HASP Student Payload Application for 2009

Payload Title: HawkHASP3		
Payload Class: (circle one) Small Large	Institution: University of Maryland Eastern Shore / Hawk Institute for Space Sciences	Submit Date: 12/19/2008

Project Abstract

Each year the HawkHASP experiments contributed by AVSC288 students at UMES are guided by the interests and experience of the students. This year more advanced projects are in development. The preceding payloads have utilized power from both LSU and an internal source. We are now configuring the payload for remote command and 100% power from HASP. To achieve this goal our team has a plan focusing on the development of a single experiment. Previously, the payload has relied on independent data loggers. While inexpensive they require manual activation during testing and launch and do not yield the detail needed for accurate conclusions. The students will develop a flight-worthy data storage unit. This device will require minimal communication relying on discrete power up and down commands. With success this storage device will be used on future CubeSat satellites designed by HawkHASP sponsor HISS. The solar cell experiment provided by the University of North Florida will test the spectral response of an Ultra-thin stimulator in an Indium Tin Oxide-Si cell. The students of AVSC288 will also be conducting a thermal experiment designed to calculate the atmospheric effect of at least two thermally dissimilar materials measuring contraction and expansion of said materials. This will hopefully have future applications for satellites.

Team Name: HawkHASP3	Team or Project Website: N/A

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UNIVERSITY OF MARYLAND EASTERN SHORE
DEPARTMENT OF ENGINEERING AND AVIATION SCIENCE
AND
THE HAWK INSTITUTE FOR SPACE SCIENCES

HawkHASP3 2009

High Altitude Student Platform (HASP) Payload Flight Application

12/19/2008

Introduction

The HawkHASP3 small payload is part of a larger program at the Hawk Institute for Space Sciences (HISS) and the University of Maryland Eastern Shore (UMES). The payload will be designed and built by the UMES AVSC 288 Gateway to Space students, and will be used as an introduction to topics applicable to spaceflight programs such as CubeSat-style micro and picosatellites.

Possibility of Early Palestine, TX Launch

The possibility of an early summer launch in Palestine, TX as opposed to the September launch in Ft. Sumner, NM presents both positive and negative consideration. A June launch, even though a shorter flight envelope, would provide a greater opportunity for students to actively participate in both integration and launch procedures since academic commitments are not as stringent as in early September. However, a June launch would compress the timeline available for the students involved in the AVSC 288 course to design, develop, fabricate and test the payload adequately. This is due to the fact that AVSC 288 is offered as a spring semester course only (late January through late May). While we view a September launch as preferable, we believe that the AVSC 288 students can successfully meet a June launch.

Payload Description

The HawkHASP3 payload will continue to improve upon and expand knowledge gained from the previous two missions.

The first experiment is a solar experiment that students at the University of North Florida are integrating with HawkHASP3. It will be comprised of solar cells utilizing a nanocrystalline and wide energy band gap semiconductor constructed of CdSe or ZnSe. This stimulator layer imbedded in the ITO-Si solar cell will theoretically reduce series resistance of the solar cell and improve photo current. In addition to reducing series resistance, the hope is that the stimulator layer of the solar cell will allow a wider spectral response in the stratosphere also improving photo current. As this will be the first stratospheric flight for the test cells the effect of the extreme temperatures will be analyzed as well. A detailed description of this experiment including a diagram can be found in Appendix 1. The Hawk Institute for Space Sciences will supply a commercial solar cell for comparison purposes.

The second experiment will be of great relevance and importance to the construction of micro and picosatellites. It will test the behavior of multiple thermally dissimilar materials in order to determine their feasibility of an automatic activation of deployable components. Use of such materials would be of significant value to the growing small satellite market. It would increase reliability of communications systems and other deployables by removing the need for computer controlled power feeds to the satellite's deployment mechanisms. This would allow for a reliable deployment of components that cannot be mounted on the exterior of the satellite due to launch volume constraints.

While this experiment is still in the preliminary design phase, it is anticipated that it will involve measuring the thermal contraction of a variety of thermally different materials throughout the altitude profile. The measurement across the profile has gained new significance due to the efforts ongoing by NASA to fly micro and pico-style satellites on future commercial manned sub-orbital vehicles such as those to be offered by Virgin Galactic and XCOR.

