Launch Readiness Review (LRR) Document

**OSU: The Water Bears**

*The study of tardigrade’s reactions to microgravity for the advancement of research in organism’s reaction to microgravity.*

Student Names: Alexis Kennaday, Cristina Martinez, Sophia Zhang

Advisor Names: Randall Milstein

School Names: Oregon State University

Submittal Date: 06/06/2015
1.0 Mission Statement, Requirements, and Expected Results

The study of tardigrade’s reaction to microgravity for the advancement of research in organism’s reaction to microgravity.

In order to have a successful experiment we need to record the extremophiles throughout their exposure to microgravity (above 100km altitude), while also quantifying the environment they are being sustained in.

We expect to discover that the tardigrades will be able to maintain their natural activity levels while being exposed to microgravity regardless of the environment they are placed in.

2.0 Final Payload Design

In the final design, our microscope cameras are still reliant upon the BeagleBone Blacks. The following description will go in order from our bottom plate that attaches to the LBCC payload to the lid of the canister. Plate One will hold the Arduino Mega2560 with the according power supply of a 9V Lithium battery. It will also hold one of the BeagleBone Blacks with a power supply of 4 AAA batteries, as well as the PCB board that is the main control of the powering of systems. The Second Plates holds the other two BeagleBone Blacks with their respective power supplies of 4 AAA batteries, we also intend on placing a momento box on this plate. The Third Plate has all three of the microscope cameras, as well as the environments, the loops that will hold the cameras together, and the secondary containment. This plate will then attach the the fourth and final plate. The sole purpose of the final plate is to attach to the lid of the canister, there is no experimental gain from this particular plate, besides security.

Final Mass Budget:

Our payload currently weighs about 5.12 pounds. We will add ballast to not only distribute weight equally along the x and y axes, but also to help reach the goal weight of 20 pounds +/- 0.2 pounds with LBCC’s payload.
Final Function Block Diagram (above)

Final Schematics:

G-Switch Schematic (above)
Payload inside the Canister (OSU)  
Payload outside the Canister (OSU)  
Payloads in Canister (OSU, LBCC)  
Payloads outside the Canister (OSU, LBCC)  
Final 3D Design of payload (OSU and LBCC) (below)
3.0 Testing Results
A. Integrated Subsystem Testing Results

All of the plates are mechanically integrated safely. We still need to attach the secondary containment on the third plate to secure the microscope cameras. We also still need to add ballast to balance the weight on the payload as well as meeting an ideal payload weight.

The electrical/power subsystem is complete. We ordered a PCB to connect all of the micro-controllers to batteries and used plugs to connect the G-Switch, armed wire with the LED at the end, and header connections to reach the power and ground pins on all the micro-controllers. Additionally, the Arduino Shield is connected onto the Arduino Mega 2560 with male headers.

The software subsystem is complete. The Arduino board is programmed to run the code for the 3-axis accelerometer once the G-Switch is triggered. Data from the accelerometer is stored onto the microSD card on the shield. The three micro-controllers are programmed to store captured video onto the microSD card. The video is stored as a .raw file that can be later compressed.

The science subsystem is complete. The three cameras can be mounted securely and focused enough to observe the location where the tardigrades are visible. The slides are secured in their holder and keep the cameras from being flush against the slides to avoid pressure on the glass. New slides will be made prior to integration on the sounding rocket in order to have the most active tardigrades in order for them to not go dormant during the days prior to launch. And observations reveal that most tardigrades do not go into their tun state until weeks after the slide is made, making the wait time on the rocket not be a factor for the tardigrades.

B. Full Mission Simulation Results

When we ran the full mission simulations test on June 5, for about 5 minutes with a completely finalized and integrated payload, the armed wire with the LED at the end was misplaced on the G-Switch PCB board. We mistook the armed wire for the RBF wire at the time. That caused the micro-controllers to not be able to run. It took a while to debug the problem. At first, we didn’t realize that the wire was connected in the wrong location, so we tried using the multimeter to measure the voltage from
different locations across the PCB board. After we realized the actual issue, we concluded that the PCB board will be able to provide power to all micro-controllers if the armed wire was placed in the power plug labeled “ARMED”.

It is unfortunate that we weren’t able to get data from the test, but we plan on performing more full simulation tests to make sure we can obtain raw video files from the Beaglebone Blacks and also to ensure we can obtain data from the 3-axis accelerometer from the Arduino board.

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>Will be after we add ballast on the first or second plate</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, 4 Bulkheads</td>
</tr>
<tr>
<td>Mass at 20±0.2lbs</td>
<td>The total weight of both the OSU and LBCC payloads combined are currently under the required mass. This requirement will be met after ballast is added to the payloads.</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, we have this in house</td>
</tr>
<tr>
<td>Activation wire at least 24 gauge</td>
<td>Yes, we checked for this</td>
</tr>
<tr>
<td>Early Activation: current &lt; 1 A</td>
<td>N/A</td>
</tr>
<tr>
<td>T-0 Activation: current &lt; .1 A</td>
<td>Yes, by G-Switch</td>
</tr>
<tr>
<td>Battery Type</td>
<td>9V batteries</td>
</tr>
</tbody>
</table>
B. Integration Plan and Procedure
Integration at Wallops involves exchanging the batteries used on the payload to new ones. The amount of data on all microSD cards will be cleared to make sure there’s enough space to store data during the launch. Mechanically integrating the OSU payload with the LBCC payload will also have to be completed for the final time.

C. Action Item
Before arriving at Wallops, we still need to conduct a few more full mission simulation test to confirm that all micro-controllers can be powered. It will also be essential to solidify that we have the ability to obtain raw video files from the Beaglebone Blacks when using a monitor versus a laptop. We also need to remeasure current and voltage values from the T-0 activation wire. New environmental slides will be made prior to integration in Virgina in order to ensure the most active tardigrades.

5.0 Conclusions
Overall, our team is confident that we will be able to be successfully ready for launch. We have had a few minor hiccups along the way, but we are at a stable point in the preparations phases that has the team confident in our ability to be prepared. We will need to perform a mission simulation prior to shipping the canister to Virginia, but that will be completed as soon as possible, long with fewer setbacks due to previous experiments that have assisted the team in realizing where these setbacks may occur. We also need to check the tardigrades’ conditions to check how they have been coping in their environments. Due to the tardigrade’s lack of a radical change to their environments, we are assuming that the days prior to launch in the rocket will not be a noticeable factor in analyzing whether the tardigrades are affected by their new environments.
Most tardigrades did not seem to noticeably change their behavior or movements in the different environments. They are more clearly visible when seen in video due to their movement.

Integration at Wallops involves exchanging the batteries used on the payload to new ones on the first and second layers of the payload. The amount of data on all microSD cards will be cleared to make sure there’s enough space to store data during the launch. This will prevent unnecessary data loss and we plan on processing the data after the launch. Mechanically integrating the OSU payload with the LBCC payload will also have to be completed once we arrive to Wallops.