Mission: To embark on a collaborative effort with academic institutions across the state of West Virginia for development of knowledge and practical experience in designing, building, launching, and operating space payloads.
Advisors: Steven Hard (IVV), Dr. Jon Saken (MU), Dr. Dimitris Vassiliadis (WVU), Dr. Tracey DeLaney (WVWC), Dr. Farshid Zabihian (WVU-Tech), Dr. Ralph Wojtowicz (SU)

School Names: West Virginia University, Marshall University, West Virginia Wesleyan College, WVU-Tech, Shepherd University, Fairmont State University

NASA Collaboration: NASA Independent Verification & Validation Facility

6/9/2015
1.0 Mission Statement, Requirements, and Expected Results

Mission objective: capture NIR images of Earth from space, measure Earth’s magnetic field, compare accuracy of redundant flight dynamics data, & detect ionized particles.

Requirements: system shall provide knowledge and hands-on experience to students, system shall be able to save data during flight for post analysis

Expected Results: B-field/IMU correlation and Earth pointing images of land masses

Benefits SmallSat community with low cost COTS orientation estimation

2.0 Final Payload Design

Final System Block Diagram:

Integrated Mechanical Design:
Full Canister Mechanical Design:
Canister Integration:
Final Mass Budget:

<table>
<thead>
<tr>
<th>Component</th>
<th>Weight (lbf)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Target Weight (lbf)</td>
<td>10</td>
</tr>
<tr>
<td>Target Payload Weight (lbf)</td>
<td>4.9</td>
</tr>
<tr>
<td>Total Payload Weight (Full Canister w/ Mid-Plate)</td>
<td>12.01</td>
</tr>
<tr>
<td>Payload Dry Weight</td>
<td>3.31</td>
</tr>
<tr>
<td>Total Ballast Weight</td>
<td>1.59</td>
</tr>
<tr>
<td>Al Ballasts</td>
<td>1.14</td>
</tr>
<tr>
<td>Washer Ballasts (x26)</td>
<td>0.45</td>
</tr>
<tr>
<td>Total</td>
<td>10</td>
</tr>
<tr>
<td>Over(+)/Under(-)</td>
<td>0</td>
</tr>
</tbody>
</table>

3.0 Testing Results

A. Integrated Subsystem Testing Results
High Altitude Balloon Integration:

High Altitude Balloon Launch:
B. Full Mission Simulation Results

High Altitude Balloon Launch:
- Date performed: 5/23/2015
- Launch Location: Bruceton Mills, WV
- Landing Location: Round Hill, VA
- Distance traveled: 106 mi
- Altitude reached: 67,000 ft
- Total duration: ~5hr45min
- Scenario: Individual battery powered subsystems arranged in 3 separate boxes: Tracking, SPACE-x4, and WVU-CAM/IVV-ARC (ARC not flying on RSC2015)
  - Mishap occurred during process of filling balloon with helium when pinhole developed near fill neck of balloon with less than target lifting force
  - Crisis averted by tying the balloon off past the pinhole, thereby sacrificing some balloon volume and ultimately overall altitude achieved (we expected to go near 100,000 ft)
Due to the lack of lifting force, balloon did not lift all 3 payload boxes
- Strategic placement of boxes allowed easy removal of WVU-CAM payload box to salvage the launch

Testing Summary:
- Marshall – Flew, battery powered, data not yet reduced, devices verified to be operation post payload retrieval
- Shepherd – Flew, battery powered, data not yet reduced, devices verified to be operation post payload retrieval
- WVWC – Flew, not powered due to voltage regulator issues, verified devices working properly after Vreg fixed
- WVU-Tech – Did not fly due to software development efforts taking precedence over flight time
- WVU-Cam – Did not fly due to HAB filling mishap

- Value gained: verified COTS devices and PCBs operate for extended periods in upper atmosphere conditions for SPACE-x4 payloads

Orbital-ATK Vibration Testing:
- Date performed: 6/4/2015
- Vibration tests:
  - Testing setup
    - Total Duration: ~30 mins
  - 20-2000 kHz
    - Total duration: 2m33s
  - Random Sine
    - Total Duration 3m
- Scenario: all payloads except Marshall U were powered on with 12 V power distribution board for full duration of setup and testing
  - All payloads working properly after testing with exception of WVWC – some jumper wires came unsoldered
- Value gained: some weak points were found through testing and all required fixes were implemented
## 4.0 Launch Readiness

### A. 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>Yes</td>
</tr>
<tr>
<td>Contained in can</td>
<td>Yes</td>
</tr>
<tr>
<td>Connected to can by 4 or 5 bulkheads on top and bottom only</td>
<td>Yes</td>
</tr>
<tr>
<td>Mass at 20±0.2lbs</td>
<td>Yes</td>
</tr>
<tr>
<td>Shared canister clearance</td>
<td>Yes</td>
</tr>
<tr>
<td>No voltage on the can</td>
<td>Yes</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>Yes</td>
</tr>
<tr>
<td>Early Activation: current &lt; 1 A</td>
<td>Yes</td>
</tr>
<tr>
<td>T-0 Activation: current &lt; .1 A</td>
<td>Yes</td>
</tr>
<tr>
<td>Battery Type</td>
<td>Lithium Ultimate AA Batteries (No recharge)</td>
</tr>
</tbody>
</table>
B. Integration Plan and Procedure
This section includes a brief description of the WV Rocketeer integration plan, and the full integration plan and procedure is attached as an appendix to this document.

- Arrive at Refuge in ~1pm and set up in conference room
- De-integrate payload from last year’s canister
- Integrate payload sections into bottom bulkhead and mid-mounting plate
- Sync with Temple U and attach canister skin
- Run through checklist before check-in

C. Action Item
This section is very important and will be referenced upon arrival at the Refuge Inn. List are the action items left to complete before arriving at Wallops:
- 3D print new version of Rpi/NIR camera mount and battery holder
- Mount Al and Steel washer ballasts
- Integrate Marshall University payload and refit/reweigh. Adjust washer ballast weight if necessary
- Finalize camera software settings for launch scenario

5.0 Conclusions (0.5 to 1 page)
Feeling good overall, we are 95% integrated with a placeholder for Marshall U. I’m just concerned that mounting holes will not match up and an adapter plate will need to be made

6.0 Appendices
Vibration printouts from ATK vibration testing:
Integration Plan:

- Receive payload from Marshall university: 6/15
- Final fit check and integrated test: 6/16
- Arrive at Refuge Inn: 6/18 @ 1pm
- 2014 canister de-integration
  - Remove bottom bulkhead
  - Remove mid-plate
  - Remove Makrolon plates from bulkhead and mid-plate
  - Unfasten all cameras, ballasts, staked wiring, and Velcro.
  - Unfasten all PCBs
  - Remove protective film on Makrolon plates
- 2015 canister integration
  - Reverse the process for integration into 2015 canister
  - Run through check-in procedure prior to actual check-in (3pm)