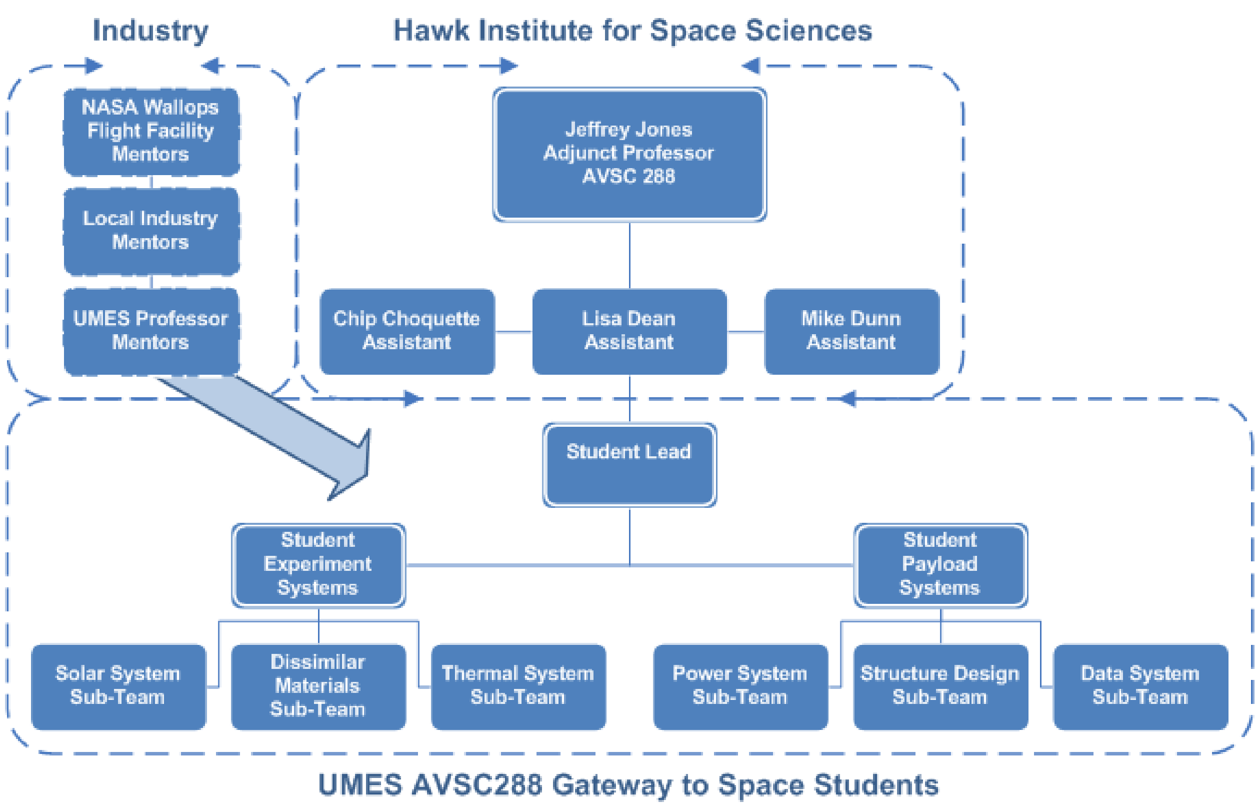
The third experiment is to launch and test a more reliable thermal monitoring system. The two previous HawkHASP payloads have had thermal data that was not entirely accurate or representative of the whole payload. Due to the failure of one data logger, HawkHASP2 had to rely on a secondary internal sensor and the LSU-logged external sensor for thermal data. Though the HawkHASP2 heating system appeared to be a success and will be utilized again, more accurate temperature monitoring could have allowed the team to see any slight problems and margins for improvements especially regarding individual experimental components. Multiple and smaller internal and external temperature sensors can be used to more accurately monitor the operation of the heating system and the health of experimental components, while providing redundancy of data against potential sensor failures.

The final experiment and a critical goal of this mission is to make the payload dependant on the HASP platform for operation. Instead of attempting to leap directly into telemetry as we have proposed in the past but scrubbed due to time constraints, HawkHASP3 will have an onboard telemetry system activated and powered by the HASP platform. This onboard telemetry system will be similar to the HOBO data loggers flown before while forgoing the need to activate by external switches mounted on the payload. This system will log all experimental data for analysis post-flight. Success in this experiment will pave the way for down-linked telemetry on a future flight and greatly expand the capabilities of the HawkHASP series of payloads.

Team Structure and Management

The team will consist primarily of the students of the AVSC288 course to be taught in the spring of 2008 by Mr. Jeffrey Jones. Students in this half lecture half lab course will design and build the components of the HawkHASP3 payload. Three interns with experience on previous HawkHASP missions will be providing assistance and direction to the students throughout the semester. Subject experts from NASA Wallops Flight Facility, UMES, and HISS will be available to assist the class with design elements in addition to peer reviews. The class will be divided into sub-teams to efficiently complete the multiple aspects of the payload.

