



University of Calgary

HASP Group

Monthly Status Report

June 2015

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Team Members:

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Summary of Activities

1. Software

- (a) Programming for the system is underway.
- (b) The speed for the SD card is satisfactory.

2. GPS

- (a) We put the GPS unit in a simulator to see how it behaves at high altitudes and fast speeds. We had a concern over CoCom (Coordinating Committee for Multilateral Export Controls) limitations, specifically whether or not the limitations implemented on the GPS for speed and height were programmed as an OR condition or an AND condition. The speed and height restrictions are around $1,900\text{km h}^{-1}$ (1,200mph) and 18,000m (60,000 feet)¹. We placed the GPS under a few different varying in height and speed:
 - i. At 150m s^{-1} and 20,000m the results were successful. All seven required satellites were spotted.
 - ii. At 150m s^{-1} at 40,000m, we were still locking properly.
 - iii. At 550 m s^{-1} we lost the signal. However, this was to be expected anyway, and has no affect on our payload.
- (b) The GPS antenna was delivered and will be mounted soon. It will be placed on the top of our unit.

3. Thermal Design

- (a) The paint has been switched to white. The Sherwin-Williams Paint that was recommended is currently not available to us. As an alternative, we will test with Krylon Appliance White Paint. We ordered two small aluminium boxes that will be used to determine which paint will be most applicable to our needs. By putting in a small arduino unit inside the box with a thermometer (TMP102) and an SD card shield we are able to record the temperature inside the box for an extended period of time. To determine which paint we will use, the boxes will be set out in the Sun for a few hours to raise their temperature, then promptly put into a cold environment. This will allow us to watch the internal temperature fluxuate from a hot extreme due to the Sun to a cold extreme. With the added use of an IR camera, we will be able to determine the α and ϵ values of each paint. This will be completed once all the components arrive.

4. Other Mechanical

¹<https://en.wikipedia.org/?title=CoCom>

- (a) The antenna is securely attached.
- (b) The chassis was delivered to us. We are happy with the results and were able to do impact testing. We placed in false electronic boards to simulate the Main Board and other electronics inside. Using a bungee system with a calculated impact force we were able to meet the standards set by HASP. By attaching bungee cords to two sides of the chassis, we placed it on the clean floor with low resistance cardboard beneath the chassis. By pulling back, we were able to reach proper impact force at the peak of the motion. We then increased the impact force experienced by the chassis system to insure our system is stale. There was still no damage to any false boards. After a day of intense testing and attempt at destruction we have deemed our setup secure.

5. Other Electrical

- (a) We were able to program a pinout for the GoPro. There is an 8 second delay between power up of the board and power up of the camera. If there is a sudden shut down of the system, the camera will be delayed as well to avoid loss of video.

Changes in Design

1. The GPS unit is sitting on the top of the chassis system.

Issues Encountered

1. Due to the inability to acquire the suggested paint, we have to use an alternative. We have two in mind and will be testing shortly.

Milestones Acheived

1. The GPS was tested and works under our conditions.
2. The SD card is fully functional
3. Geiger boards are produced and are ready to be placed in the chassis, as well as the PreAmp

Outlook

1. We have encountered some unexpected problems with the ADCs. They should be fixed by the end of this week.
2. Most of our participants were able to receive their HAM radio licence (with one getting advanced qualifications, and a few more expected later in the summer). This allows us to launch baby balloons without the assistance of another organization who does have amateur radio qualifications.

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3. We should be able to ship out payload via FedEx and have it arrive a few days early.

Meeting Minutes

June 1st, 2015

1. Chassis should be complete and delivered by Tomorrow (June 2)
2. Considered wedging foam between the boards and the chassis to eliminate vibration and side to side motion. Possible thermal consideration.
3. The Geiger boards were determined to be too small in one dimension. Marc proposed a solution for this by switching the main board to the bottom and adding to more mounting holes for the Geiger boards.
4. The VLF pre-amp had a couple design errors. Justin and Juan are working to fix these (We should be able to do this without ordering new PCBs)
5. Armando and Cooper are finishing assembly of the Geiger boards.
6. The first GoPro was fried and we are still not sure exactly why. But we have another one.
7. We discussed how the camera will work. We decided on a 555 timer circuit to turn the camera on and start recording when every it is off.
8. Marc to complete more functional testing on the camera.

