Hobart and William Smith Colleges
Misty Chien, Dimosthenis Chrysochoou, Anupam Dhuhgana, Walden Marshall, Willow Munn-Oberg, Emma Stuart, Joseph Tate
Advisors: Dr. Ileana Dumitriu and Dr. Peter Spacher
7 October 2019
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Mission Overview
Mission Statement

- Our payload has 3 subsystems:
  - Muon Detector
  - Magnetometer
  - Vibration damping

- The goal of our payload is to continue measuring different properties of the Earth (magnetic fields, muon flux at different altitudes). We also plan to study materials to dampen vibrations in order to open up new possibilities in the future for more sensitive equipment.

- We also plan to continue our outreach program the local middle school.
  - They will be taught some of the skills we have learned to promote youth interest in STEM.
Mission Objectives

- Our objectives for each subsystem are to:
  - Collect more data on Earth’s magnetic fields
  - Improve our muon detector to only detect muons
  - Find materials that dampen vibrations caused by the rocket

- Minimal Success conditions:
  - Collect data from the magnetometer and the muon detector
  - Read vibration data
  - Get the local middle school to participate in the outreach program
Theory and Concepts

- Muon Detector:
  - Muons are negatively charged subatomic particles that are created when cosmic rays collide with the particles that form earth’s atmosphere.
  - Little data has been collected on the flux of muons in the upper atmosphere.
  - Hobart and William Smith Colleges has worked with RockSat-C to collect data on muon occurrences and hopes to improve on our experiment and help solidify our data.

- Magnetometer:
  - The geomagnetic field is essential for protecting the Earth from 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 magnetic fluctuations with respect to altitude.

- Vibration Damping
  - As the rocket flies and vibrates it could damage sensitive components of an experiment. Reducing the vibrations would be extremely helpful in protecting them.
Expected Results

● Muon Detector
  ○ Similar results to the previous year
  ○ A decrease in the muon flux with increasing altitude

● Magnetometer
  ○ Magnetic field decreases as the altitude increases

● Vibration Damping
  ○ We expect to see different materials provide different levels of dampening.
Concept of Operations

Altitude (km)

- 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
  - All systems activated
  - Begin data collection

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

- Apogee
  - $t \approx 4.0$ min
  - Altitude: 95 km

- Medium Muon Flux and Magnetic Field, High Tumble
  - $t \approx 15$ min
  - Splash Down
  - Payload Turns off

- $t = -3$ min
Design Overview
Structure

- A single plate with all of the subsystems mounted to that plate will be used. This will allow to easily place the center of mass in the center of half of the canister.
Major Technological Dependencies

- The muon detector must be able to detect muons.
- The magnetometer must be able to detect the Earth’s magnetic field at increments of 0.1 μT.
- The vibration sensors need to take as many readings as fast as possible and be able to read accurate data.
Heritage Elements

- **Muon Detector**
  - Improvement to the design of the muon detector in order to collect more and better data.

- **Magnetometer**
  - Collect more data to confirm data from last year and improve data collection method.
Special Request

- The vibration damping subsystem could use a liquid/gel. The subsystem would be suspended in a liquid/gel to decrease the vibrations.
Electrical Block Diagram

Muon Detector -> Arduino 1
Magnetometer -> Arduino 2
Vibration Damping -> Arduino 3

Data:
V+:
GND:

Power Supply 9.0V
WFF t-3
Functional Block Diagram

VD - Vibration Damping
MAG - Magnetometer
MAG ARD - MAG microcontroller
MUON - Muon Detector
Payload Layout

● The layout of the payload will consist of one plate that will have all of the subsystems mounted to it.
● Because of the half canister the plate mounting system is to be determined.
● The positions of the subsystems will depend on their mass.
RockSat-C 2020 User’s Guide Compliance

