Community Colleges of Colorado
Full Mission Simulation Report

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April 29, 2016
1.0 Mission Overview

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Mission Overview

Successfully launch an inter-school payload.
  • Test viability of Carbon Fiber for radiation shielding
  • Gather successful Cherenkov radiation data from a low-cost GoPro based RICH detector
  • Test durability of DNA under physical conditions of ascent and reentry.
Conceptual Ops

Data collection begins before launch and lasts until battery dies

Points of interest:
- Altitudes of interest for radiation experiments
- Forces, and spin rate are highest for Biological RICH detector, highest energy particle readings

Altitude

- Spin rate at maximum
- Start of Apparent Weightlessness

- End of Apparent Weightlessness

Pfotzer maximum ~50 km

- Early activation
- Begin data collection
- High force at launch related to DNA experiment

Altitude: 95 km

Apogee

- Altitude: ~115 km
- t ≈ 2.8 min

End of Orion Burn

- Altitude: 52 km
- t ≈ 0.6 min

Highest Geiger counter reading

- t ≈ 4.0 min
- Altitude: 95 km

Splash Down

- t ≈ 15 min

RockSat-C 2015
FMSR
2.0 Integrated Subsystem Testing Status

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Integrated Subsystem Testing Status

• **Structure:**
  - Center of mass currently at {.193",-.405",-.738"} offset from geometric centroid of payload.
  - Mass currently at **13.955 lbs.** without partner payload, but with the bottom makrolon plate and canister (including canister mid-plate).
    - Canister weight: **8.124 lbs**
    - Payload weight, including base makrolon plate: **5.831 lbs**
  - All individual components fit spatially on payload
  - 4 of 5 bolts will be used for mounting plate to canister
  - New bolts (slightly longer) are being purchased to achieve 2-thread compliance.

• **RICH:**
  - RICH construction completed, mechanically integrated into payload.
  - Final electrical integration pending, tbc 4/29/16
  - Tested on DemoSat flight - particle detection successful, results on subsequent slides.

• **Electronics:**
  - All subsystems have been wired and integrated.
  - Activation wires have been added and meet length and gauge requirements
  - Final placement dependent on center of mass needs
  - All attachment plates have been constructed
Integrated Subsystem Testing Status

• Geiger Counter/Shielding:
  ○ Geiger board construction complete, mechanically integrated into geiger box.
  ○ Geiger board integration into flight computer complete, fully successful.
  ○ Carbon fiber shield complete, integrated into payload.
  ○ Geiger box construction complete, mechanically integrated into payload.
  ○ Testing performed separate from integration, successful, data on subsequent slides
  ○ Logging and accuracy tests performed once integrated into flight computer, both successful.

• DNA Containment:
  ○ Outer shell construction complete, mechanically integrated into payload.
  ○ Lid construction complete, mechanically integrated into payload.
  ○ Inner bio-sample containment construction complete, integrated into payload.
    ■ Secondary containment waterproof test completed 4/27/16, successful
  ○ All shearing tests on DNA have been completed.

• Sensor Package/Data Collection:
  ○ Piezo accelerometer integrated into payload, adding additional for accurate data
  ○ SD Logging system integrated into flight computer, fully tested.
  ○ Pressure/Temp sensor integrated into flight computer, accurate data, pending I2C bug-fixes
  ○ 9dof accelerometer integrated into flight computer, pending I2C bug-fixes, pending data confirmation
Integrated Subsystem Testing Status: RICH

- RICH detector construction is complete
- Magnesium Fluoride lens securely attached to CMOS
- Code to run the GoPro and exposure values completed and tested
- RICH detector box (Mounting system) printed and flight ready
- Battery life and data storage capacity tests run and passed
- RICH successfully survived Balloon flight and collected data
- RICH box structurally integrated onto payload, full electronic integration pending
Data collected from balloon flight and from Strontium-90 radiation exposure on the ground was analyzed using a variety of methods

- High/Low pass filtering
- Thresholding and Binary image processing

Particle traces were found using binary image analysis.
Integrated Subsystem Testing Status: Geiger

1.0 Shielded & Unshielded Geiger Assembled

Verified and calibrated the function of both geiger boards together

Test was completed on April 26th

Additional tests will be conducted with full electronics integration
Integrated Subsystem Testing Status: DNA

