STR

Hobart and William Smith Colleges

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Shreeya Desai, William Elliman, Victoria Loshusan, James Truley
Advisors: Dr. Ileana Dumitriu and Dr. Peter Spacher
15 February 2019
Contents

● Section 1 - Mission Overview
  ○ Mission Overview
  ○ Mission Objectives
  ○ Theory and Concepts
  ○ Expected Results
  ○ Concept of Operations
● Section 2 - Final Design Description
  ○ Design Overview
  ○ Functional Block Diagrams
  ○ Payload Layout
  ○ RockSat-C 2019 User’s Guide Compliance
● Section 3 - Project Management Update
  ○ Team Contact Matrix
  ○ Team Availability Matrix
● Section 4 - Hardware Procurement Status
● Section 5 - Subsystem Testing Results
  ○ Team Contact Matrix
  ○ Team Availability Matrix
● Section 6 - Integrated Subsystem Testing Results
  ○ Risks and Worries
  ○ Conclusion
● Section 7 - User Guide Compliance
  ○ Risks and Worries
  ○ Conclusion
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
  - Provide a STEM opportunity for local middle school students
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 ≈ 1.3 min
- Altitude: 75 km

End of Orion Burn
- t ≈ 0.6 min
- Altitude: 52 km

Apogee
- High Muon Flux
- Low Magnetic Field Strength
- t ≈ 2.8 min
- Altitude: ≈115 km

Medium Muon Flux and Magnetic Field, High Tumble
- t ≈ 4.0 min
- Altitude: 95 km

t = -3 min
- All systems activated
- Begin data collection

t ≈ 15 min
- Splash Down
- Payload Turns off
Final Design Description
Changes Since CDR

- We didn’t have any major changes since the CDR.
Circuit will break here and connect to WFF Power source to be turned on (activate with early activation)
System Definitions

- STR: Structure
- BAT: Battery
- MUON: Muon Detector
- MAG: Magnetometer
- MAG ARD: Magnetometer arduino controller
- VIB: Vibration Damping module
- ACC: Accelerometer
System Design - Physical Model

- Muon Box
- MAG Arduino
- Batteries
System Design - Physical Model
System Design - Physical Model (Accelerometer boxes)
Design in Canister
### Subsystem Design – Weight Budget

- The masses of some of the subsystems are still unknown.
- Mass of can is ~6.6 lb
- Mass of mid-mounting plate is ~1.5 lb if applicable
- How we will ballast: lead

<table>
<thead>
<tr>
<th>Subsystem</th>
<th>Weight (lbs)</th>
</tr>
</thead>
<tbody>
<tr>
<td>MUON</td>
<td>0.953</td>
</tr>
<tr>
<td>MAG</td>
<td>0.118</td>
</tr>
<tr>
<td>VIB</td>
<td></td>
</tr>
<tr>
<td>Batteries</td>
<td>0.2</td>
</tr>
<tr>
<td>Mounting plate</td>
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</tr>
<tr>
<td>Ballast</td>
<td></td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td><strong>1.271</strong></td>
</tr>
<tr>
<td>Total with Half Canister weight</td>
<td><strong>4.721</strong></td>
</tr>
<tr>
<td><strong>Under/Over</strong></td>
<td><strong>(5.279)</strong></td>
</tr>
</tbody>
</table>
Electrical Design Elements

- We plan on having four accelerometers, multiple arduinos, a magnetometer, a muon detector, and a logic level converter.
Hazardous Mechanical Items

- The payload does not have any hazardous mechanical items because it is comprised of sensors.
- There are gels on our payload.
  - Jell-O
  - Hair Gel
  - Honey
Electrical Design (Accelerometer)
Electrical Design (Magnetometer)
Electrical Design (Muon Detector)
## Subsystem Design – Power Budget

<table>
<thead>
<tr>
<th>Subsystem</th>
<th>Voltage (V)</th>
<th>Max Current (A)</th>
<th>Time On (min)</th>
<th>Watts</th>
<th>Ah</th>
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<tbody>
<tr>
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<td>9.0</td>
<td>0.30</td>
<td>18</td>
<td>2.70</td>
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<tr>
<td>MAG</td>
<td>9.0</td>
<td>0.075</td>
<td>18</td>
<td>0.68</td>
<td>0.0225</td>
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<tr>
<td>VIB</td>
<td>9.0</td>
<td>0.075</td>
<td>18</td>
<td>0.68</td>
<td>0.0225</td>
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<tr>
<td><strong>Total</strong></td>
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<td><strong>Total Power Capacity</strong></td>
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<td><strong>0.66</strong></td>
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<tr>
<td><strong>Over (+)/Under (-)</strong></td>
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<td></td>
<td></td>
<td></td>
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<tr>
<td><strong># of Flights Margin</strong></td>
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<td></td>
<td><strong>4.888888889</strong></td>
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</tbody>
</table>
Hazardous Electrical Items

- The payload does not have any hazardous electrical items.
- There are gels on our payload.
  - Jell-O
  - Slime
For the magnetometer and accelerometer, our software will read sensor data and then write the data to an SD card.