June 8th, 2015

- We are officially a club!
- Thermal design
 - Considering the recent outcry on the teleconference, we are changing the colour of the paint from black to white.
 - The paint we are currently looking at is Sherwin-Williams White Powered Paint
- Main Board
 - GPS has done well in testing so far, but still needs to go through high altitude testing
 - ADCs are in working order but need to be characterized
 - Temperature sensors need to be checked
 - RS232 connections work
- Geiger Tubes & Power Supplies
 - They have been set to around 550V

- One of the problems we had was with flux.
 - * **Please keep in mind flux can cause connection issues. This should be something you remember to check.**
- Geiger Tube number 6 was having some undervoltage issues and was found to be defective. It was replaced.
- Several of our devices were connected up and powered on. This showed we are at around 30V, 155-160 mA and 5 watts. We are under the power budget.
- Watch the temperature sensitivity of the resistors when soldering - they have issues around 500°C
- We need to do an inrush current characterizations to make sure we are not going to blow a fuse.
- Chassis and Antenna
 - We should be receiving it by Wednesday now and the bolts we ordered should be in as well. Epoxy was also ordered and that needs to be tested
 - The antenna didn't attach properly the first time, so a new method has been devised and yet to be tested.
- GoPro and PreAmp
 - It turns itself off at 60°C. Keep in mind that this will be lower up at altitude because of convection.
 - The GoPro needs to receive more attention - there are a few things about how it handles different temperatures that is a little sketchy. We need to know when the video starts to fault at lower temperatures.
 - The PreAmp works!
 - * The PCB flaws have been fixed
 - * There was another issue with **flux issues again. See? Very important to keep in mind**
 - * Characterization for PreAmp needs to be done.
 - * Timers were ordered for the protoboard.
 - * We need a cable for the PreAmp. Ideally, a twisted pair shielded cat5 cable. We have the ability to make this.
 - * We have a portable oscilloscope that we can use for testing. Justin has offered to take the setup home and test it with a storm to watch our counts.

- Entire System, SD Card and Miscellaneous
 - Thermal modeling for the entire system is being completed. There is question as to whether we need a passive radiator on the bottom.
 - The write speed of the SD card has been increased to about 500 kbps and can be further increased.
 - Depending on how fast we want the write speed, a lot of the code will need to be rewritten.
 - We were having an issue with a burst of information, then a pause. This has been fixed.
 - We need to run a resistor or have a small sweater for the ADCs to keep them warm.
- Baby Balloons
 - We found a launch site, but we need permission to enter so we may need to find another site.
 - Testing for HAM Radio
 - * **If you want to have any say in when the testing occurs, you need to fill out the form by June 10th at 4 pm. If you don't fill out the form, we may assume you are not interested in taking it**
 - There are weight restrictions on the mass of the payload for a Baby Balloon - its about 1.1 kg but this includes the trackers, parachute and power. This brings up the question of what exactly can we launch. We need to weigh everything first and decide from there
 - We can use the 3D printed model as a chassis for the Baby Balloon.

June 15th, 2015

- Its time to start thinking about integration - we have created a list in the root folder of Google Drive to allow people to add anything that needs to be done before integration, as well as brought to integration in a kit.
- The two we are sending are Dain and Cooper. If there is anything they need to know, make sure they know it please. Upload and update documentation for them. Thanks!
 - For those of you who are not going, we plan on sending a laptop out and are going to try to do a Google Hangout. This is so we know what will be going on, and in case anything goes wrong we might be able to offer assistance. Im not 100% sure on how this is going to work.

- We need to figure out how to mount the red LED
- GPS
 - There was discussion about the GPS concerning which one to choose and how it will be mounted. All models of GPS presented had some problems.
 - For mounting, we decided that on top was the best. This results in the elimination of a lot of issues encountered with the GPS. Now its mostly down to how we are going to stick it on, and their temperature tolerance.
- The 555 timer will be set up shortly
- The Geiger interface needs to be set up and tested.
- Testing with lighting can be done this week, if the storms we were promised arrive.
- Justin needs advice - any volunteers feel free to respond to his call for help on facebook.
- BBQ
 - To celebrate the work we have all done, a BBQ is in the planning stages! Justin has generously decided to host. There will be a poll on facebook to finalize the date.
 - Please bring food stuffs - post what you would like to bring.
 - As a courtesy to Justin, let him know if your bringing anyone and get the a-okay. In addition, BYOB but no more than one or two - getting drunk will get you removed.
 - Preferably, this event will take place on the weekend so we will have time for games. I will bring as many as I can. Will you?
 - He does live outside of Calgary, so transport will need to be arranged. If you dont have a vehicle, we can work something out for you!

