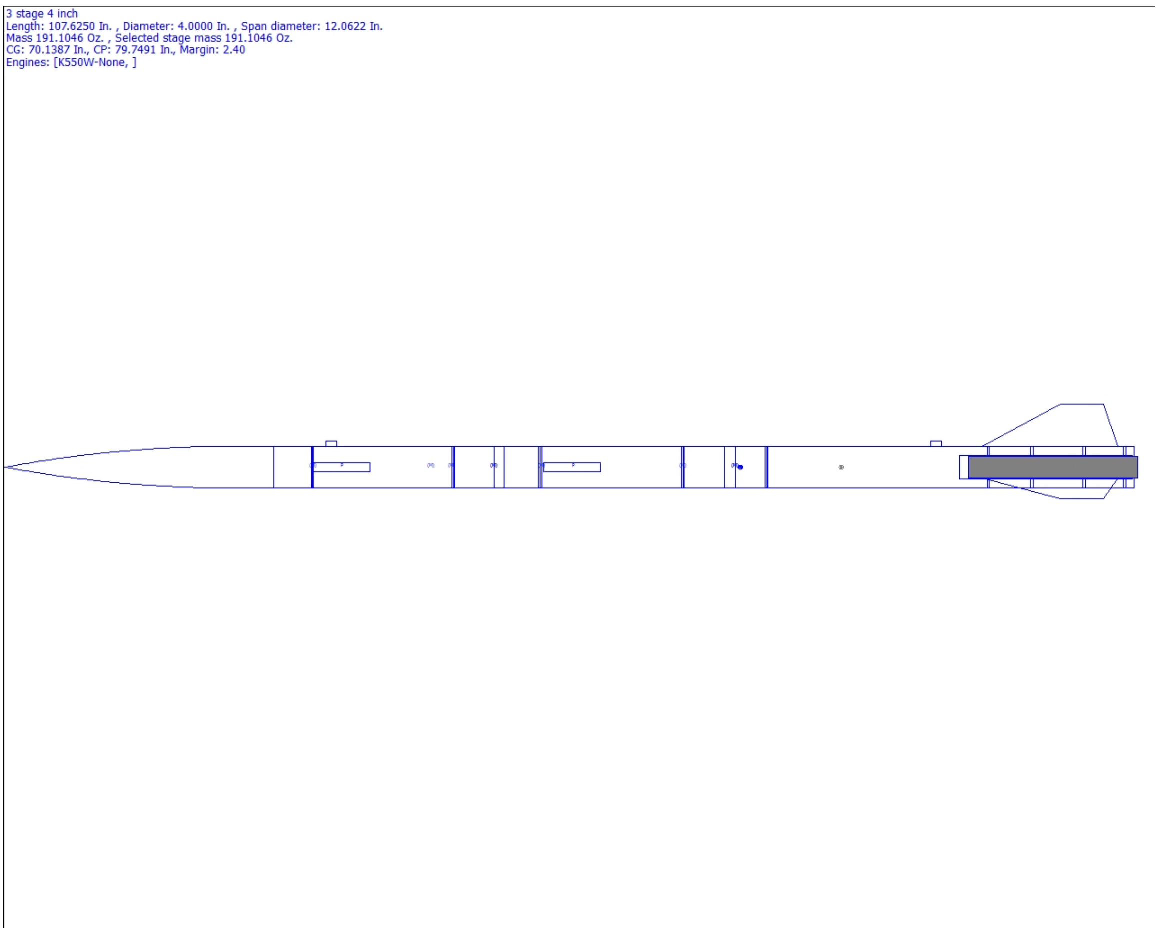
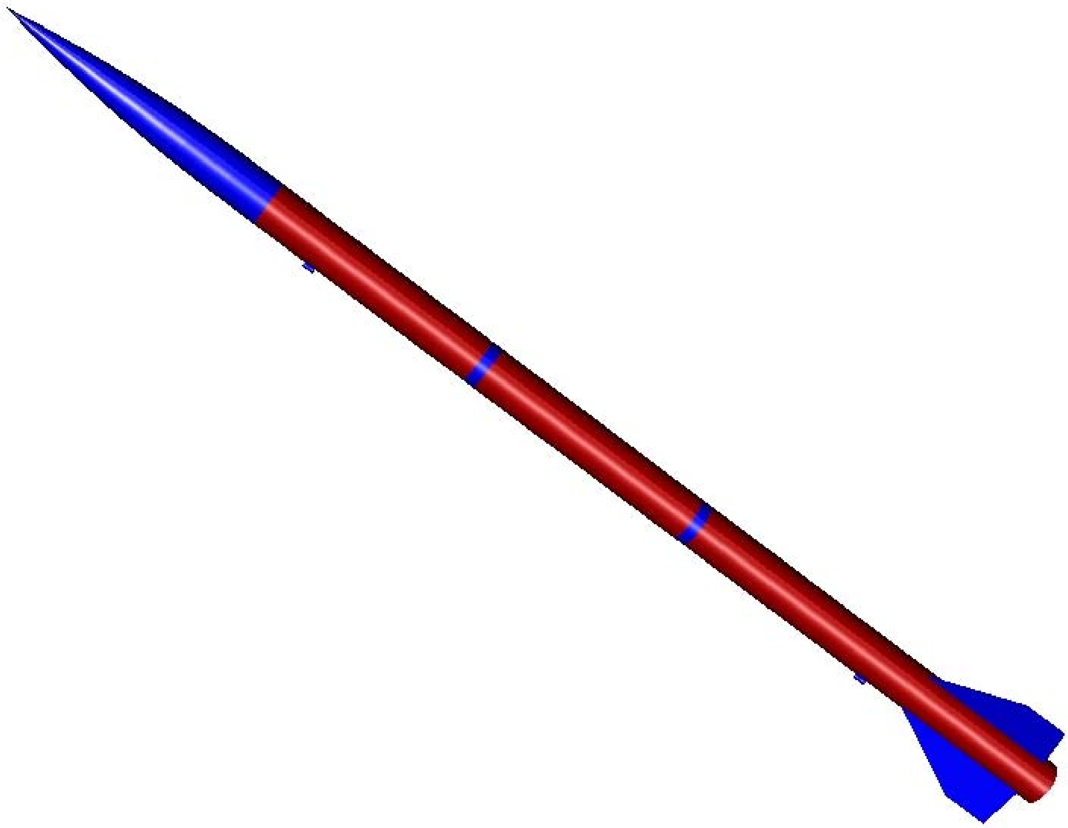
I. Summary of PDR report