- Our weight will be 6±1 pounds.
- Our center of mass will be within the required 2.54 x 2.54 x 2.54 centimeter box.
- Dimensions will be within the 4.75” height and 9.1” diameter limit.
- The payload will be activated 3 minutes before launch.
- The payload will be neutrally charged.
- The payload will not generate any heat.
- The entire team are U.S. Citizens.
Project Management
Team Organization

Faculty Advisors

Student Research Team
<table>
<thead>
<tr>
<th>Item/Event</th>
<th>Description</th>
<th>Source</th>
<th>Unit Price</th>
<th>Quantity</th>
<th>Subtotal</th>
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<td>Payment to NASA for surcuring a space in the rocket</td>
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<td>Logic level converter</td>
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<td>Accelerometer</td>
<td>Used for detecting vibrations</td>
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<td>Arduino</td>
<td>The microcontrollers that will drive the experiments</td>
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<td>Adafruit DataLogger shield</td>
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Total: $18,838.43
Faculty Advisors

- Ileana Dumitriu, Ph.D (dumitriu@hws.edu)
- Peter Spacher, Ph.D (spacher@hws.edu)
# Team Contact Matrix

<table>
<thead>
<tr>
<th>Team Member</th>
<th>Role/Position</th>
<th>Email Address</th>
</tr>
</thead>
<tbody>
<tr>
<td>Misty Chien</td>
<td>Researcher</td>
<td><a href="mailto:misty.chien@hws.edu">misty.chien@hws.edu</a></td>
</tr>
<tr>
<td>Dimosthenis Chrysochoou</td>
<td>Researcher</td>
<td><a href="mailto:dimosthenis.chrysochoou@hws.edu">dimosthenis.chrysochoou@hws.edu</a></td>
</tr>
<tr>
<td>Anupam Dhuhgana</td>
<td>Researcher</td>
<td><a href="mailto:anupam.dhuhgana@hws.edu">anupam.dhuhgana@hws.edu</a></td>
</tr>
<tr>
<td>Walden Marshall</td>
<td>Researcher</td>
<td><a href="mailto:walden.marshall@hws.edu">walden.marshall@hws.edu</a></td>
</tr>
<tr>
<td>Willow Munn-Oberg</td>
<td>Researcher</td>
<td><a href="mailto:willow.munn-oberg@hws.edu">willow.munn-oberg@hws.edu</a></td>
</tr>
<tr>
<td>Emma Stuart</td>
<td>Researcher</td>
<td><a href="mailto:emma.stuart@hws.edu">emma.stuart@hws.edu</a></td>
</tr>
<tr>
<td>Joseph Tate</td>
<td>Researcher</td>
<td><a href="mailto:joseph.tate@hws.edu">joseph.tate@hws.edu</a></td>
</tr>
<tr>
<td>Ileana Dumitriu</td>
<td>Faculty Advisor</td>
<td><a href="mailto:dumitriu@hws.edu">dumitriu@hws.edu</a></td>
</tr>
<tr>
<td>Peter Spacher</td>
<td>Faculty Advisor</td>
<td><a href="mailto:spacher@hws.edu">spacher@hws.edu</a></td>
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# Team Availability Matrix

## HOBART AND WILLIAM SMITH COLLEGES:

### Fall 2019 RS-C Team Availability Matrix

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<th>Time</th>
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**PLEASE USE MOUNTAIN TIME ZONE TIMES**
Conclusions
Risks and Worries

- We are not worried about either of our two heritage elements because we know how to deal with them.
- Our biggest worry is how to deal with the vibration damping if a sensor is suspended in a liquid/gel.
Conclusion

● The mission is to collect more data on muon flux and the Earth’s magnetic field as well as test some solutions for vibration damping.
● The largest concern we have now is how we are going to fund the project.
● From here we plan to:
  ○ Look into how to suspend a sensor inside a liquid or gel.
  ○ Rebuild the heritage elements and improve them.
Questions?

- Will we be able to use a real time clock this year? This will need to have a battery running during the arming of the rocket.