RESULTS OF THE THERMAL MODEL

The solid line is the chassis whereas the dotted line is the mounting plate. Note the clear difference that results in different white paint used.

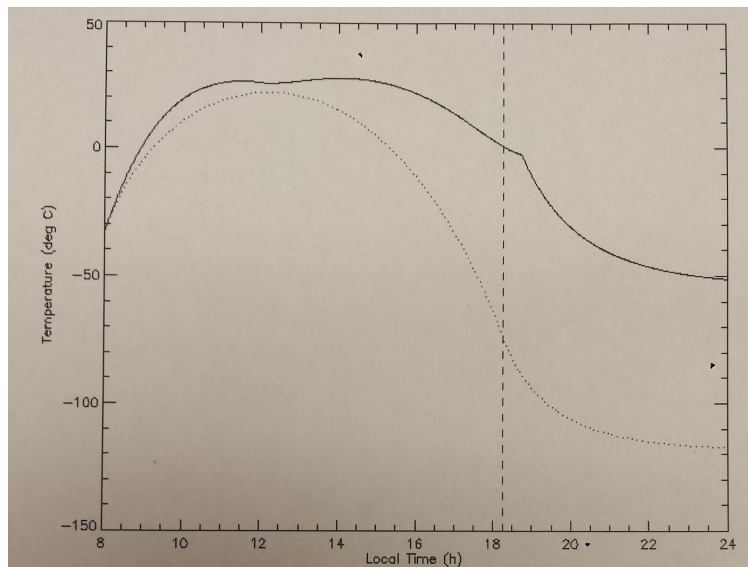


Figure 1: Sherwin Williams White F8WJ2030 ($a=0.39$, $e=0.82$)

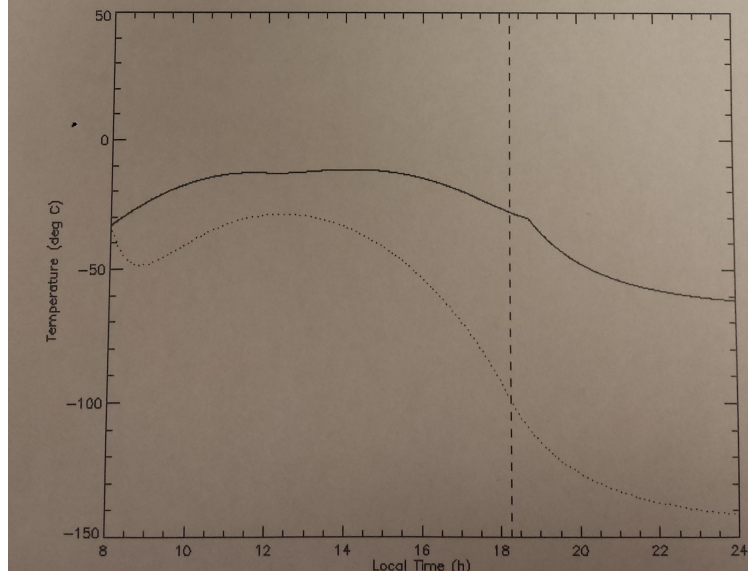


Figure 2: Zerlauts S-13G White ($a=0.20$, $e=0.90$)

June 22nd, 2015

- Geiger Tubes

- The interface is set up, so they can be put into the Main Loop of the program

- Thermal

- Any of the ones that were looked at online are not available, even the one recommended to us. Alternatives will be found - just some Krylon Appliance White Paint should work.

- The insulation will be assembled quite soon. Once that is complete, painting can be done shortly after.
- Funding
 - We may be able to wrangle up some extra funding for anyone interested in going to launch. If Liz doesn't already know you are interested, please send her an email or facebook message.
 - Keep in mind the actual launch date is dynamic, depending on the weather. We will go for the first week in September, but there is no guarantee that it will happen then - the launch may not be able to occur until the week after.
- Inrush Current and Thermistors
 - The hotter the temperature, the more current there is, so the less resistance. This is exactly what we want the thermistors to do.
 - The small thermistors seem to have less desirable behaviours. They have a low power draw, but don't stand up to the inrush.
 - The medium thermistors are perfect for what we need. Some thermal testing results:
 - * At 0°C there was 125Ω resistance which isn't an issue due to the behaviour of the entire system at this temperature. The startup time is at 700ms rather than the 200ms it was originally.
 - * At -40°C there was weird fluctuations every 7 seconds - it would be under voltage for around 15ms which is scary. This behaviour is still seen at -55°C. This behaviour may be explained via the DC/DC converter rather than the thermistor.
 - * The upper limit was found to be 50°C, which is around 40°C ambient.
 - * More thermal testing will be done
- GoPro
 - The protoboard works as expected
 - There is an 8 second delay before the GoPro is turned on and if there is an emergency shut off, the GoPro can handle it properly without risking the video
 - There is nothing implemented to monitor the GoPro - nor do we really have any means to do so.
- The Preamp and Antenna setup works!