- Two viable versions of bio-experiment secondary containment, different mass, different waterproofing specs
- Both pieces meet fluid containment requirements.
- All pieces have been constructed, assembled and attached to plate.
- Final filling of tubes and insertion into containment to be completed prior to leaving for Wallops.
- All DNA shearing tests have been completed
Electrical Testing Status: Sensors

Piezo Vibration Sensor

- Need a second to measure lateral acceleration; will be ordered week of 5/1
- Currently processing data from sensors to determine correct way to extract info we need (tbc 5/8/16)
- Sensor logs expected data consistently.
Software Testing Status: Flight Computer

- Ability to log sensor and flight data to SD card tested and working
- Flight computer software tested and working
- Accurate Geiger data collection confirmed
- Accurate pressure and temp collection confirmed (prior to I2C bug)
- **Action item:** Squash I2C communication bug - was working perfectly, now fails at the base communication level. Testing alternate hardware and working from ground up. (needed for temp, pressure, and backup accelerometer collection)
- **Action item:** Accurate backup accelerometer data collection confirmation needed
Integrated Subsystem Testing Status: Electronics

- Geigers to main flight computer (Apr27)
- RICH GoPro to flight computer (Apr29)
  - Runs on internal power source
  - Auto-shutoff in case of delayed launch
- Early activation wires of correct length and gauge (4’, 24 AWG)
- Final mounting location dependant on center of mass, all mounting plates have been constructed

75%
Integrated Subsystem Testing Status: C.O.M.

- Center of Mass (C.O.M.)
- These calculations are for our payload only, not combined with SIT
- On the horizontal, .4485” from center
- On vertical we are .7388” from center.
- This calculation is an estimate based on estimated ballast and electronic placement.
- We only have 12g of ballast
- See appendix A for more detail.
3.0 Full Mission Simulation Results

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Full Mission Simulation Results

• Full Mission Simulation Test Delayed
  – All components (waterproofing, software, structure, electronics, data collection, etc.) have been tested individually and are being integrated into canister currently.
  – All components have been installed on plate without electronic activation and fit as expected.
  – Regulatory compliance is expected to be met.
  – First full mission simulation test scheduled for night of Friday, 4/29 after full payload integration is complete.
4.0 Project Management Update

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Action Item Summary

• Geiger counters:
  – Final securing of boards to cradle (tbc 4/29/16)
  – Minor modification to wireway in carbon fiber shielding (tbc 4/29/16)

• RICH
  – Final adjustments for RICH detection (tbc 5/5/16)

• Electronics:
  – Activation wire attachment (tbc 4/28/16)
  – Order, receive, and integrate additional piezo for vibration sensing (tbc 5/5)
  – Final attachment of RICH to power activation circuit (tbc 4/28)
  – Final attachment of Geiger counters to flight computer (tbc 4/28)
  – Final mounting of flight computer to flight-computer mounting plate (tbc 4/29)
  – Final mounting of sensors, flight computer, and other breakouts to payload (tbc 4/29, c.o.m. dependent)
Action Item Summary

- **Software:**
  - I2C Bug squash (tbc prior to 5/1/16)
  - Confirm accurate data received from 9dof orientation sensor (tbc 5/1/16)
- **Bio:**
  - Final attachment of experiment to plate (tbc 4/28/16)
  - Drill hole in lid for flipped attachment (tbc 4/29/16)
  - Filling tubes, inserting tubes into containment (tbc prior to leaving for Wallops)
- **Structure:**
  - Finalize ballast placement and necessity, attain more optimal center of mass
  - Replace bolts with slightly longer variant for 2-thread compliance (tbc 4/29/16)
  - Full simulation test scheduled 4/29/16
## User Guide Compliance

