Full Mission Simulation Report

May 2015

LBCC Space Exploration Club

“It’s not hard. It’s just rocket science!”

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Our Payload in All Its Glory!
1.0 Mission Overview
Mission Overview

Our mission is to collect readings of cosmic radiation using Geiger tubes during a rocket’s flight.

Our mission was born from a desire to learn and work as a team to achieve a common goal. We hope our experiment to detect cosmic rays will enhance our education, inspire our fellow students, spark interest in the STEM disciplines, and ignite a passion for space exploration.

In addition, Oregon State University RockSat C team will utilize our data to enhance their Tardigrades research.
Concept of Operations: Diagram

- **t = 0 min**
  - G switch activates
  - Begin data collection

- **t = 15 min**
  - End data collection

- **Apogee**
  - We anticipate fewest low energy readings per cosmic ray

- **Altitude ~30 km**
  - Anticipate change in readings based on atmosphere density

- **Altitude = 0 m**
  - Splashdown
2.0 Integrated Subsystem Testing Status
Full List of Tested Subsystems:

Subsystems Fully Tested

- Electrical systems
  - Voltage on each board
  - Current draw during flight
- Software
  - Detecting events from all boards
  - Storing data to SD card
  - Shutting down on time
- Mechanical
  - Fit boards to Makrolon plates
  - Assembled standoffs, screws to test hole placement
Full List of Un-Tested Subsystems:

Subsystems **Not** Fully Tested

- **Electrical**
  - Have not tested using final (expensive) Lithium-Ion batteries
  - Not completed a 5 day standby then power up test

- **Software**
  - We haven’t detected a real-world coincidence

- **Mechanical**
  - Test fit together with OSU in the same canister
  - Need to perform shake test
Full List of Integrated Subsystems:

Subsystems Fully Integrated To Makrolon Plates

- **Electrical**
  - Boards have been conformal coated and components epoxied
  - Test fit the wiring harness
- **Software**
  - Installed on primary and backup Arduino
- **Mechanical**
  - Boards installed on plates
  - Screws and standoff hardware test fitted
Full List of Un-Integrated Subsystems:

Subsystems **Not** Fully Integrated To Makrolon Plates

- **Mechanical**
  - Will extend slots in makrolon, moving Geiger boards closer together
  - May add or move a couple holes for ease of assembly
  - Need to test fit completed assembly in the canister
  - Ballast needs to be integrated and balanced

Close up of Geiger boards integrated onto Makrolon inside the canister.
Integrated Subsystem Testing: Software

We tested the software on the logic board, connected to all geiger boards.

- The software can read from each of the geiger boards.
- It can control the shutdown circuit, which works properly.
- The SD breakout on the logic board works correctly.
Integrated Subsystem Testing: Electrical

- Shutdown system tested and working, cuts all power on shutdown
- G-switch tested and working, toggles system startup
- Wires between logic and geiger boards tested in final positions
- 3 pin molex connectors make solid contact in final positions
- Tested electrical conductivity after conformal coating
- Epoxy on physically vulnerable parts
Integrated Subsystem Testing: Mechanical

Full LBCC/OSU integration Overview

- LBCC on bottom half
- OSU on top half
- Mathematical Integration Subsystem test with OSU and LBCC
- A guide to our fitting with OSU
- Currently both teams are on track to following the schematic
- Fit test of full integration will occur on Wednesday
Integrated Subsystem Testing: Mechanical

LBCC Full integration Overview

- Complete assembly fit test
- Canister fit test
- Initial test was successfully completed on May 15th
- Additional tests will be conducted May 18th

Side View of Full Integration

Top view of Full Integration within Canister
Integrated Subsystem Testing: Mechanical

Level One Integration

- Logic board
- Four 9v batteries
- One G-switch
- Spacers
- Last tested May 15th

Test was mostly successful
- Need to adjust mounting holes to canister
Integrated Subsystem Testing: Mechanical

Level Two Integration

- Last tested 5/13
- Geiger Tube
- Geiger Housing
- Geiger Board
- Spacers
- Two Makrolon Plates