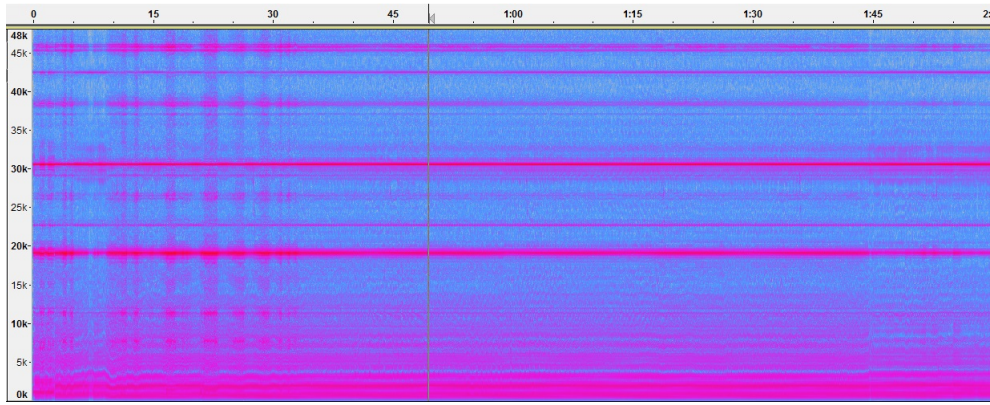


Figure 1: Wires on the table outside the security doors.

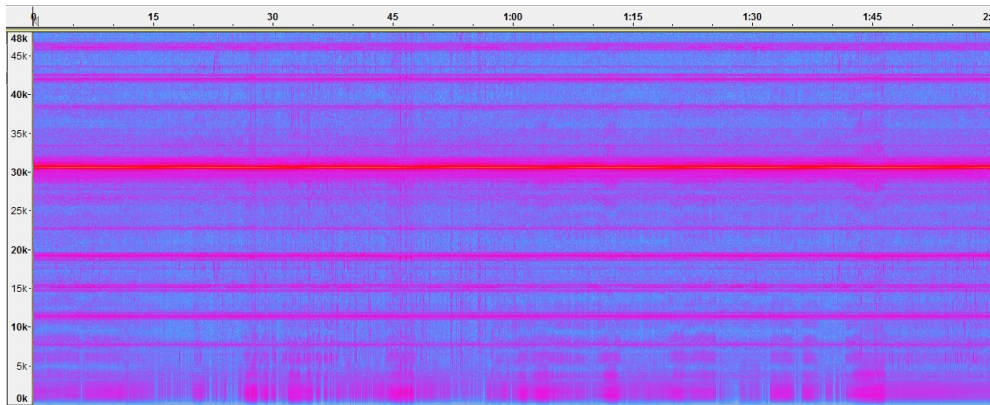


Figure 2: Car antenna on the table outside the security doors.

- GPS

- Simulations were run on the GPS last week. The results are as follows:
 - * At 150m s^{-1} at 20,000m the results were successful. This is just above the height CoCom limit set for GPS. All seven required satellites were spotted.
 - * At 150m s^{-1} at 40,000m, which is around the flight altitude of HASP we were still locking properly.
 - * At 550 m s^{-1} we lost the signal. However, this was to be expected anyway, and has no affect on our payload.
- The GPS units came in and will fit nicely on top - they will be waterproof and will sit flush.

Okay, so we still have a lot to do before the due date. The most important details (in no particular order) are:

- The Main Loop needs to be worked on.

- The epoxy needs to be applied
- Measurements need to be done for the PISIP
- Finalize the Thermal Design
- Complete assembly
- Characterization of the preamp
- Stickers for the payload
- Thermal and vacuum testing of the whole unit
- Regulators need to be temperature tested