The Launch Vehicle will be constructed of a 4 inch airframe and will be 108 inches in length. It will weigh approximately 238 ounces. The proposed engine is an Aerotech K550W. The recovery system will be activated by redundant Perfectflite Minialt/WD+ flight computers. The Skyangle Cert3 drogue parachute will deploy at apogee. The Skyangle Cert3-L main parachute will be deployed on the way down when the rocket reaches an altitude of 600 ft.





The payload will consist of 2 Data Harvest No. 3227 UV probes attached to a Data Harvest Easysense Advanced datalogger. The probes will be mounted perpendicular to the rocket and facing opposite directions in relation to each other. The sensors will continually measure the UV radiation outside of the rocket. The data points will be recorded by the datalogger. An identical setup consisting of 2 sensors and a datalogger will be located on the ground and will take concurrent ground level UV radiation levels.

II. Changes made since Proposal

The most important change made since the initial proposal was the dimensions of the rocket. We originally proposed to build a 13ft long rocket which consisted of a 6 inch airframe transitioning down to a 4 inch airframe towards the forward end of the rocket. We were concerned about additional drag created by the transition negatively affecting our rocket's performance. This change also reduced the overall mass of the rocket. Additionally, we determined that we needed to move to improve our thrust to weight ration with regard to the motor. We chose a motor with a higher average thrust that will safely lift our heavy rocket.

Our design is a scaled-up version of the Little Dog rocket. We chose this design because it is a proven design and is economically advantageous. We will be able to use a modified Little Dog kit to build our scale model, which will be a ½ scale model of our proposed design. We will be using the scale model to certify team members for their NAR High Power Level 2 certification.

III. Vehicle Criteria

Being a part of the Student Launch Initiative is an honor for The Phelps School Rocketry Team. Operating under the requirements of the program will challenge us to work as a team in order to accomplish the goals of the mission. The main goal of our team is to safely and successfully launch a rocket one mile in the air and execute a scientific experiment. Using RockSim, we have created and tested multiple rockets to achieve our experiment's altitude requirements taking into consideration our scientific payload criteria as well. The scientific experiment portion of our rocket will be to test UV Radiation levels at varies altitudes. Once the rocket is retrieved, we will compare our UV flight readings to our control UV readings which will be taken at ground level concurrently with the launch of our rocket. We will be able to answer our experimental question: Does Ultra Violet radiation significantly increase at higher altitudes?

Our rocket’s performance is dependent on several subsystems working together to provided a safe and productive launch. The Recovery system is extremely important relative to safety. We will have a dual-deployment and redundant recovery system to bring our rocket to the ground safely. The drogue parachute will be ejected from the rocket at apogee. This will be activated by a pair of Perfectflite altimeters which will ignite a black powder charge to eject the parachute. The drogue parachute has a surface area of 6.3 square feet and will be attached to the rocket between the payload and the avionics bays. The main parachute will be deployed at 600 feet. The onboard flight altimeters will monitor the altitude and ignite a second black powder charge to release the main parachute. The main parachute will have a surface area of 57 square feet and will bring the rocket down at a safe pace. It will be positioned above the avionics bay in the area between the bay and the nose cone. On either side of each break in the rocket, there will be a removable bulkhead to secure the shock chord.

The avionics bay will be a prefabricated bay manufactured by LOC Performance. When assembled, both ends will completely seal the bay from all gasses produced by the black powder charge. A properly sized static port will be drilled into the avionics bay to allow the altimeters to correctly sense pressure changes. The bay will be 8 inches long with a 3.9 inch diameter to ensure a tight fit and no movement during flight. In the bay, we will install a sheet of G10 Fiberglass, creating two equal halves which will give room to mount all necessary instruments. Redundant altimeters will insure that our parachutes will eject even if one altimeter fails. Both altimeters will be wired to a terminal mounted externally on each end of the bay. From the terminals the wires will lead to a crucible. Inside the crucible will be an electronic match to ignite the black powder charge. Each electronic match will be powered by the altimeter which has a 9 volt power source. On one side of the board, below the flight computer, we will install our Big Red Bee GPS. The GPS has its own battery and will not be attached to the altimeters' power source. The avionics bay will be in the middle section of the rocket aft of the main parachute. Aft of the avionics bay will be the drogue parachute. The Rocket will split both above and below to release the parachutes.

