ISTR
INTEGRATED SUBSYSTEM TESTING REVIEW
April 5th, 2017
Team Members

Student Researchers
- CODY RIVERA
- JESSE MALITESE
- ZAHRA ARABZADA
- DUNIYA SYED
- HAYES TORRENCE
- EMILY KREPS
- WILLIAM ORTLIEB
- CHASE BROWN
- JASPER WHITE

Student Advisors
- CHRISTOPHER DEMAS
- FRANK OPLINGER
- JEFFREY RIZZA

Faculty Advisors
- ILEANA DUMITRIU, Ph.D.
- PETER J. SPACHER, Ph.D.
Mission Overview
Mission Goals

- Our mission is to measure atmospheric muon flux with a solid state scintillator, the intensity of different visible wavelengths with a Hamamatsu spectrometer through an optical port, and use Geiger detectors to model the mitigation of gamma and beta radiation with different levels of shielding.
- Furthermore, we will also include an outreach program to work with students at the high school and middle school level in Geneva, New York, to promote and advance students’ interest in Science, Technology, Engineering, and Mathematics (STEM)
Concept of Operations

Altitude (km)

Medium Muon Flux, Radiation, and Light Intensity
- $t \approx 1.3$ min
- Altitude: 75 km

End of Orion Burn
- $t \approx 0.6$ min
- Altitude: 52 km

Apogee
High Muon Flux, Radiation, and Light Intensity
- $t \approx 2.8$ min
- Altitude: $\approx 115$ km

Medium Muon Flux, Radiation, and Light Intensity
- $t \approx 4.0$ min
- Altitude: 95 km

$\approx 15$ min
Splash Down
Payload Turns off

$-3$ min
- All systems activated
- Begin data collection
Modifications Since STR (Brief Overview)

- Muon Detector has modified its whole design.
- Spectroscopy Subsystem has not modified anything since STR.
- Radiation Subsystem has modified its overall layout since STR.
Modifications Since STR (Radiation)

- The layout of our Mighty Ohm Geiger Counter Radiation Kits and our Arduinos, on the top plate of our payload, has been re-organized. As a result, the location of our L-Brackets, which are used to mount the Radiation Kit to the top plate, has been modified.
- We reduced the use of our Arduinos from four to two Arduinos.
- The shielding material for the Geiger Tubes have been modified to only consist of Hemp Filament and PLA Filament, both are 3D printing plastic material.
Subsystem Status
# Power Budget

<table>
<thead>
<tr>
<th>Component</th>
<th>Max Voltage(V)</th>
<th>Current(mA)</th>
<th>Start time(s)</th>
<th>Running Time(s)</th>
<th>Watts(mW)</th>
<th>Milliamp hours(mAh)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Spectrometer</td>
<td>5</td>
<td>500</td>
<td>-180</td>
<td>1320</td>
<td>2500</td>
<td>183.3</td>
</tr>
<tr>
<td>Arduino/Temp probe</td>
<td>12V</td>
<td>50</td>
<td>-180</td>
<td>1320</td>
<td>600</td>
<td>18.34</td>
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<tr>
<td>Berkley Circuit</td>
<td>5V</td>
<td>50</td>
<td>-180</td>
<td>1320</td>
<td>250</td>
<td>18.34</td>
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<tr>
<td>SiPM</td>
<td>25 V</td>
<td>0.36</td>
<td>-180</td>
<td>1320</td>
<td>8.64</td>
<td>0.132</td>
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</tbody>
</table>

(GM tube power consumption is negligible)
Muon Detector Subsystem Status

- We have had significant issues procuring the specific wave shaping and amplification (Berkley) circuit, which is halting progress and integration plans. In order to get around this we are considering the previous years tactic of building a much simpler detector that makes use of some of the GM tubes leftover from other subsystems. Given the current circumstance the probability that we opt for this simpler design is high.
Muon Detector Subsystem Status

- Our concerns are primarily based in the electronics in our own subsystem. However, the integration of our electronic systems with the other subsystem was taken into account in the design. Our only integration concerns at the moment are the same as those mentioned above. This is in light of possible last minute design changes. Should we chose to built the simpler model, we will have to work with other subsystem to ensure it does not impact them mechanically.
MUON, Previous year’s GM tube design

Side-view

GM tubes
Lead plates

Top-down view

GM tube circuit board
MUON, Previous year’s GM tube design (cont.)