Integration was a success but we want to make some adjustments to the slots in the makrolon for better possible coincidence results.
Integrated Subsystem Testing: Mechanical

Final Design of Geiger Cozies

- Made final adjustments to design
- All cozies are assembled to boards
- Geiger tubes are epoxed in cozies
3.0 Full Mission Simulation Results
Full Mission Simulation Results: Electrical

- New logic boards with delay circuit is correctly working
- G-switch and RBF activation tested
- New regulators on geiger boards allow for steady 5v supply as batteries drop from 9V nominal.
Full Mission Simulation Results: Power

- Completed several full mission tests with 20 min to 1 hour durations.
  - Even after an hour of flight testing, steady results still coming in.
  - Using 2 batteries for an hour, batteries showed ~6v.
- Completed battery power test using lower capacity 9v batteries.
- Will follow up with testing of the 9v lithium batteries to be used in flight.
We have run several full system simulations to test the software.

- Data from the SD card is parsed to look for boards which are getting unexpectedly low, or high numbers of results.
- The system correctly starts up, and shuts down on time.
- Data from the SD card is consistently readable, no corruption issues.
Full Mission Simulation Results: Mechanical

We still need to complete several pieces of our project:
● Center of mass testing
● Determine and fabricate exact ballast amount, and placement
● Run a shake test and analyze results

We faced some challenges and delays during fabrication of the makroлон and integration, which meant we were not able to complete these steps yet.

However, we believe the delays are behind us and we’re continuing to move forward to get back on schedule.
4.0 User Guide Compliance
# User Guide Compliance

<table>
<thead>
<tr>
<th>Requirement</th>
<th>Status/Reason (if needed)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Center of gravity in 1&quot; mid-can?</td>
<td>0.3”</td>
</tr>
<tr>
<td>Contained in can</td>
<td>yes</td>
</tr>
<tr>
<td>Connected to can by 4/5 bulkheads on top and bottom only</td>
<td>yes</td>
</tr>
<tr>
<td>Mass at 20±0.2lbs</td>
<td>16.66lbs (Waiting for OSU’s final weight)</td>
</tr>
<tr>
<td>Shared canister clearance</td>
<td>.5 in clearance between LBCC and OSU</td>
</tr>
<tr>
<td>No voltage on the can</td>
<td>No opportunity to check yet</td>
</tr>
<tr>
<td>Activation wires at least 4 ft</td>
<td>Yes</td>
</tr>
<tr>
<td>Activation wire at least 24 gauge</td>
<td>22 gauge</td>
</tr>
<tr>
<td>T-0 Activation: current &lt; .1 A</td>
<td>Not using</td>
</tr>
<tr>
<td>Battery Type</td>
<td>Lithium Polymer (will not charge at Wallops)</td>
</tr>
</tbody>
</table>
## Weight Budget