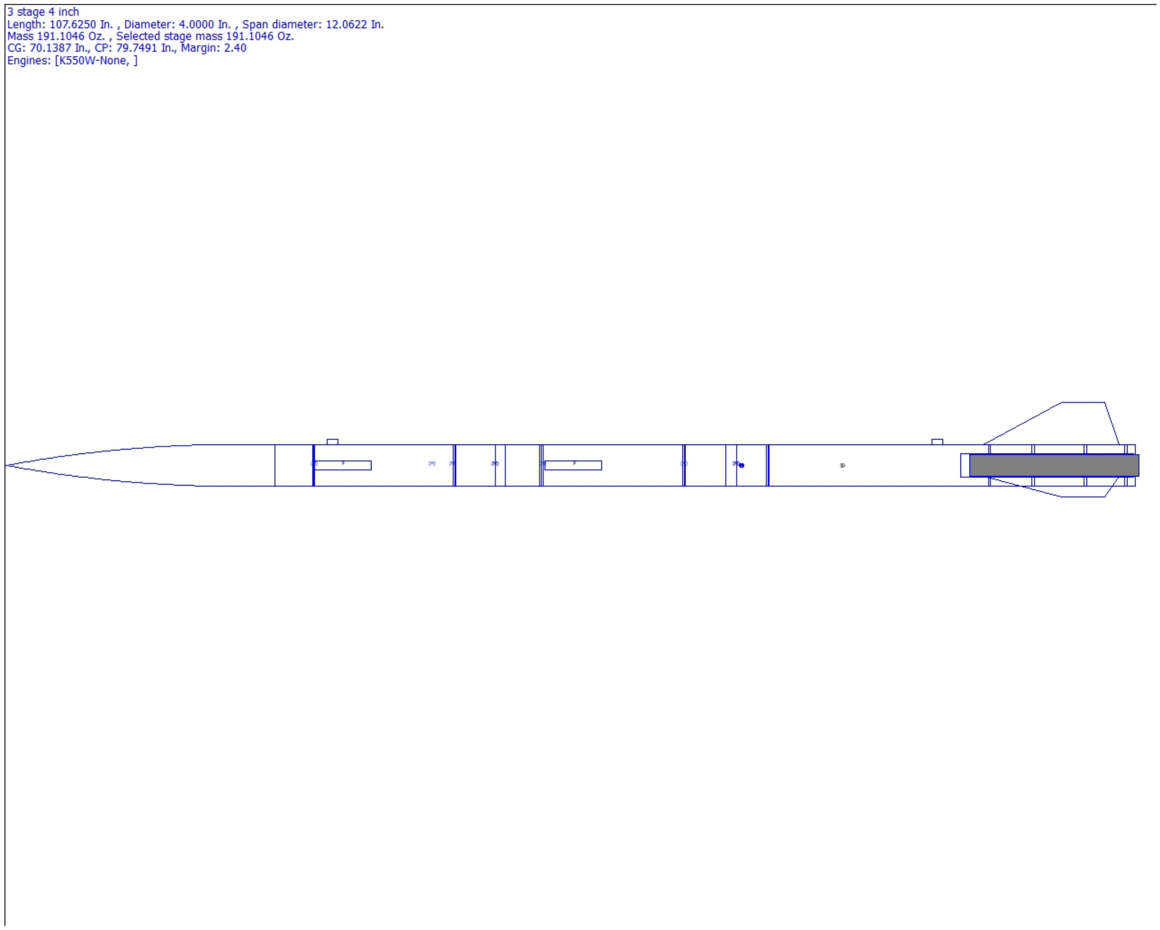
Below the drogue parachute, in the bottom section of the rocket, is where we will house the scientific payload. The bay itself will have the same physical design as the avionics bay minus the crucibles and terminals. The reason we have picked the bottom section of the rocket for the scientific payload is the fact that this section will remain almost vertical the entire flight. This will help with getting accurate data from one plane. Inside the scientific payload we will have two Data Harvest sensors, one mounted on each side horizontally facing opposite directions. The two sensors will be connected to a data logger. The sensors will need exposure to sunlight to collect data; therefore holes will have to be drilled in the frame of the rocket to align with the sensor. We will protect our payload from exhaust heat by putting a sealed bulk head above the motor mount, spraying foam insulation inside and then sealing the top with another bulk head. This will keep the extreme heat away from our instruments and protect our payload.

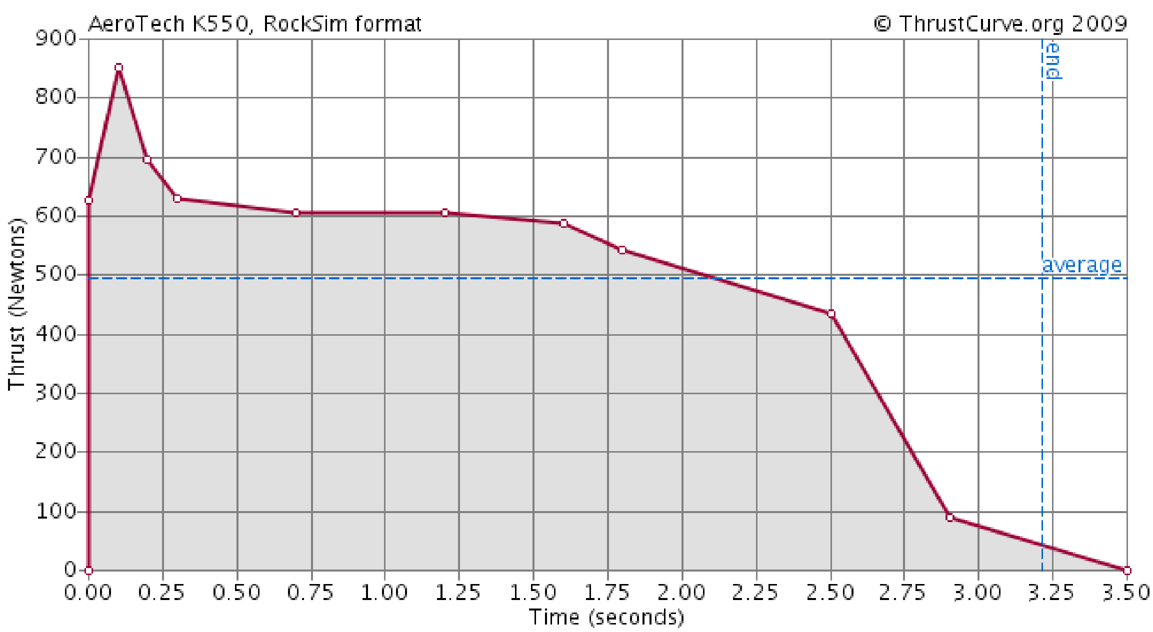
The accuracy and calibration of the sensors must be faultless to ensure that our final conclusion has a sound justification. To test and calibrate our sensors, we have bought UV emitting light bulbs that will give a constant output of UV radiation. Fortunately, the sensors will come pre-calibrated but having the UV lights will give us good verification that our sensors are working properly.