Bottom-up view

- Arduino (contains a comparator circuit)
- Battery holders
- SD card
Spectroscopy Mechanical Schematics
Spectroscopy Electrical Schematics
Spectroscopy Electrical Schematics
Spectroscopy Electrical Schematics
Spectroscopy Software Schematics
Spectroscopy Science/Optical Port

- Records the visible spectrum at each altitude
- Spectrometer is attached to a plexiglass mount which allows it to see out of the optical port halfway down the canister.
SPEC Mounting

- The Spectrometer will be held within a 3D printed casing
- The Plexiglas mount will be secured to the payload using threaded screws
- From previous launch experience we know that the hardware provide enough structural stability to hold spectrometer in place
Spectroscopy Initial Testing

Ambient Light Testing

Dark Testing
Spectroscopy Calibration One

Neon Light Testing

Neon Light Spectrum
Spectroscopy Calibration Two
Radiation Mechanical Schematics
Radiation Electrical Schematics
Radiation Electrical Schematics (Contin.)
Radiation Subsystem Testing Status

- We have not tested our radiation sensors or arduinos.
- We have tested our 3D printing PLA plastic material for the L-Brackets that will mount the radiation sensor to the top plate.
Radiation Subsystem Status

- 3D Printed Mold
- The Geiger Muller tubes will be held by 3D printed molds that we lock down the circuits onto the top platform of the payload.
- [The mold will be 3D printed later today and the images will be uploaded.]
Radiation Subsystem Status

- 3D Printed shielding encasement
- The radiation subsystem has 3D printed the shielding for the Geiger Tubes. The shielding has been printed using plastic and hemp plastic.
- [Image of the casing will be inserted to the right later today.]
GSat-1 Outreach Program Mission

- Our team included an outreach program to work with students at the middle school level in Geneva, New York, to promote and advance students’ interest in Science, Technology, Engineering, and Mathematics (STEM)
GSat-1 Outreach Program Benefits

- The HWS Outreach Program expects to
  - Increase student opportunity and participation in Science, Technology, Engineering and Mathematics.
  - Teach students about electronics, 3D printing, payload design, and workshop.
  - Have middle school students work with a college institution, college professors, and college students.
  - Encourage kids to attend college
  - Increase middle school college campus visits to physics and architecture department.
  - Have students gain experience working on a rigorous team project.
  - Teach students how to push boundaries and get out of their comfort zone.
  - Have their constructed Radiation Sensor be attached to a rocket and sent into space.
  - Watch a rocket launch through a live streamed video.
GSat-1 Outreach Program Schedule

- 4.4.17 Geiger Counter Kit Workshop (Location: Geneva Middle School)
- 4.6.17 Geiger Counter Kit Workshop (Location: HWS Colleges)
- 4.11.17 Geiger Counter Kit Testing (Location: Geneva Middle School)
- 4.13.17 Geiger Counter Kit Integration (Location: HWS Colleges)
- 4.18.17 Final Integrative Testing with HWS
- 4.20.17 Lab workshop: Drone Launch
- 4.25.17 Lab Workshop: Balloon Launch
- 6.22-25/17 LAUNCH DAY. Live video feed.
GSat-1 Outreach Program Progress Update

- We are now in our sixth week of the GSat-1 Program.
- So far the middle school students have completed a
  - Full campus tour
  - Soldering a Siren Practice Kit
  - Soldering a Voice Changer
- As of Tuesday, April 4th, the students started soldering and constructing the Mighty Ohm Geiger Counter Radiation Kit.
Integrated Subsystem Testing Status
Integration Subsystem Overview

- Our three subsystems operate independently
- Most of the challenges that we face has to do with the mechanical component of integration, not testing multiple subsystems together.
Project Management Update
Schedule (MUON)

Due to the likelihood that we will be doing the simpler design, instead of the older design requiring the Berkley wave-shaping circuit, the schedule below will be for the GM tube design.

Week 1: Building the two GM tubes, and GM tube circuit boards needed to make a coincidence circuit

Week 2: Building the coincidence circuit for the arduino

Week 3: Assembly of mechanical design (lead sheets, GM tubes, arduino)

Week 4: Integrated System Testing
## SPEC Budget

<table>
<thead>
<tr>
<th>Component</th>
<th>Cost</th>
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<tr>
<td>Arduino Mega</td>
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<td>Hamamatsu C12880MA Breakout Board</td>
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<td>Hamamatsu C12880MA Micro-Spectrometer</td>
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<td>Thor Labs NDUV513B Neutral Density Filter</td>
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<td>Thor Labs NDUV540B Neutral Density Filter</td>
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<td>Adafruit Data Logging Shield</td>
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<td>Adifruit SD Card</td>
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<td><strong>Total</strong></td>
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# RAD Budget

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<tr>
<th>Product</th>
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<tr>
<td>Arduino Uno</td>
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<tr>
<td>Geiger Müller Kits</td>
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<td>Shielding Materials</td>
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<tr>
<td>Adafruit SD Card</td>
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**Total**: 1704.84
# MUON Budget

<table>
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<th>Item</th>
<th>Supplier</th>
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<th>Quantity</th>
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<td>Arduino Uno</td>
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<td>SiPm</td>
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<td>Pre-Amp</td>
<td>Mini Circuits</td>
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<tr>
<td><strong>Total</strong></td>
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<td></td>
<td><strong>$1,274.85</strong></td>
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</table>
The above budget is for the original design, should we opt for the other, simpler design, then it will only require us to buy lead for plates in between the two GM tubes. The cost of this is well within the boundaries set by the original design, whose budget has largely not been dug into yet.