<table>
<thead>
<tr>
<th>Components</th>
<th>OSU Qty</th>
<th>LBCC Qty</th>
<th>Individual Weight</th>
<th>Total Weight</th>
</tr>
</thead>
<tbody>
<tr>
<td>Arduino Mega</td>
<td>1</td>
<td>0</td>
<td>37 grams</td>
<td>37 grams</td>
</tr>
<tr>
<td>Arduino Uno</td>
<td>0</td>
<td>1</td>
<td>23 grams</td>
<td>23 grams</td>
</tr>
<tr>
<td>Beagleboard-xm</td>
<td>3</td>
<td>0</td>
<td>40.6 grams</td>
<td>121.8 grams</td>
</tr>
<tr>
<td>9V Battery</td>
<td>4</td>
<td>4</td>
<td>34 grams</td>
<td>272 grams</td>
</tr>
<tr>
<td>Makrolon Plate</td>
<td>4</td>
<td>4</td>
<td>300.8 grams</td>
<td>2406.4 grams</td>
</tr>
<tr>
<td>USB Microscope Camera</td>
<td>3</td>
<td>0</td>
<td>200 grams</td>
<td>600 grams</td>
</tr>
<tr>
<td>Camera Mounting</td>
<td>9</td>
<td>0</td>
<td>5 grams</td>
<td>45 grams</td>
</tr>
<tr>
<td>Geiger boards</td>
<td>0</td>
<td>6</td>
<td>39.5 grams</td>
<td>237 grams</td>
</tr>
<tr>
<td>Logic board</td>
<td>0</td>
<td>1</td>
<td>94 grams</td>
<td>94 grams</td>
</tr>
<tr>
<td>Geiger Tube</td>
<td>0</td>
<td>6</td>
<td>1 grams</td>
<td>6 grams</td>
</tr>
<tr>
<td>Tube Mounting</td>
<td>0</td>
<td>6</td>
<td>5 grams</td>
<td>30 grams</td>
</tr>
<tr>
<td>Canister</td>
<td>.5</td>
<td>.5</td>
<td>3356.6 grams</td>
<td>3356.6 grams</td>
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<tr>
<td>G-Switch</td>
<td>1</td>
<td>1</td>
<td>9 grams</td>
<td>18 grams</td>
</tr>
<tr>
<td><strong>Total Weight:</strong></td>
<td>3830.3g</td>
<td>3416.5g</td>
<td>7246.8 grams</td>
<td>15.98 lbs</td>
</tr>
</tbody>
</table>

Under 1825.05 Grams: 4.02 Pounds
### Weight Budget Continued

<table>
<thead>
<tr>
<th>Components</th>
<th>OSU Qty</th>
<th>LBCC Qty</th>
<th>Weight Each (grams)</th>
<th>Total (grams)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Total weight</td>
<td>1</td>
<td>0</td>
<td>3830.3</td>
<td>3830.3</td>
</tr>
<tr>
<td>Total weight</td>
<td>0</td>
<td>1</td>
<td>3416.5</td>
<td>3416.5</td>
</tr>
<tr>
<td>Logic board Mounting</td>
<td>0</td>
<td>4</td>
<td>20</td>
<td>80</td>
</tr>
<tr>
<td>Level 2&amp;3 Spacing</td>
<td>0</td>
<td>6</td>
<td>16</td>
<td>64</td>
</tr>
<tr>
<td>Level 1 Mounting</td>
<td>8</td>
<td>4</td>
<td>8</td>
<td>96</td>
</tr>
<tr>
<td>Battery Mounts</td>
<td>4</td>
<td>4</td>
<td>9</td>
<td>72</td>
</tr>
<tr>
<td>Total Weight:</td>
<td>3930.3g</td>
<td>3628.5g</td>
<td>7558.8g</td>
<td>16.66 lbs</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Under weight</td>
<td>1513.05g</td>
<td>3.34 lbs</td>
</tr>
</tbody>
</table>
5.0 Project Management Update
Detailed Schedule for Payload Completion:

**Monday** - Bottom plate done
**Monday** - Finalized OSU weight budget
**Wednesday** - Full canister fit test (LBCC OSU meeting)
**This week** - Final full standby + flight test for power system

**Memorial Weekend** - Canister fully integrated, ideally ballast integrated, momento box decision go/no-go

**Week of the 25th** - Fiddling with Ballast
**Friday** - Fully integrated and canister centered on x,y,z
Conclusions: Biggest Worries

- Ballast
  - Ballast plan needs to be finalized
  - We cannot fully finalize the ballast until OSU has a finished their weight budget

- 1”x1”x1” Centering - Will be adjusted with ballast/added weight.

- Shake test - The conformal coating and epoxy should prevent damage, but will also slow down repairs if something breaks during the test.

- We have not seen a coincidence during real-world testing. Bench tests suggest it’s working, but probability has not been our friend.
Note: Check in Procedure

● We have started the gather all documentation in a 3 ring binder
  ○ electrical schematics
  ○ data sheets
  ○ printed code
  ○ solidworks designs
  ○ weight budget
  ○ etc

● What is the “structural integration procedure”?