To effectively prove that UV levels are higher above the grounds surface, UV levels must be tested from the ground. During our flight, a ground team will be operating a UV sensor to collect our control data. If we were to compare our flight data to ground data that was taken prior to launch, we would still be able to show the difference but it would not give us an accurate comparison. If weather conditions during flight are sunny and humid, and the weather conditions during our ground data collection are overcast, this would give us an inaccurate comparison. We feel as if our plan to collect data during flight both in air and on ground is the most effective way to find differences in UV radiation levels.

Mission Performance Predictions

Below is a graph of our predicted Acceleration, Velocity, and Altitude versus time. We have also included a RockSim profile listing the Center of Gravity, Stability Margin, and Center of Pressure in the upper left corner.


3 stage 4 inch
Length: 107.6250 In. , Diameter: 4.0000 In. , Span diameter: 12.0622 In.
Mass 191.1046 Oz. , Selected stage mass 191.1046 Oz.
CG: 70.1387 In., CP: 79.7491 In., Margin: 2.40
Engines: [K550W-None,]


AeroTech K550, RockSim format
© ThrustCurve.org 2009
Thrust (Newtons)
Time (seconds)
end
average
0
100
200
300
400
500
600
700
800
900
0.00
0.25
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3.50

Payload integration:

The science payload will be in a self-contained subsystem that will be activated prior to launch and deactivated after recovery. This subsystem will be located in the section of the airframe that is forward of the motor compartment and aft of the drogue parachute. Inside the subsystem the two sensors will be positioned in opposing directions mounted horizontally and will be recording at the same time. This will give us redundancy. So we will have more sensors to rely on and to collect our data. The prefabricated LOC Precision payload section will allow us to very simply integrate the payload into our rocket design.

Launch Operation Procedures:

- We will use a Heavy Duty 10 foot launch rail from Giant Leap Rocketry in conjunction with a Heavy Duty launch pad from discountrocketry.com.
- There will be a 200 ft. perimeter formed around the launch position. There will be a countdown, beginning with 10 reaching 0. We will have a level two certified assistant to help us launch.
- All onboard electronics will be activated and verified on the launch rail after the motor is installed and connected.
- The launch and flight will be under direct control and supervision of the Range Safety Officer.

Safety and Environment (Vehicle):

- The safety officer for our rocketry team is Mohammed Mohsen
- Some of the accidents that may occur while we are building the rocket are:
    - Black powder can spill: in such situations, first all the black powder will be picked up off the floor with proper equipment and someone wearing latex gloves, the place where the black powder spilled will be mopped.
    - Although goggles will be worn at all times, 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.
- The PPE that will be used while handling hazardous materials include: protective goggles, latex gloves, hearing protection, and dust masks. All persons not involved with handling these hazardous materials will be asked to stay clear of all material as well as keep a minimum distance of a 15 ft away from the material while it is being handled. This is to insure the maximum amount of safety possible.

- The rocket motors will only be assembled and installed by Level 2 certified persons.

VI. Payload Criteria:

We will have a total of four UV sensors and two data loggers during the experiment. Our control for the experiment is composed of one data logger and two sensors on the ground that will start recording simultaneously with the sensors and data logger mounted in the vehicle. So our results have another set of data points that will correlate by time with the data points received from the vehicle.

Selection, Design, and Verification of payload experiment:

- The subsystem that will be made to house the sensors and data logger will be made out of G10 fiberglass and plywood bulkheads; it will fit inside the main air frame and remain vertical for the entire flight.
- We will verify through manufacturer's specifications that the payload and avionics bays will fit properly.
- The accuracy and calibration of the sensors will be key in proving our conclusion is accurate. Therefore, we will use our UV mini lights to test the sensors to ensure that they are working correctly before placing them in the vehicle. We will follow the sensor manufacturer's recommended procedures to calibrate the sensor.
- Due to the very high strength and durability of the payload and vehicle, multiple flights are possible. The recovery system is very safe because it is a dual deploy setup which will help the vehicle to come down to earth slowly.

Science Values

- **Identify the problem-** During the increase of altitude, does the amount of harmful UVA and UVB radiation increase to fatal or potentially harmful levels?
- **Research -** Ultraviolet (UV) radiation is part of the electromagnetic spectrum between x-rays and visible light, comprised of light in the 40-400 nm wavelength range. UV radiation is divided into five different kinds: Vacuum UV (40-190 nm), Far UV (190-220 nm), UVC (220-290 nm), UVB (290-320 nm) and UVA (320-400). Vacuum UV, Far UV, and UVC are mostly absorbed by the atmosphere and do not reach the earth's surface. UVB and UVA are the most common forms of Ultraviolet radiation that people encounter on earth. Overexposure to the small percentage of UV radiation that passes through our atmosphere is not good for our health and can cause serious health problems.

