CoDR

Hobart and William Smith College

October 9th, 2017
Team Members

Student Researchers

Max Brodheim
William Elliman
Naphatsorn Kaewwanna
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Faculty Advisors

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Student Advisors

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Duinya Syed
Emily Kreps
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Section 1

Mission Overview
Mission Overview

- Our mission is composed of 2 parts:
  - Muon detector
  - Magnetometer

- Information from these elements could help scientists better model the upper atmosphere and interact with it

- Additionally, our mission includes outreach to local high school/middle schools in order to promote interest in STEM
Mission Objectives

- Measure muon flux at different levels in the atmosphere.
- Model how the Earth’s magnetic field changes with respect to altitude.
- Get local students engaged in STEM fields, and have them help us build our payload.
System Objectives

● Successfully operate all of the following:
  ○ A muon detector that measures muon flux using a self contained apparatus containing a scintillating material and silicon photomultiplier.
  ○ A fluxgate magnetometer that measures the strength of the geomagnetic field with a resolution in micro-teslas.

● Get a local school to participate in:
  ○ The design and construction of the payload
  ○ Make a presentation to a STEM class at a local school, outlining our mission and its importance to the scientific community
Success Conditions

● This mission will be considered successful if:
  ○ The muon detector can accurately measure muon flux at different altitudes
  ○ The magnetometer can gather enough data to model a relationship between altitude and magnetic flux
  ○ We reach a local school to get help in the construction of our payload

● This mission will be partly successful if:
  ○ At least one of the experiments succeeds in the above goals and
  ○ The local outreach listed above is accomplished
Theory and Concept

- **Muon Detector:**
  - Muons are fundamental particles that are created when cosmic rays collide with the particles that form earth’s atmosphere. We want to test where muons are most prevalent and thereby gain a better understanding of muons.
  - Muons are created when cosmic rays come in contact with Earth’s atmosphere.
  - Little data has been collected on the concentration of Muons in the upper atmosphere.
  - Hobart and William Smith Colleges has previously worked in conjunction with RockSat-C to collect data on Muon occurrences, we hope to improve upon our experiment, and to help solidify our data.

- **Magnetometer:**
  - The geomagnetic field is essential for protecting the Earth from the harmful radiation that the sun emits. Although it extends to several Earth radii, the plasmasphere begins at around 60km above the surface, which should offer a rocket reaching altitudes around 100km a good stretch to measure fluctuations with respect to altitude.
RockSat-C 2015-17 - Muon detector results

- Muon Detectors:
  - Our detector reported a linear increase of muons as it entered space.
  - We would like to use a solid state scintillator this year.
Expected Results

- **Muon Detector**
  - We predict we will find a layer of the atmosphere where Muons are most common, potentially allowing us to find under what conditions Muons are most commonly produced.

- **Magnetometer**
  - We predict that the geomagnetic field will be modelable as a continuous function with respect to altitude, ideally allowing us to predict altitude from the strength of the geomagnetic field.
**Concept of Operations**

- **Medium Muon Flux and Magnetic Field Strength**
  - $t \approx 1.3$ min
  - Altitude: 75 km

- **End of Orion Burn**
  - $t \approx 0.6$ min
  - Altitude: 52 km

- **Apogee**
  - High Muon Flux
  - Low Magnetic Field Strength
  - $t \approx 2.8$ min
  - Altitude: $\approx 115$ km

- **Payload Turns off**
  - $t \approx 15$ min
  - Splash Down
  - Payload Turns off

- **High Muon Flux, High Tumble**
  - Altitude: 95 km

- **Medium Muon Flux and Magnetic Field**
  - $t \approx 5.5$ min

- **Chute Deploys**

- **Altitude (km)**
  - $t = -3$ min

- **-All systems activated**
- **-Begin data collection**
Section 2

Conceptual Design Review
Structure

- We will mount sensors on two plates, using the top plate for securing a microprocessor and magnetometer. The bottom plate will be used to secure our power source and any ballast needed to balance the payload.

- We will suspend this plate in the middle of our cannister, with thin plastic shields above and below to protect from potential debris from other canisters.
Major Technology Dependencies

● The Muon detector must be able to permit Muons to cause scintillation but not other forms of ionizing radiation and store information on a microcomputer. It will require a power source.

● The magnetometer must be able to read increments of .1 µT, store information on a microcomputer, and be calibrated just before launch to nullify the rockets own magnetic field.
Heritage Element: Muon Detector

To improve on the Muon detection subsystem utilized in previous launches we will redesign and modify our existing detector so as to better protect it from ionizing radiation, which can trip the detector to create false positive readings.
Electrical Free Body Diagram

- Power Supply 9.0V
- Arduino 1
  - Muon Detector
- Arduino 2
  - Magnetometer
Mechanical Free Body Diagram

Top

Magnetic field detector

Arduino 1

Top and bottom of the same plate

Bottom

Arduino 2

Muon Detector

Plate mounted in cannister
User’s Guide Compliance

- Our weight will be 10±.1 pounds.