For the muon detector, when there is an event, our software will read sensor data and then write the data to an SD card.
Software Design (Data Analysis)

- All three sensors will have moving averages calculated and plotted after the flight
- MATLAB will be used to make the plots for the data
De-Scopes & Off-Ramps

- If one gel does not work as expected or easily leaks, the container will be reconfigured to have a better seal and/or a different gel will be used.
- ?
Hardware Procurement Status
Mechanical Elements

- We have printed many different boxes for our accelerometer.
- The possible gels have been procured, as well as the components of the subsystems (magnetometer, accelerometer, muon detector, and logic level convertor).
- Schedule:
  - February 2019: Test boxes with various gels
  - March 2019: Finalize gels and box size
  - April 2019: Final Testing
  - May 2019: Final Testing
Electrical Elements

- Pins have been soldered onto the accelerometer to allow for testing with a breadboard. We plan to solder wires directly to the accelerometer once we have completed all of our breadboard tests.
- Similarly, pins have been soldered onto our magnetometer to allow for testing with a breadboard and we will solder wires directly to the magnetometer once testing is complete.
- We have obtained parts for the muon detector.
Electrical Elements

- We anticipate making at least 3 revisions of the electronics.
- We have been conducting tests with the various subsystems on breadboards in order to minimize the number of revisions we will have to make.
- We need to procure the Arduinos that we will be using with the accelerometers.
- **Schedule:**
  - February 2019: Test breadboards and subsystems
  - March 2019: Finalize breadboards and subsystems
  - April 2019: Final Testing
  - May 2019: Final Testing
Software Elements

- We will be using MATLAB for data analysis. A MATLAB script needs to be written for each of our subsystems.
- The only block code that depends on another for our subsystems is saving the data that is collected. Arduino has libraries for writing data to SD cards.
- Schedule:
  - February 2019: Test code using breadboards and subsystems
  - March 2019: Finalize code
  - April 2019: Final Testing
  - May 2019: Final Testing
Software Elements

- **ACC**: We need to complete code that reads the x, y, and z axes of the accelerometer and code that saves the data to an SD card. Arduino has a library that works with the LIS331 family, in addition to their Wire library which allows you to communicate with I2C devices. The H3LIS331DL accelerometer has I2C and SPI modes.
- **MAG**: We have completed code that reads the data from the magnetometer and saves the data onto an SD card.
- **MUON**: We have code that reads the data from the muon detector and saves the data onto an SD card.
Subsystem Testing Results

Muon Detector
Quick Status
- Muon detector is soldered and completed
- Muon detector has been tested and is functioning
  - Outputting data correctly
- What has not yet been checked out
  - Muon detector may not be detecting muons efficiently because no patterns were found between day and night and day to day detection periods

Progress: 50%
• What tests were completed?
  ○ Muon detector was left on over the course of several days to collect data and compare day and night periods
  ○ There wasn’t much of a pattern present so more testing is being done to test if muon detection is plausible using our designed subsystem

Progress: 50%
MUON

- Time difference
- Moving average time difference (10 points)
- Moving average time difference (100 points)

- Show data, interpret success/failure of the tests
Subsystem Testing Results

Magnetometer
MAG

- Quick Status
  - Magnetometer is completed and is functioning
MAG Data

- 5cm
- 10cm
- 20cm
- 40cm
- 60cm
- 80cm
- 100cm
- The 100cm test did not make it into this graph
What tests were completed?

- Sensitivity of magnetometer has been tested
  - Checking the output of the magnetometer by holding a strong magnet various distances away from the subsystem
- Next, we want to test the magnetometer on 3 different axes (x, y, z) because last year it seemed only two of the axes were working
Subsystem Testing Results

Vibration Damping
Quick Status
- Gels/liquids are being narrowed down for testing.
- Multiple containers of various sizes and thicknesses have been 3-D printed.
- The code to read the x, y, and z axis of the accelerometer needs to be completed. The code to write the data from the accelerometer to an SD card needs to be completed.
We tested the permeability of the boxes we made. To test this we filled the box with water and then placed it on a paper towel to see if any water could leak out.
The first box we tested was 0.08 inches thick.  
The second box we tested was 0.12 inches thick.
Plan for Integrated Subsystem Testing
Plan for Subsystem Integration