- Skin cancer is the most serious threat that Ultraviolet radiation poses on us. One in five Americans has a form of skin cancer and the numbers are rising. Skin cancer is caused by continual exposure to high levels of UV radiation. If Pilots or Astronauts are exposed to a higher dose of UV radiation, they would be more in more danger of developing Skin Cancer. Cataracts are also an illness due to overexposure to UVB. Cataracts form when the lenses of the eye turn cloudy and lose their transparency. Cataracts will cause vision to become blurry and can lead to permanent blindness. With our data results, we will be able to determine if extra precautions must be taken when traveling to high altitudes. Electromagnetic radiation is a transfer of energy through space via waves of Oscillating electromagnetic fields. What distinguishes the parts of the electromagnetic spectrum is the frequency of the oscillation and consequently the wavelength. The Ultraviolet (UV) radiation band in the electromagnetic spectrum extends from the very short wavelengths of 100 nm, very short wavelengths, to 400 nm wavelengths, which are just above violet light in the visible region of the spectrum (Latin word for beyond is ultra). True ultraviolet light is invisible.
- **Hypothesis-** It is our hypothesis that as altitude increases, the amount of harmful UV radiation also increases.
- **Experiment-** We will have two sensors located in opposite directions mounted horizontally within the rocket. During the launch procedures, we will synchronize the ground sensors and the rocket sensors to log data concurrently. After the launch, we will compare the ground sensors data and the rockets data, determining what increase is present.
- **Conclusion-** Upon conclusion of the experiment, we will be analyzing and comparing the results of the two sensors on the ground to the two sensors in the rocket.
- **Payload success criteria-** Our success would depend on collecting and recovering the UV level data and being able to successfully determine if an increase in UV radiation is present at higher altitudes.
- **Describe experimental logic, approach, and method of investigation-** As people approach higher altitudes, there is more exposure to UV radiation. Our method would to have two sets of sensors taking readings as the rocket is launched, one set being on the rocket to take readings throughout the flight and the other set of sensors are on the ground taking constant readings. Then, we will compare the two sets of readings to see if there is a clear difference in the readings between the sensor sets.
- **Describe test and measurement, variables, and controls**- Measurements of altitude and radiation levels will be taken. Variables- The variable in the experiment is the altitude of the measurement. Controls- The weather, temperature, and time will all be controlled since we are collecting the two sets of data simultaneously.
- **Show relevance of expected measurements and accuracy/ error analysis-** The levels of radiation that we will measure from the rocket's

sensors would be higher than the readings we will get from the sensors located on the ground.

- **Describe preliminary experiment process procedures-** We will be initiating both sets of sensors simultaneously in order to get accurate measurements. They will both be initiated a few moments before launch.

V. Activity Plan

Budget plan and parts list:

Parts List

1. Nose cone LOC Precision - LOC PNC-3.90 - Plastic nose cone, Material: Fiberglass

   Nose shape: Hollow Ogive, Len: 22.0000 In., Dia: 4.0000 In. Wall thickness: 0.1250 In. Body insert: OD: 3.8800 In., Len: 3.7500 In.

   CG: 8.2500 In. , Mass: 5.0000 Oz. Radius of gyration: 0.15936 (m) , 15.936 (cm) Moment of inertia: 0.00359975 (kgm^2) , 35997.5 (gcm^2) , RockSim XN: 10.2390 In. , CNa: 2

2. Body tube LOC/Precision - LOC BT-3.9 - Airframe tube, Material: Fiberglass

   OD: 4.0000 In. , ID: 3.9000 In. , Len: 21.0000 In.

   CG: 10.5000 In. , Mass: 0.9652 Oz. Radius of gyration: 0.158191 (m) , 15.8191 (cm) Moment of inertia: 0.000684716 (kgm^2) , 6847.16 (gcm^2) , RockSim XN: 0.0000 In. , CNa: 0

3. Tube coupler LOC Precision - TC-3.90 - Tube Coupler, Material: Fiberglass

   Tube couplerOD: 3.9000 In., Hole #1: : 97.2820 In. Len: 8.0000 In. Location: 17.2500 In. From the front of Body tube

   CG: 0.0000 In. , Mass: 1.3000 Oz. Radius of gyration: 0.0682357 (m) , 6.82357 (cm) Moment of inertia: 0.000171598 (kgm^2) , 1715.98 (gcm^2)

4. Launch lug Giant Leap - RG - ACME Rail Guide, Material: Polycarbonate

   OD: 0.5000 In., ID: 0.4000 In., Len: 1.0000 In., Loc: 5.0000 In.

   CG: 0.5000 In. , Mass: 0.0490 Oz. Radius of gyration: 0.00839368 (m) , 0.839368 (cm) Moment of inertia: 9.79129e-08 (kgm^2) , 0.979129 (gcm^2)

5. Bulkhead Public Missiles - BP-3.9 - Was BP-06, Material: Birch

BulkheadOD: 3.9000 In., Len: 0.1880 In. Location: 17.0000 In. From the front of Body tube

CG: 0.0940 In. , Mass: 0.8838 Oz. Radius of gyration: 0.0248312 (m) , 2.48312 (cm) Moment of inertia: 1.54485e-05 (kgm^2) , 154.485 (gcm^2)

6. Parachute b2 Rocketry - SkyAngle - Classic 36, Material: 1.3 oz. Ripstop Nylon (SkyAngle)

   1 parachute, Shape: Round Dia: 32.5000 In., Spill hole: 0.0000 In.