- Our center of mass will be within the required 2.54 x 2.54 x 2.54 centimeter box.

- Our dimensions will be within the 4.75” height and 9.1” diameter limit.
Section 3

Management
Management and Advisors
## Payload Budget

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<tr>
<th>Item/ Event</th>
<th>Brief Description</th>
<th>Merchant/ Source</th>
<th>Unit Price</th>
<th>Quantity</th>
<th>Item total</th>
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<tr>
<td>Half Canister Space</td>
<td>Payment done to NASA to secure a spot in the Rocket</td>
<td>NASA</td>
<td>$6,000.00</td>
<td>1</td>
<td>$6,000.00</td>
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<tr>
<td>Cannister Reservation</td>
<td>Payment to NASA done at the beginning for reserving a spot in the rocket</td>
<td>NASA</td>
<td>$1,000.00</td>
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<td>$1,000.00</td>
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<tr>
<td>Aluminum Rod</td>
<td>Needed for the integration of the experiment</td>
<td>MSC</td>
<td>$12.79</td>
<td>3</td>
<td>$38.37</td>
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<tr>
<td>Pre-Amps</td>
<td>Used to make the experiment</td>
<td>Mini Circuits</td>
<td>$94.95</td>
<td>3</td>
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</tr>
<tr>
<td>Scintillator Plate Material</td>
<td>used in the experiment</td>
<td>Eljen</td>
<td>$200.00</td>
<td>2</td>
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<tr>
<td>Batteries</td>
<td>Needed to run charge the experiment and run it</td>
<td>MSC</td>
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<td>$325.84</td>
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<tr>
<td>Electrical/Hardware Components</td>
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<td>Arduino Uno</td>
<td>Used to put into the experiment</td>
<td>Arduino</td>
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<td>$124.75</td>
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<tr>
<td>Si Photomultiplier</td>
<td>Used to put into the experiment</td>
<td>Ketek</td>
<td>$132.00</td>
<td>6</td>
<td>$792.00</td>
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<tr>
<td>Magnetic Sensors</td>
<td>Part of the experiment to measure magnetic Field in the atmosphere</td>
<td>Adafruit</td>
<td>$100.00</td>
<td>4</td>
<td>$400.00</td>
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<tr>
<td>Geiger Muller sensor</td>
<td>Sensor needed for the muon detection experiment</td>
<td>Adafruit</td>
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<td>Aluminum Plate 1 inch</td>
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<td>Pin Photo Diodes</td>
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<td>Teviso Sensor technology</td>
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## Travel Budget

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<th>Item</th>
<th>Supplier</th>
<th>Cost ($)</th>
<th>Quantity Required (per day)</th>
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<th>Total Cost ($)</th>
<th>Notes</th>
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<td>Queen Room</td>
<td>Refugee Inn</td>
<td>$170.00</td>
<td>3</td>
<td>7</td>
<td>$3,570.00</td>
<td>1 person per room</td>
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<td>Suite</td>
<td>Refugee Inn</td>
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<td>Gas for Van</td>
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<td><strong>$22,024.00</strong></td>
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Total Budget

We anticipate a total cost of around $33,000 for our this year’s program, with funding from:

- HWS Budget Allocation Committee (designates funds for clubs)
- Club recycling program
- Local Sponsorship
- Donations
<table>
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<th>Date Range</th>
<th>Event Description</th>
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<tr>
<td>10/9-13/2017</td>
<td>Conceptual Design Review (CoDR)</td>
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<td>10/13/2017</td>
<td>Earnest Payment of $1,000 Due</td>
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<td>10/30-11/3/2017</td>
<td>Preliminary Design Review (PDR)</td>
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<td>12/4-8/2017</td>
<td>Critical Design Review (CDR)</td>
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<td>Select—Flights Awarded</td>
<td>Final Down</td>
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<td>2/12/2018</td>
<td>First payment due</td>
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<td>4/2/2018</td>
<td>Final payment due</td>
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<td>6/13/2018</td>
<td>Travel to Wallops Flight Facility</td>
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<td>6/21/2018</td>
<td>Launch Day!!</td>
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<tr>
<td>7/27/2018</td>
<td>Final Report Due</td>
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Weekly Availability Matrix

- Weekly meetings every Thursday from 3:00 to 4:00 and Friday from 2:00 to 3:00 PM
- Work time in smaller groups spread throughout the week.

