Team Near Infinity

Final Presentation

Project

Light Year


December 8th, 2015
Mission Overview

Hypothesis:
1. Cosmic radiation will increase as a function of altitude.
2. The strength of the magnetic field of Earth will decrease as a function of altitude.

Mission Objective:
To use a BalloonSat to investigate the interaction between the magnetosphere and cosmic rays at increasing altitudes.

Why:
We are doing this mission to measure the radiation levels higher up in the atmosphere to be able to better protect pilots and astronauts who are exposed to this high altitude radiation.
Design
Concept of Operations

Launch:
- Went smoothly

Flight:
- Heater died
- Only 1hr 30mins of mission data
- Camera turned off

Landing:
- Went as planned
Original Design

YELLOW: GEIGER COUNTER
RED: HEATER
GREEN: SENSORS
BLUE: CAMERA

Final Design
Final Design

Flown Design
Functional Block Diagram

Diagram includes various components and connections such as:
- Arduinos (Arduino 1, Arduino 2)
- Sensors (Ext. Temp., Int. Temp., Pressure, Humidity)
- Batteries (9V Battery)
- SD Card
- Switches
- LED Indicators
- Geiger Counter
- Magnetometer
- Camera
- Heater
Results and Analysis
Radiation Expected Results
http://planet.weber.edu/harbor/FlightData/HAR110710FlightData/HAR110710.html

Magnetic Field Expected Results
http://www.ngdc.noaa.gov/geomag-web/#igrfwm
Radiation with Altitude

- Radiation increases initially
- Radiation levels begin to level out
- Burst, Geiger stopped writing data

Magnetic Field with Altitude

Balloon String was spinning, which resulted in sporadic readings from Magnetometer.
Accelerometer Expected Results Graph from 2014, Project RadSat

Humidity Expected Results
http://www.societyofrobots.com/images2/space_data_humidity_altitude.png
The graph on the left shows the acceleration over time, with labels indicating:
- **Launch**
- **Some spinning**
- **Burst and fall**
- **Landing**

The graph on the right illustrates the relative humidity over time, noting:
- Humidity should be decreasing over time
- Humidity should not oscillate during flight and after burst.
Temperature Expected Results
Pressure Expected Results http://www.physicalgeography.net/fundamentals/
Pressure decreases exponentially with altitude.
• Early turn-off
  o Heater
  o Arduino 2
  o Camera
• Temperature Issues
  o Internal Temperature reached -17°C
• Humidity Sensor
  o Strange readings from sensor
• Magnetometer
  o Lots of spinning resulted in readings that are hard to analyze
Early Turn-Off

- Heater Failure
  - Batteries on Arduino 2 get too cold
  - Battery loses charge due to low temperature
    - Arduino writes multiple files onto SD card due to low power
      - Data extracted is truncated due to multiple files written
  - Camera battery gets too cold
    - Battery loses charge due to low temperature
      - Camera turns off past the operable temperature
Failure Replication

- Repeat Cold Test
- Both Arduino’s wrote more than one data file
- Test showed that as the box got colder, the batteries lose charge
Humidity Sensor

Humidity

Relative Humidity (%) vs. Time (min)
Humidity should not be 120%
The forecasted humidity was about 10%, these readings are too high.

Relative Humidity

Relative Humidity (%) vs. Time (sec)
Humidity Sensor breathed on
The inconsistent nature of the humidity sensor made it impossible to replicate the failure. Concluded that sensor was broken.
Magnetometer

- Performed spin test to replicate flight data
- Held magnet up to sensor during test to detect change
- Replicated range of flight data
- Found similar results
- Used spin test graph range on flight data
- Found little change in magnetic field
Conclusions

• No observable change in magnetic field
  o Earth’s magnetic field extends far above atmosphere
• Increase in radiation
  o Less deflecting atmospheric particles
• Gathered data disproving the Team’s hypothesis
Ready to Fly:

• Storage:
  o Upright with UP arrow in correct direction
  o Must be handled carefully
  o Any batteries stay disconnected until flight

• Flight
  o Must replace humidity sensor
  o Install new 9V batteries
  o Seal with aluminum tape
  o Turn each switch to on position to gather data
Acknowledgements:

- We would like to thank:
  - Professor Koehler
  - Colorado Space Grant
  - Michael Schefferstein
  - Edge of Space Sciences
Appendices
Appendix: Message to Fall 2015