   CG: 0.0000 In. , Mass: 6.0000 Oz. Radius of gyration: 0.044434 (m) , 4.4434 (cm) Moment of inertia: 0.000335837 (kgm^2) , 3358.37 (gcm^2)

7. Bulkhead Public Missiles - BP-3.9 - Was BP-06, Material: Birch

   BulkheadOD: 3.9000 In., Len: 0.1880 In. Location: 3.6250 In. From the front of Body tube

   CG: 0.0940 In. , Mass: 0.8838 Oz. Radius of gyration: 0.0248312 (m) , 2.48312 (cm) Moment of inertia: 1.54485e-05 (kgm^2) , 154.485 (gcm^2)

8. Screw Eye Semroc - SE-10 - Screw Eye, Material:

   CG: 0.0000 In. , Mass: 0.0200 Oz. Radius of gyration: 0 (m) , 0 (cm) Moment of inertia: 0 (kgm^2) , 0 (gcm^2)

9. Screw Eye Semroc - SE-10 - Screw Eye, Material:

   CG: 0.0000 In. , Mass: 0.0200 Oz. Radius of gyration: 0 (m) , 0 (cm) Moment of inertia: 0 (kgm^2) , 0 (gcm^2)

10. Shock cord LOC Precision - SC-500 - 1/2 In Elastic shock cord, Material: 1/2 In. flat elastic

    CG: 0.0000 In. , Mass: 0.2000 Oz. Radius of gyration: 0 (m) , 0 (cm) Moment of inertia: 0 (kgm^2) , 0 (gcm^2)

11. Shock cord LOC Precision - SC-500 - 1/2 In Elastic shock cord, Material: 1/2 In. flat elastic

    CG: 0.0000 In. , Mass: 0.2000 Oz. Radius of gyration: 0 (m) , 0 (cm) Moment of inertia: 0 (kgm^2) , 0 (gcm^2)

12. Body tube LOC/Precision - LOC BT-3.9 - Airframe tube, Material: Fiberglass

    OD: 4.0000 In. , ID: 3.9000 In. , Len: 1.0000 In.

CG: 0.5000 In. , Mass: 0.0460 Oz. Radius of gyration: 0.0362655 (m) , 3.62655 (cm) Moment of inertia: 1.71362e-06 (kgm^2) , 17.1362 (gcm^2) , RockSim XN: 0.0000 In. , CNa: 0

13. Body tube LOC/Precision - LOC BT-3.9 - Airframe tube, Material: Fiberglass

    OD: 4.0000 In. , ID: 3.9000 In. , Len: 21.0000 In.

    CG: 10.5000 In. , Mass: 0.9652 Oz. Radius of gyration: 0.158191 (m) , 15.8191 (cm) Moment of inertia: 0.000684716 (kgm^2) , 6847.16 (gcm^2) , RockSim XN: 0.0000 In. , CNa: 0

14. Centering ring Public Missiles - CCR-3.9-2.1 - Was PML CCR-14, Material: Aircraft plywood (Birch)

    Centering ringOD: 3.9000 In., ID: 2.2710 In., Len: 0.2500 In. Location: 46.0000 In. From the front of Body tube

    CG: 0.1250 In. , Mass: 0.8272 Oz. Radius of gyration: 0.0287486 (m) , 2.87486 (cm) Moment of inertia: 1.93811e-05 (kgm^2) , 193.811 (gcm^2)

15. Centering ring Public Missiles - CCR-3.9-2.1 - Was PML CCR-14, Material: Aircraft plywood (Birch)

    Centering ringOD: 3.9000 In., ID: 2.2710 In., Len: 0.2500 In. Location: 59.0000 In. From the front of Body tube

    CG: 0.1250 In. , Mass: 1.2516 Oz. Radius of gyration: 0.0287486 (m) , 2.87486 (cm) Moment of inertia: 2.93245e-05 (kgm^2) , 293.245 (gcm^2)

16. Centering ring Public Missiles - CR-3.9-2.1 - Was PML CR-14, Material: Aircraft plywood (Birch)

    Centering ringOD: 3.9000 In., ID: 2.2710 In., Len: 0.2500 In. Location: 50.1248 In. From the front of Body tube

    CG: 0.1250 In. , Mass: 1.2516 Oz. Radius of gyration: 0.0287486 (m) , 2.87486 (cm) Moment of inertia: 2.93245e-05 (kgm^2) , 293.245 (gcm^2)

17. Centering ring Public Missiles - CR-3.9-2.1 - Was PML CR-14, Material: Aircraft plywood (Birch)

    Centering ringOD: 3.9000 In., ID: 2.2710 In., Len: 0.2500 In. Location: 55.1248 In. From the front of Body tube

    CG: 0.1250 In. , Mass: 1.2516 Oz. Radius of gyration: 0.0287486 (m) , 2.87486 (cm) Moment of inertia: 2.93245e-05 (kgm^2) , 293.245 (gcm^2)

18. Launch lug Giant Leap - RG - ACME Rail Guide, Material: Polycarbonate

OD: 0.5000 In., ID: 0.4000 In., Len: 1.0000 In., Loc: 40.6252 In.