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<tr>
<th>Time</th>
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<th>Tuesday</th>
<th>Wednesday</th>
<th>Thursday</th>
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<td>12:00 PM</td>
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<td>Yes/Best time</td>
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<td>1:00 PM</td>
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<td>4:00 PM</td>
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<td>No</td>
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<td>5:00 PM</td>
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## Contact Matrix

<table>
<thead>
<tr>
<th>Team Member</th>
<th>Role/Position</th>
<th>Email Address</th>
<th>Phone Number</th>
<th>US Person?</th>
</tr>
</thead>
<tbody>
<tr>
<td>Duinya Syed</td>
<td>Student Advisor</td>
<td><a href="mailto:duinya.syed@hws.edu">duinya.syed@hws.edu</a></td>
<td>(310) 596-9238</td>
<td>No</td>
</tr>
<tr>
<td>Marshall Ireland</td>
<td>Researcher</td>
<td><a href="mailto:marshall.ireland@hws.edu">marshall.ireland@hws.edu</a></td>
<td>(585) 402-3496</td>
<td>Yes</td>
</tr>
<tr>
<td>Charlie Seldon</td>
<td>Researcher</td>
<td><a href="mailto:charlie.seldon@hws.edu">charlie.seldon@hws.edu</a></td>
<td>(203) 540-9331</td>
<td>Yes</td>
</tr>
<tr>
<td>Will Elliman</td>
<td>Researcher</td>
<td><a href="mailto:william.elliman@hws.edu">william.elliman@hws.edu</a></td>
<td>(774) 232-0146</td>
<td>Yes</td>
</tr>
<tr>
<td>Christian Escano</td>
<td>Researcher</td>
<td><a href="mailto:christian.escano@hws.edu">christian.escano@hws.edu</a></td>
<td>(374) 772-4817</td>
<td>Yes</td>
</tr>
<tr>
<td>Jamie Kaewwanna</td>
<td>Researcher</td>
<td><a href="mailto:naphatsorn.kaewwanna@hws.edu">naphatsorn.kaewwanna@hws.edu</a></td>
<td>(714) 330-5063</td>
<td>Yes</td>
</tr>
<tr>
<td>Sergio Perez</td>
<td>Researcher</td>
<td><a href="mailto:sergio.perez@hws.edu">sergio.perez@hws.edu</a></td>
<td>(630) 669-0756</td>
<td>No</td>
</tr>
<tr>
<td>Max Brodheim</td>
<td>Researcher</td>
<td><a href="mailto:max.brodheim@hws.edu">max.brodheim@hws.edu</a></td>
<td>(917) 442-2405</td>
<td>Yes</td>
</tr>
<tr>
<td>Emily Kreps</td>
<td>Researcher</td>
<td><a href="mailto:emily.kreps@hws.edu">emily.kreps@hws.edu</a></td>
<td>(603) 583-6845</td>
<td>Yes</td>
</tr>
<tr>
<td>Hayes Torrence</td>
<td>Researcher</td>
<td><a href="mailto:hayes.torrence@hws.edu">hayes.torrence@hws.edu</a></td>
<td>(216) 280-7040</td>
<td>Yes</td>
</tr>
<tr>
<td>Jasper White</td>
<td>Researcher</td>
<td><a href="mailto:william.white@hws.edu">william.white@hws.edu</a></td>
<td>(917) 373-6543</td>
<td>Yes</td>
</tr>
<tr>
<td>Ileana Dumitriu</td>
<td>Faculty Advisor</td>
<td><a href="mailto:dumitriu@hws.edu">dumitriu@hws.edu</a></td>
<td>(315) 781-3853</td>
<td>No</td>
</tr>
<tr>
<td>Peter Spacher</td>
<td>Faculty Advisor</td>
<td><a href="mailto:spacher@hws.edu">spacher@hws.edu</a></td>
<td>(315) 781-3853</td>
<td>Yes</td>
</tr>
</tbody>
</table>
Section 4

Conclusion
Risks and Worries

1. Not receive ample funding
2. Magnetic field interference from other payloads
3. Catastrophic sensor failure
4. Unexpected in flight interference
Conclusion

- We will be performing one new and one repeat experiment
  - Measurement of the earth's magnetic field
  - High altitude muon detection
- To assist us in the creation of the components needed for these experiments we will utilize an outreach program with local schools
Questions

- Is it possible to contact other participants in the RockSat-C program, such as the team we will share a cannister with?

- Is there data on magnetic flux due to electrical or structural components of rocket?

- Is there any telemetry data available about the rotation of the rocket?