Team Structure Diagram



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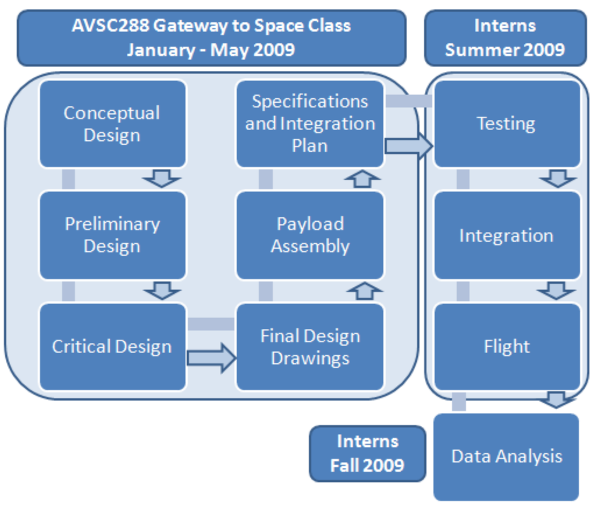
Project Timeline



- January
  - Payload Selection Announcement
- February
  - Student Concept Proposal
  - Preliminary Design Review
- March
  - Critical Design Review
  - Parts List & Progress Report
  - Design/Drawings for Construction
  - Begin Construction
- April
  - Second Parts List
  - Payload Spec/Integration Plan
- May
  - Final Class Report/Presentation
- June/July
  - Environmental Testing/Final Construction
  - Pre-Shipment Review
  - Integration (anticipated 2-4 personnel)
- August
  - Post Integration Review
  - Flight Readiness Review
- September
  - Launch (anticipated 2-4 personnel)

Payload Specifications

Power

The HawkHASP3 small payload will use the supplied 29-33VDC and no more than .5 amps at 30VDC. There are no intentions to use any other sources of power at this time.

Mass

The HawkHASP3 small payload is intended to deliver well under the 3kg weight limit. The exact weight will be known once the experiment designs are complete and will be included in the **Payload Specification & Integration Plan.**

Volume

Specified volume limit of 15 x 15 x 30cm above the mounting plate will be observed. As the payload this year has fewer experiments involved the height of the payload may be reduced from previous designs resulting in a size well below specific limits.

Mounting plate

The supplied payload mounting plate will be used to attach the payload and the specified footprint will not be exceeded. The payload will be attached to the mounting plate using multiple bolts that utilize the positions proven to be successful in previous HawkHASP missions.

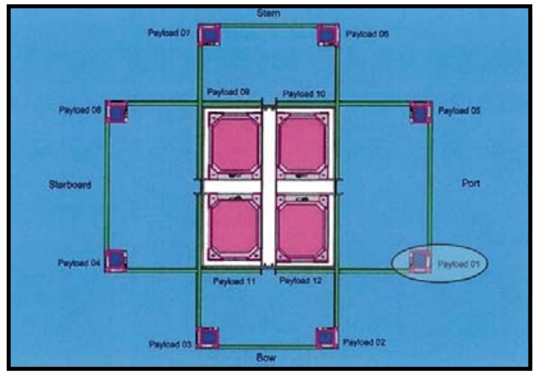
Downlink serial telemetry

There are no plans to use downlink serial telemetry at this time.

Uplink discrete commands

HawkHASP3 will utilize discrete commands for controlling power on/off of payload systems. This will enable the payload to be activated remotely as opposed to manual activation in previous years.

Drawings



Currently there are only very basic conceptual drawings of the HawkHASP3. The students of the AVSC288 Gateway to Space Course will complete detailed drawings as part of their design documentation. Final drawings will be included in the **Payload Specification & Integration Plan.** The desired location of the HawkHASP3 is position 01 as circled on the LSU provided diagram to the right.

Lessons learned from previous HawkHASP missions

Every year of involvement with HASP has proven a learning experience. Operations and components not working as planned are not failures but provide opportunities to learn and improve. The 2007 and 2008 HawkHASP missions both had experiments that did not perform as intended and the 2009 mission will build upon and learn from those instances.

Technical Improvements

- More accurate and redundant thermal monitoring system
- Omission of previously successful photography experiments
  - Allows more time to focus on new and more demanding experiments
- Remote activation of payload systems
  - No need for flight line access to the payload and less complicated power on procedure in absence of HawkHASP3 team members.