CG: 0.5000 In. , Mass: 0.0490 Oz. Radius of gyration: 0.00839368 (m) , 0.839368 (cm) Moment of inertia: 9.79129e-08 (kgm^2) , 0.979129 (gcm^2)

19. Tube coupler LOC Precision - TC-3.90 - Tube Coupler, Material: Fiberglass

    Tube couplerOD: 3.9000 In., Hole #1: : 97.2820 In. Len: 8.0000 In. Location: 17.1250 In. From the front of Body tube

    CG: 0.0000 In. , Mass: 1.3000 Oz. Radius of gyration: 0.0682357 (m) , 6.82357 (cm) Moment of inertia: 0.000171598 (kgm^2) , 1715.98 (gcm^2)

20. Avionics Bay Loc Precision – 8 inch, Material: Fiberglass

    CG: 0.0000 In. , Mass: 48.0001 Oz. Radius of gyration: 0 (m) , 0 (cm) Moment of inertia: 0 (kgm^2) , 0 (gcm^2)

21. Bulkhead Public Missiles - BP-3.9 - Was BP-06, Material: Birch

    BulkheadOD: 3.9000 In., Len: 0.1880 In. Location: 3.3750 In. From the front of Body tube

    CG: 0.0940 In. , Mass: 0.8838 Oz. Radius of gyration: 0.0248312 (m) , 2.48312 (cm) Moment of inertia: 1.54485e-05 (kgm^2) , 154.485 (gcm^2)

22. Bulkhead Public Missiles - BP-3.9 - Was BP-06, Material: Birch

    BulkheadOD: 3.9000 In., Len: 0.1880 In. Location: 16.8750 In. From the front of Body tube

    CG: 0.0940 In. , Mass: 0.8838 Oz. Radius of gyration: 0.0248312 (m) , 2.48312 (cm) Moment of inertia: 1.54485e-05 (kgm^2) , 154.485 (gcm^2)

23. Parachute b2 Rocketry - SkyAngle - Classic 36, Material: 1.3 oz. Ripstop Nylon (SkyAngle)

    1 parachute, Shape: Round Dia: 32.5000 In., Spill hole: 0.0000 In.

    CG: 0.0000 In. , Mass: 6.0000 Oz. Radius of gyration: 0.044434 (m) , 4.4434 (cm) Moment of inertia: 0.000335837 (kgm^2) , 3358.37 (gcm^2)

24. Screw Eye Semroc - SE-10 - Screw Eye, Material:

    CG: 0.0000 In. , Mass: 0.0200 Oz. Radius of gyration: 0 (m) , 0 (cm) Moment of inertia: 0 (kgm^2) , 0 (gcm^2)

25. Screw Eye Semroc - SE-10 - Screw Eye, Material:

CG: 0.0000 In. , Mass: 0.0200 Oz. Radius of gyration: 0 (m) , 0 (cm) Moment of inertia: 0 (kgm^2) , 0 (gcm^2)

26. Body tube LOC/Precision - LOC BT-3.9 - Airframe tube, Material: Fiberglass

    OD: 4.0000 In. , ID: 3.9000 In. , Len: 1.0000 In.

    CG: 0.5000 In. , Mass: 0.0460 Oz. Radius of gyration: 0.0362655 (m) , 3.62655 (cm) Moment of inertia: 1.71362e-06 (kgm^2) , 17.1362 (gcm^2) , RockSim XN: 0.0000 In. , CNa: 0

27. Body tube LOC/Precision - LOC BT-3.9 - Airframe tube, Material: Fiberglass

    OD: 4.0000 In. , ID: 3.9000 In. , Len: 38.0000 In.

    CG: 19.0000 In. , Mass: 1.7465 Oz. Radius of gyration: 0.281195 (m) , 28.1195 (cm) Moment of inertia: 0.00391495 (kgm^2) , 39149.5 (gcm^2) , RockSim XN: 0.0000 In. , CNa: 0

28. Fin set Public Missiles - FIN-PTERJ - Fins, Material: G10 fiberglass

    CG: 7.7358 In. , Mass: 8.8431 Oz. Radius of gyration: 0.0814233 (m) , 8.14233 (cm) Moment of inertia: 0.00166207 (kgm^2) , 16620.7 (gcm^2) , RockSim XN: 99.0311 In. , CNa: 16.5585

29. Body tube Giant Leap - B-2.152 - 54mm BT, Material: Fiberglass

    OD: 2.2710 In. , ID: 2.1520 In. , Len: 16.5000 In. Location: 21.3750 In. From the front of Body tube

    CG: 13.5000 In. , Mass: 0.8268 Oz. Radius of gyration: 0.199192 (m) , 19.9192 (cm) Moment of inertia: 0.000929976 (kgm^2) , 9299.76 (gcm^2) , RockSim XN: 0.0000 In. , CNa: 0

30. Bulkhead Public Missiles - BP-3.9 - Was BP-06, Material: Birch

    BulkheadOD: 3.9000 In., Len: 0.1880 In. Location: 2.8750 In. From the front of Body tube

    CG: 0.0940 In. , Mass: 0.8838 Oz. Radius of gyration: 0.0248312 (m) , 2.48312 (cm) Moment of inertia: 1.54485e-05 (kgm^2) , 154.485 (gcm^2)

31. Payload Estes Loc Precision – 8 inch, Material: Fiberglass

    CG: 0.0000 In. , Mass: 48.0001 Oz. Radius of gyration: 0 (m) , 0 (cm) Moment of inertia: 0 (kgm^2) , 0 (gcm^2)