- Since the plates have been created, the subsystems are being modeled on them to check the spacing and conducts preliminary fit tests.
  - The subsystems are being modeled using cardboard and 3-D printed boxes.
- Once the final models are made, final fit tests will be conducted to ensure fit. Adjustments will be made accordingly.
- The major hurdles are going to be making sure everything fits well and the center of mass is achieved.
Outreach Program Update
Outline for Outreach (GSAT-3)

- We have been in correspondence with Geneva Middle School’s Principal, Robert Smith and Guidance Counselor, Adrianna Kam

- Students will be alternating weeks between the middle school and our campus
Project Management
Project Management and Team Update

Faculty Advisor
Peter Spacher, Ph.D.

Faculty Advisor
Ileana Dumitriu, Ph.D.

Project Manager
William Elliman

Student Researcher
Shreeya Desai

Student Researcher
Victoria Loshusan

Outreach Manager
James Truley
Schedule

Integrated Subsystem Testing Review Teleconference
3/18-22/2019
Final payment due
4/11/2019
RockSat Payload Canisters sent to customers *pending receipt of final payment*
4/11/2019
Progress Update Telecon
4/15-4/19/2019
Full Mission Simulation Test Report Presentation Telecon
4/29-5/3/2019
Progress Update Telecon
5/20-24/2019
Possible Program Telecon
5/29/2019
Preliminary Check-In Procedure Document Due
6/3/2019
Launch Readiness Review Document Due
6/3/2019
Travel to Wallops Flight Facility
6/12/2019
Visual Inspections at Refuge Inn
6/13/2019
Vibration/Integration at Wallops
06/(14-17)/2019
Presentations to next year’s RockSat
6/19/2019
Launch Day!!
6/20/2019
Preliminary Launch Results Document Due
7/12/2019
Final Report Due
7/26/2019
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>
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</thead>
<tbody>
<tr>
<td>William Elliman</td>
<td>Researcher</td>
<td><a href="mailto:william.elliman@hws.edu">william.elliman@hws.edu</a></td>
</tr>
<tr>
<td>Shreeya Desai</td>
<td>Researcher</td>
<td><a href="mailto:shreeya.desai@hws.edu">shreeya.desai@hws.edu</a></td>
</tr>
<tr>
<td>James Truley</td>
<td>Researcher</td>
<td><a href="mailto:james.truley@hws.edu">james.truley@hws.edu</a></td>
</tr>
<tr>
<td>Victoria Loshusan</td>
<td>Researcher</td>
<td><a href="mailto:victoria.loshusan@hws.edu">victoria.loshusan@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:

<table>
<thead>
<tr>
<th>Time</th>
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<th>Tuesday</th>
<th>Wednesday</th>
<th>Thursday</th>
<th>Friday</th>
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</table>
User Guide Compliance
RockSat-C 2019 User’s Guide Compliance

- Our weight will be 10±.1 pounds. (includes canister weight)
- 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.
Shared Can Logistics

- We are sharing a canister with Stevens Institute of Technology.
- SIT has 3 experiments:
  - a reflow soldering oven to test soldering in zero g
  - a presser sensor to observe the boundary layer development of the rocket
  - accelerometers to test vibrations
- Plan for Collaboration
  - We have emailed SIT.
  - Currently we do not have plans to do actual fit checks before June, we will try to make a single CAD model in order to check
- SIT is using a mid-plate.
<table>
<thead>
<tr>
<th>Income</th>
<th>Supplier</th>
<th>Cost</th>
<th>Number Required</th>
<th>Total Cost</th>
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<td><strong>$21,900.00</strong></td>
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## Budget
(Estimated Expenses)

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<th>Item</th>
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<th>Number Required</th>
<th>Total Cost</th>
</tr>
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<tbody>
<tr>
<td>Gorilla 2-Part Epoxy (2 Pack)</td>
<td>Amazon</td>
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<tr>
<td>MicroFC-60035-SMT-TR1 SiMP</td>
<td>Mouser</td>
<td>$ 72.92</td>
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<tr>
<td>MicroSD card breakout board</td>
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<td>$ 7.50</td>
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<tr>
<td>Pro Micro - 5V/16MHz Arduino</td>
<td>SparkFun</td>
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<td>Queen Room (2 people)</td>
<td>Refuge Inn</td>
<td>$ 1,801.98</td>
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<td>$ 3,603.96</td>
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## Budget

(Estimated Expenses)

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## Budget

*(Estimated Expenses)*

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**Total** $ 17,376.60
Conclusions
Worries and Concerns

- 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?

- Have you received our $3000 payment?