When organizing your wires, DO NOT use too much electrical tape. Instead, use zip ties as well as labels showing where each connection goes. Organization will help tremendously in the end result, even if it seems like busy work at the time. Second, something is bound to go wrong, whether it is the day before launch or the weeks leading up to it. Remember that nothing you build is perfect the first time. Lastly, you are not done with this class immediately after launch. There are still many things to do including analysis and failure analysis. Make sure your team keeps meeting and stays on top of the work that needs to be done.
Appendix: Lessons Learned

• More testing of possible failures pre-flight

• Organization within the team
  o Better scheduling
  o Evenly distribute work

• Organization within payload
  o Labeled wiring
  o Less electrical tape
Appendix: RFP Compliance

Project Light Year shall comply with the requirements set by the Request for Proposal as part of the class.

Team Near Infinity shall measure interior and exterior temperature, humidity, acceleration, and pressure.

Team Near Infinity shall measure gamma and beta radiation as a function of altitude

Team Near Infinity shall measure the strength of the magnetosphere as a function of altitude

Team Near Infinity shall compare the data from the Geiger counter and magnetometer in order to find a correlation between the data.

Project Light Year weighed in at 863 grams, passing the weight requirement. Project Light Year met all requirements listed on RFF card. Project Light Year flew to 95,000ft. in altitude collected data for the Team’s mission

Project Light Year carried each required sensor. Team Near Infinity did not meet the temperature requirement of -10 degrees C or higher. The humidity sensor did not read correct data.

The Team flew a Geiger counter to complete their mission

The Team flew a magnetometer to complete their mission

Data from the Geiger counter and magnetometer were successfully analyzed, but the data disproved the team’s hypothesis.
Appendix: Budgets
<table>
<thead>
<tr>
<th>Instrument</th>
<th>Source</th>
<th>Company Contact Information</th>
<th>Part Number</th>
<th>Proposed Cost</th>
<th>Actual Cost</th>
<th>Weight</th>
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<tbody>
<tr>
<td>BalloonSat Structure (including hot glue and aluminum tape)</td>
<td>Gateway</td>
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<td>Provided</td>
<td>120g</td>
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<tr>
<td>Geiger Counter</td>
<td>SparkFun</td>
<td>6333 Dry Creek Parkway Niwot, CO 80503</td>
<td>SEN-11345</td>
<td>$119.96</td>
<td>$119.96</td>
<td>200g</td>
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<tr>
<td>Replacement Geiger Tube</td>
<td>SparkFun</td>
<td>6333 Dry Creek Parkway Niwot, CO 80503</td>
<td>COM-08875</td>
<td>Unexpected purchase, proposed cost was $0.</td>
<td>$75.16</td>
<td>Included in Geiger Counter</td>
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<td>Price</td>
<td>Amount</td>
<td>Description</td>
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<tr>
<td>Dry Ice</td>
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<td>1650 30th St, Boulder, CO 80301</td>
<td>$15.00</td>
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<tr>
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<td>External Temperature Sensor</td>
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<tr>
<td>Humidity Sensor</td>
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<tr>
<td>Canon Camera</td>
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<td>Heater Kit</td>
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<td>Smoke Detectors (2)</td>
<td>McGuckin's</td>
<td>2525 Arapahoe Ave Boulder, CO 80302</td>
<td>(303) 443-1822</td>
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<td>Sticker Paper</td>
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<td>1- (888) 280-4331</td>
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# Appendix: Final Parts List

<table>
<thead>
<tr>
<th>Part</th>
<th>Number</th>
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<td>Geiger Counter</td>
<td>SEN-11345</td>
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<tr>
<td>Replacement Geiger Tube</td>
<td>COM-08875</td>
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<td>Triple Axis Accelerometer Breakout</td>
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<td>Internal Temperature Sensor (TMP36)</td>
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<td>Pressure Sensor</td>
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<td>Humidity Sensor (HH-4030 Breakout)</td>
<td>SEN-09569</td>
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<tr>
<td>Canon Camera</td>
<td>PowerShot A3400 IS</td>
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<tr>
<td>Heater Kit</td>
<td></td>
</tr>
<tr>
<td>Magnetometer (MAG3110)</td>
<td>SEN-12670</td>
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<tr>
<td>Logic Level Converter</td>
<td>BOB-12009</td>
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