Budget

Product Description	**Retailer**	**Quantity**	**Unit Price**	**Total price**
4'' diameter Ogive Nose Cone	PreformanceRocketry.com	1	$38.00	$38.00
48'' airframe tube	PreformanceRocketry.com	2	$80.00 (per unit)	$160.00
4'' tube coupler	PreformanceRocketry.com	2	$18.00 (per unit)	$36.00
1'' ACME rail button	giantleaprocketry.com	2	$2.00 (packs of 2)	$2.00
3.9'' diameter BP-3.9	publicmissiles.com	5	$1.85 (per unit)	$9.25
Large C3/L sky angle parachute	wildmanrocketry.com	1	$139.00	$139.00
Drogue C3/D sky angle parachute	wildmanrocketry.com	1	$27.50	$27.50
Screw eye semroc SE-10	Home Depot	4	$2.00 (per unit)	$8.00
1/2 in elastic shock cord	LOCprecision.com	2	$17.50	$17.50
3.9'' diameter centering ring CCR-3.9-2.1	publicmissiles.com	4	$3.25 (per unit)	$13.00
Avionics bay	LOCprecision.com	2	$40.72	$40.72
K550W motor and casing	wildmanrocketry.com	1	$210.00	$210.00
Fin set FIN-PTERJ	publicmissiles.com	3	$13.59 (per unit)	$40.77
16.5'' body tube	giantleaprocketry.com	1	$11.33	$11.33
Launch Pad	DiscountRocketry.com	1	$159.95	$159.95
Barrel swivel	Wildmanrocketry.com	2	$6.00	$12.00
Rocksim 9 with school site license	Apogee Rockets	1	$148.00	$148.00
Scale model budget	Performancerocketry.com	1	$250.00	$250.00
Payload budget – sensor and data logger	Data Harvest	1	$800 (under negotiation)	$800.00
GPS/Telemetry System	Big Red Bee Products	1	$299	$299.00
Flight Computers – MiniAlt WD+	Already own	2	NA	NA
Solder	Radio Shack	1	$6.99	$6.99
Shipping to Huntsville, AL	UPS	1	$250.00	$250.00
Shipping to Malvern, PA	UPS	1	$250.00	$250.00
Travel Expenditures	Retailer	Quantity	Unit cost	Total cost
Hotel in Huntsville, AL	cheaptickets.com	7	$450.00	$3,150.00
Flight to/from Huntsville, AL	cheaptickets.com	17	$297	$5,049.00
Rental van in Huntsville, AL	cheaptickets.com	1	$479	$479.00
Meals in Huntsville, AL	various	255	$10	$2,550.00
Gas for rental van	any gas station	1	$50	$50.00

Summary					
Rocket Expenditures					$2,599.01
Travel Expenditures					$11,278.00
Pledged Sponsorship	Pledge from Schaeffer Pyrotechnics				-500
Pledged Sponsorship	Pledge from Debrah Dhillon				-250
NASA monies					-3,700.00
Our Financial Obligation					$9,427.01

Timeline:

- **December:** Finalize Preliminary Design Review DUE in early of this month. Order Parts and *possibly* begin final scale rocket construction. Continue payload and avionics design. Test recovery system design and payload integration.

    - **Second Week:** Continue payload and avionics design. Update our current status in production.
    - **Third Week:** Start first draft of Critical Design Review (CDR) Update our current status in production. Leave on Winter Break 12/17/09-1/4/10.

- **January:** Complete prototype of payload and avionics. Finish construction of scale rocket. Work on report due for February 1st (CDR). Complete Payload Design and build prototype.

    - **First Week:** Construct rocket. Complete prototype of payload. Create Critical Design Review draft. Work on report due for January 20th (CDR). Work on website and update our current status in production.
    - **Second Week:** Construct rocket. Complete prototype of payload. Test the avionics on the ground. Create Critical Design Review draft. Update our current status in production.
    - **Third Week:** Have CDR completed and submitted. Construct rocket. Complete prototype of payload and avionics. Test the avionics on the ground. Update our current status in production.
    - **Fourth Week:** Construct rocket. Complete final prototype of payload. Continue construction and implementation of avionics into rocket. Update our current status in production. Leave on 1/28/10-2/1/10 for midwinter break.

- **February:** Final prototype of avionics design. Implement final avionics design into rocket. Work on Construction of Final Rocket.

    - **First Week:** Start first draft of Flight Readiness Review (FRR) update our current status in production.
    - **Second Week:** Continue construction and implementation of avionics into rocket and final modification of payload design. Continue on FRR. update our current status in production.
    - **Third Week:** Work on Construction of Final Rocket. Work on website and update our current status in production.
    - **Fourth Week:** Work on Construction of Final Rocket. Have FRR finished. Work on website and update our current status in production. Leave for spring break 2/25/10—3/15/10

- **March:** Create Flight Readiness Review draft. Make final modifications to payload or avionics. Finish rocket construction.

    - **Third Week:** Review FRR final draft and prepare for FRR presentation. Update our current status in production.
    - **Fourth Week:** First test launch of rocket? Update our current status in production on website. FRR Presentation (tentative)

- **April:** Test fly rocket. Work on final report. Develop final launch procedures and make modifications to payload or avionics if necessary. Get ready for SLI Trip.

    - **First Week:** Modify payload or avionics if necessary. FRR Presentation (tentative). **U**pdate our current status in production. Long weekend 4/1/10-4/4/10 Easter break.
    - **Second Week:** Develop launch procedures and test fly rocket. Travel to Huntsville. Rock 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:** **SLI Trip and Final Launch.** 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

Education Engagement

- We are still in the planning stages and will be giving presentations to local schools in early Spring (weather permitting).
- We have acquired a list of Middle Schools that our school has reciprocal agreements with. We will be scheduling training alongside our school's admissions visits. We have agreements with approximately 50 middle schools. We will be scheduling outreach visits with as many of these schools as possible. We believe that "Pay Forward" is a necessary and productive activity to promote and recruit future rocketeers.

VI. Conclusion

We believe that we have selected a meaningful and challenging scientific experiment. We have developed a safe and efficient rocket that will meet all the criteria required to deliver our scientific experiment to fruition. The next step will be building and testing our scale rocket as well as purchasing and testing our flight and payload electronics.