<table>
<thead>
<tr>
<th>Requirement</th>
<th>Status/Reason (if needed)</th>
</tr>
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<tbody>
<tr>
<td>Center of gravity in 1&quot; mid-can?</td>
<td>.74” low on z-axis</td>
</tr>
<tr>
<td>Contained in can</td>
<td></td>
</tr>
<tr>
<td>Connected to can by 4/5 bulkheads on top and bottom only</td>
<td>4 of 5 bottom (shared canister)</td>
</tr>
<tr>
<td>Mass at 20±0.2lbs</td>
<td>19.9 lbs pre-ballast</td>
</tr>
<tr>
<td>Shared canister clearance</td>
<td>~.5” separation between payload and plate, established clearance plan with partner</td>
</tr>
<tr>
<td>No voltage on the can</td>
<td>No opportunity to check yet, very minimal concern</td>
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<tr>
<td>Activation wires at least 4 ft</td>
<td></td>
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<tr>
<td>Activation wire at least 24 gauge</td>
<td>24 gauge</td>
</tr>
<tr>
<td>Early Activation: current &lt; 1 A</td>
<td>Unknown at moment, less than 1A expected</td>
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<td>T-0 Activation: current &lt; .1 A</td>
<td>Not using</td>
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<tr>
<td>Battery Type</td>
<td>Lithium Polymer (will not charge at Wallops)</td>
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</table>
Biggest Worries

• Possible center of mass/ballasting concern
  ○ Flipped installation of bottom-heavy bio cradle, strategic ballast/electronics mounting locations

• Minimal data from partners, awaiting exact mass data
  ○ Planning conference call with team leaders next week

• I2C bug
  ○ Further debugging/testing, more attention/focus upon full integration
Conclusions

- Working hard! Almost there!

- Discuss Check-In Procedure – you don’t have to put anything here, this is just an FYI that we will be talking about this (I will be quizzing you on it so be familiar!)

- Discuss Presentation to RockOn! 2015

- Discuss Final Report

- Discuss extra launch attendees
<table>
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<tr>
<th>Component</th>
<th>weight grams</th>
<th>x</th>
<th>x*weight</th>
<th>y</th>
<th>y*weight</th>
<th>z from top of our plate</th>
<th>z*weight</th>
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<td>Bio cradle big shell</td>
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<td>Bio bolt Middle</td>
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<td>Mounting plate</td>
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<td>14.8494</td>
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<tr>
<td>bolt botom left</td>
<td>6</td>
<td>-2.4749</td>
<td>-14.8494</td>
<td>-2.4749</td>
<td>-14.8494</td>
<td>-0.24</td>
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<tr>
<td>bolt middle</td>
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<td>0</td>
<td>0</td>
<td>0</td>
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<td>-1.44</td>
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<td>6</td>
<td>2.4749</td>
<td>14.8494</td>
<td>2.4749</td>
<td>14.8494</td>
<td>-0.24</td>
<td>-1.44</td>
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### Appendix A2

<table>
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<tr>
<th>Battery</th>
<th>43.7</th>
<th>-2.6241</th>
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<td>Electronics flight controller</td>
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<td>1.3918</td>
<td>73.7654</td>
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<td>190.8 on top of shield 04-28</td>
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<td>Extra electronics</td>
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<td>-1.6587</td>
<td>-157.07889</td>
<td>-2.1173</td>
<td>-200.50831</td>
<td>3.6</td>
<td>340.52 big battery which is .05g heavier. Placed on bio side by geiger 04-28</td>
</tr>
<tr>
<td>Electronics tray</td>
<td>49.9</td>
<td>1.3918</td>
<td>69.45082</td>
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<td>-91.56151</td>
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Final weight should be 2693g

<table>
<thead>
<tr>
<th>28-Apr</th>
<th>David's Weight Calculation</th>
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</thead>
<tbody>
<tr>
<td>My bolt weight</td>
<td>339.5</td>
</tr>
<tr>
<td>Davids bolt weight</td>
<td>308.89</td>
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</table>

Could account for extra weight, but I will leave it in because the Bio tube bolts are not included in this.

max weight 5.938lbs 2693.4315g

```
<table>
<thead>
<tr>
<th>lbs</th>
<th>g</th>
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<tbody>
<tr>
<td>total canister</td>
<td>8.124</td>
</tr>
<tr>
<td>makroden baseplate</td>
<td>0.607</td>
</tr>
<tr>
<td>Bio, w/container+ s</td>
<td>1.314</td>
</tr>
<tr>
<td>Shield</td>
<td>1.819</td>
</tr>
<tr>
<td>RICH</td>
<td>0.363</td>
</tr>
<tr>
<td>All bolts/nuts</td>
<td>0.681</td>
</tr>
<tr>
<td>electronics</td>
<td>0.422</td>
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<tr>
<td>geiger cradle</td>
<td>0.515</td>
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<td>electronics tray</td>
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