CSU 2013 NASA Space Grant DemoSatB Team Re-Launch

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Mission Overview Refresher

• The objective of this mission is to determine the correlation between increased cosmic radiation with altitude and the rate at which soft errors occur in Static Random Access Memory (SRAM) and Flash Memory.

• The relationship, if any, among the magnetic field of the earth, the incident radiation, and error rate will be studied.

• We expect to prove that the soft error rate increases with altitude due to an increase in cosmic radiation.
Data Collected

CPM vs. Altitude

Altitude [ft]

CPM [counts/min]
Data Collected

Altitude vs. Time

Altitude [ft] vs. Flight Time [s]
Data Collected

Internal Temperature vs. Altitude
Data Collected

Magnetic Field vs. Altitude

Magnetic Field [Micro T] vs. Altitude [ft]

- Magnetic Field vs. Altitude
Memory Loop Errors

• A few things occurred when reading loop errors
  – Had two early recorded errors over 200
    • Seems very high for such a low radiation hit
  – No errors for an extended period of time
  – At very end the data become unusable
Items Fixed

– Idle to active mode: removed idle mode entirely
– Have heaters turned on from the beginning of flight
  • Have backup heaters (hand warmers)
– Battery life: heat and solid connection firmly ensured
– Arduino-Arduino interface was fine tuned
– SRAM was tested more thoroughly
– Weight reduction as to add the hand warmers
Design Changes

Assembled Payload

Exploded View

Locking Mechanism Removed
A Base
B Spring Plate
C Spring Assembly
D Lock Plate
E Core Locking Blades

Substantial Amount of Weight Removed
Assembled Core

Locking Mechanism Replacement

Locking Mechanism
Electronic Changes

• Increased variable size for Arduino-to-Arduino communication
• Clipped many solder leads that could cause shorts
# Test 1: Drop Test

**Objective:** Determine structural integrity of payload upon landing  
**Procedure Name:** Drop Test  
**Completion Date:** July 2, 2013

## Test Setup Overview:
Payload was dropped from an elevated platform that was 15’ 3” high onto a hard dirt surface. Structural integrity was determined upon recovery.

## Test Details:
- Electronics were simulated with weighted foam mockups
- Flight cord was not integrated during the test

## Test Results:
Top acrylic lid fractured upon impact but the inner core remained intact. This showed that all electronics would have most likely survived the impact.

## Open Issues:
If an SD shield fastener becomes detached during flight the memory chip could be released out the top of the payload.
Test 2 : Stair Test

Objective: Determine structural integrity of payload upon possible re-inflation of parachute after landing.
Procedure Name: Stair Test
Completion Date: July 3, 2013

Test Setup Overview:
Payload was pushed down a flight of 24 steel stairs that were 6 ¾ in. high and 44 in. wide.

Test Details:
- Electronics were simulated with weighted foam mockups
- Flight cord was not integrated during the test

Results: Top acrylic lid slightly fractured upon impact but the inner core remained intact showing that all electronics would have most likely survived impact.

Open Issues: If an SD shield fastener becomes detached during flight the memory chip could be released out the top of the payload.
# Test 3 : Whip Tests

**Objective:** Determine structural integrity of payload under worst case scenario acceleration and impact forces from other payloads.

**Procedure Name:** Overhead Whip Test, Drop Whip Test

**Completion Date:** July 8, 2013

## Overhead Whip Test Setup Overview
Payload was swung overhead for 30 seconds then a sudden directional change was implemented.

**Test Details:** Electronics were simulated with weighted foam mockups and a 6 ½ foot flight string was attached.

## Drop Whip Test Setup Overview
Payload was dropped from an elevated surface secured to an 8 ft. flight string to stop the fall.

**Test Details:** Electronics were simulated with weighted foam mockups.

**Results:** Slight impression in outer foam core from washers connecting the polyurethane foam to the fiberglass core. Otherwise, payload remained structurally intact.

**Open Issues:** None.
**Test 4 : Vacuum Test**

**Objective:** Determine if the high voltage Geiger Muller circuit will operate at the lowest pressure environment of the flight.

**Procedure Name:** Bell Jar Vacuum Test

**Completion Date:** July 19, 2013

**Test Details:** The pressure was dropped to 603 Pascal and held for 5 minutes to simulate lowest pressure in flight. Pressure was then brought back to room temperature and the payload was

**Test Setup Overview:**
Payload was powered on and then placed inside the bell jar vacuum.

**Results:** Geiger Muller tube counted radiation hits properly and the micro SD card successfully recorded them.

**Open Issues:** None.
### Test 5: Geiger Muller Tube Calibration

**Objective:** Determine if the Geiger Muller circuit is accurately calibrated.

**Procedure Name:** Calibration Test

**Completion Date:** July 17, 2013

<table>
<thead>
<tr>
<th>Test Setup Overview:</th>
<th>Test Details:</th>
</tr>
</thead>
<tbody>
<tr>
<td>Geiger Circuit was placed two meters away in the path of a known amount of Cesium 137. Readings were taken for three minutes.</td>
<td>An average of 21,320 counts per minute (cpm) of beta and gamma radiation were seen. Converting into mR/hr the radiation readings were compared to the known amount provided by the lab technician.</td>
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</tbody>
</table>

**Results:** Geiger Muller tube read 17.5 mR/hr and the data sheet showed approximately 18 mR/hr showing the calibration is accurate.

**Open Issues:** None.
Test 6: Day in the Life

Objective: Determine if all components will function properly for the duration of the flight.

Procedure Name: Day in the Life Test

Completion Date: July 23, 2013

Test Setup Overview: Completed payload was turned on for two and a half hours. Payload was taken outside, inside, and placed in a fridge.

Test Details: An average of 21,320 counts per minute (cpm) of beta and gamma radiation were seen. Converting into mR/hr the radiation readings were compared to the known amount provided by the lab technician.

Results: All components functioned properly throughout the entirety of the test. This instilled confidence in us that the device will function the entire duration of the flight.

Open Issues: None.
**Test 7 : Cold Test**

**Objective:** Determine if all components will function at the lowest temperature that will be encountered for an extended period of time.

**Procedure Name:** Cold Test

**Completion Date:** July 25, 2013

<table>
<thead>
<tr>
<th>Test Details:</th>
<th>Results: All components were able to be held above zero degrees Celsius until two hours and fifteen minutes in. At that point the battery powering the two heaters had died.</th>
</tr>
</thead>
<tbody>
<tr>
<td>The ice chest was maintained at – 69.6 degrees Celsius throughout the test. The internal temperature of the payload was monitored by a Trendicator to ensure the temperature did not drop below zero.</td>
<td><strong>Open Issues:</strong> Condensation forming on the inside of the lid may affect the electronics on the top tray.</td>
</tr>
</tbody>
</table>

**Test Setup Overview:** Placed the completed payload inside an ice chest with 15 pounds of dry ice for two hours.
Conclusion

• A few items that are expected
  – The added heaters will keep all electronics operating throughout the flight
  – Loop errors will be successfully read
  – Payload will remain structurally intact after a second launch
  – Will be able to verify all other sensors were operating properly by comparing to the previous launch data