Appendix 1

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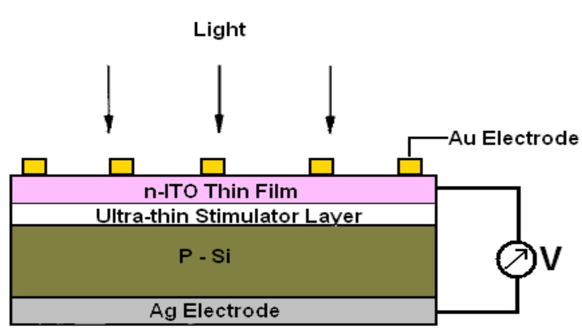
Work plan for HASP 2009 jointly with Hawk Institute for Space Sciences

<u>Fabrication of nanocrystalline ITO-Si solar cells for high altitude applications</u>

Crystalline p-n homojunction silicon solar cells modules are widely used in the commercial and space applications because of having higher efficiency and well-optimized processing technology. These solar cells have two limitations for the space applications: narrow spectral response and medium power density. For example, a standard 160 watt solar cells module requires more than a kilogram of electronics-grade silicon. For the small payload satellite applications, the high power density solar cells are highly required. There are several approaches including the use of organic solar cells are going on. In that direction, we wish to apply use of nanocrystalline and wide energy band gap semiconductor for the window layer in order to improve the wider spectral response. This work is based on our one decade old work on solar cells [1, 2] and current ongoing work on nanocrystalline ITO thin films, particularly for sensors applications (US patent pending).

Looking into these issues, the UNF students proposed the following objectives for the work:

(1) The solar cells having the following structure will be fabricated by the students.



Chemically cleaned p-type silicon wafer will be used as a base of solar cell, while n-type indium tin oxide (ITO) thin film used as a window. 5000 Å thick Ag film electrode will

Appendix 1

be deposited on the back side of polished Si wafer. An ultra-thin layer of CdSe or ZnSe thin film having thickness of 15 to 20 Å oA will be deposited over polished surface of p-type Si. This layer will work as a stimulator or buffer layer. Then, nanocrystalline ITO thin film having thickness about 2000 Å will be deposited over ultra thin stimulator coated p-Si at 250 ^oC substrate temperature. Finally 4000 Å thick Au film grid will be deposited on top of ITO, which will work as a front electrode. Copper wire will be bonded on the top and bottom electrodes for the connecting cell with an external circuit.

(2) Ultra thin layer of stimulator will minimize the stresses due to the lattice mismatching between Si and ITO, and improve the orientation of grain of ITO. This may result in reducing the series resistance of the hetrojunction solar cell and hence the short circuit photo current will improve.
(3) ITO have wide energy band gap of 3.5 eV. This layer will have good optical transparency to allow the wider spectral response including more ultraviolet light in the stratosphere. This may result in improving an open circuit photo voltage.
(4) Due to last two features, the fill factor and efficiency of cell may be improved. However, we are not expecting the good efficiency like commercially available solar cells because of the limited technology facilities available in the lab. But, it will certainly give the clear concepts of solar cells to the students.
(5) At least two or three fabricated solar cells will be tested at UNF for the determination of all solar cells parameters and then delivered to the HAWK University for the integration of cells with their payload and flight.
(6) During HASP flight, solar cells will generate the photo voltage /photo current signals and data will be communicated to the ground through HASP computer. A commercially available solar cell will also be used simultaneously for the comparison purpose and also input light power will be continuously measured during the flight. Effect of temperature on the performance of solar cells will also be determined.
(7) The surface morphology of solar cells before and after flight will be examined by scanning electron microscope.
(8) No special requirement for the operation of cell during the flight. It should be well mounted on the payload surface so that the maximum amount of sun light can hit the surface of cell. These solar cells will have the first flight for the testing in the stratosphere. Further improvement will be made based on the feedback of the results.

References:

[1] Improvement of efficiency of ITO/Se thin film solar cells using telluride stimulator
N. G. Patel, B. H. Laskari, C.J. Panchal and K.K Makhija
Crystal Research and Technology, Vol. 29, No.6 (1994) 859-864

[2] Fabrication and characterization of ZnTe/CdSe thin film solar cells
N. G. Patel, C.J. Panchal, K.K Makhija, P.G.Patel and S.S. Patel
Crystal Research and Technology, Vol.29, No.2 (1994) 247-252