Colorado Space Grant Consortium

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December 19, 2008

Dear Dr. Guzik,

Thank you for taking the time to read our proposal. As the selection process nears, we look forward to hearing from you. The University of Colorado at Boulder's DIEHARD team received encouraging data from the September 2008 HASP flight and it provided valuable information towards our mission goals. This HASP 2009 flight opportunity proposal is called the Balloon Observatory for Wavelength and Spectral Emission Readings (BOWSER), and this will be an exciting opportunity to further our pursuit towards proving the feasibility of high altitude observatory platforms. Also, this opportunity allows our scientific advisers from the DIEHARD 2008 flight to continue to work with students and further explore and provide data regarding a lighter than air observatory possibilities. We find this platform the most suitable and beneficial device for furthering the investigation of light intensity and celestial imaging at high altitudes.

Sincerely the CU Boulder BOWSER proposal team,

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Project Manager

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HASP Student Payload Application for 2009

Payload Title: Balloon Observatory for Wavelength and Spectral Emission Readings (BOWSER)

Payload Class: (circle one) Small [✓ Large]	Institution: University of Colorado	Submit Date: 12/19/08

Project Abstract

The University of Colorado at Boulder team will determine the feasibility of high altitude observatories by recording spectral emissions of light (wavelengths) throughout the ascent and for the duration of the float as well as capturing high quality still images of celestial bodies.

This will be achieved by orienting four high resolution cameras to capture the same field of view which will correspond to the field being viewed by the spectral emission sensors. All science instruments will be mounted along the same side of our structure inclined 30° above the horizon. Three cameras will create a wide panoramic field of view, mounted directly below a telescope with the fourth camera mounted in the eyepiece. The array of cameras will take pictures in unison through the duration of the flight creating two comparable images (wide view versus telescopic view). Additionally, magnetometer, accelerometer and gyroscope electronics will take recordings regarding the turbulence, directional orientation and stability of the platform.

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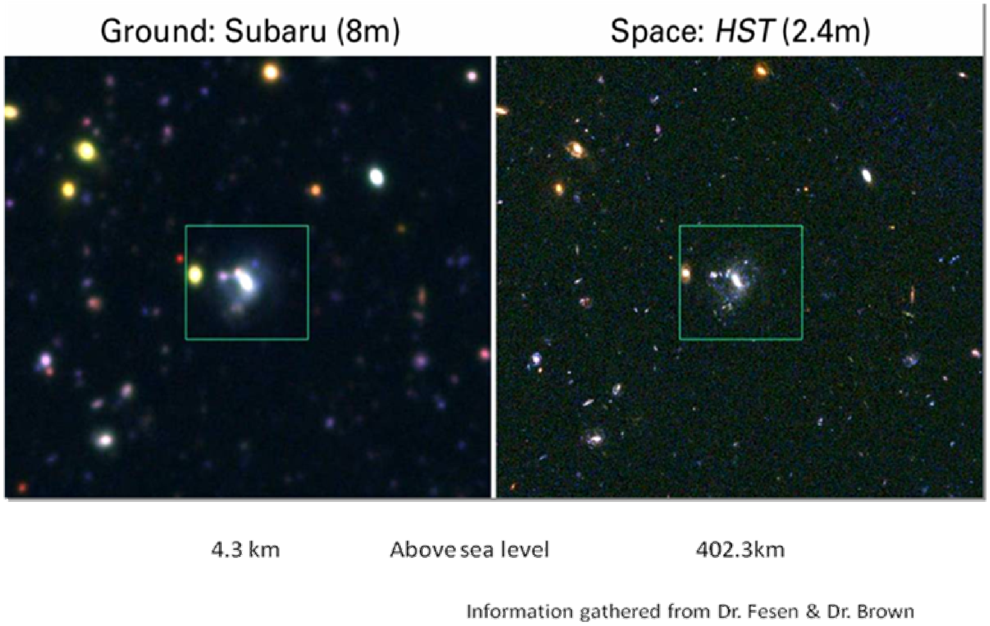
1.0 Mission Statement

The University of Colorado-Boulder mission, called Balloon Observatory for Wavelength and Spectral Emission Readings (BOWSER), will determine the feasibility of high altitude observatories by examining cosmic light ranging from 350 nm to 1000 nm and by conducting corresponding diurnal imaging and light intensity readings of the observed sky. The BOWSER payload will also measure platform stability in order to determine the conditions that a lighter-than-air platform would experience at HASP flight altitudes.

1.1 Mission Premise

The celestial images produced by the orbiting Hubble Space Telescope have not only shown the indescribable beauty of the heavens, but have provided key answers to the scientific origin of the universe. The achievements of this orbiting telescope are far beyond the capabilities of any ground based observatory because these arrays are hindered by distortion and bad weather, figure 1.1.



Information gathered from Dr. Fesen & Dr. Brown

Figure 1.1: Even the 8 meter aperture of the land based Subaru telescope cannot compare with the 2.4 meter aperture of the orbiting Hubble Telescope.

However, it may now be possible to achieve the same capabilities of Hubble for a fraction of its multi-billion dollar cost with the use of lighter than air vehicles. Missions like DIEHARD, stationed on the HASP in September 2008, have made significant strides in establishing the viability of stationing an optical observatory at the edge of space. The negligible atmospheric distortion and minimal weather disturbances of this near space environment may provide the perfect conditions for capturing crystal clear imaging of the cosmos. The DIEHARD payload, equipped with three photometers, a CCD wide-angle camera, and an Orion Newtonian Telescope gave valuable support for this cause. Stars were unmistakably viewable from the low resolution CCD just before sunset and throughout the night. The telescope witnessed many distant stars, and verified the relatively mild climate found in the upper atmosphere. The photometers demonstrated the intensity of ambient light at high altitudes. This evidence is sufficient to support another mission, the proposed BOWSER mission, which will further explore the practicality and benefits of a balloon stationed observatory.

1.2 Mission Description

The University of Colorado-Boulder team envisions a project that will provide empirical data regarding light intensity, platform stability, and the subsequent feasibility of diurnal celestial imaging. This will be executed in two stages: ascent mode and float mode. On ascent, a LED array will act as photometers by taking readings of wavelength intensity over the visible, ultraviolet and infrared spectrum. This data will be coordinated with high resolution images of the sky. It will be useful to compare the relative intensity of light from each part of the spectrum with the actual stars, identifiable with panoramic high resolution pictures. Telescope high resolution images, within the field of view of the panoramic pictures, will capture more light allowing more distant celestial bodies to be seen. At the same time, the payload's attitude determination system will take readings showing the movement of the platform as a function of time. All three forms of data will be used to determine the altitude above which a balloon-based observatory becomes practical, the criteria being light quality, picture quality, and flight conditions. Upon reaching float altitude the same systems will continue to run, with the goal being to demonstrate the full capabilities of a platform taking readings and images in the stratosphere. The data from this second stage will act as further evidence for the feasibility of cost efficient balloon observatories in the upper atmosphere.

1.3 Mission Background

The following sections show previous analysis regarding the feasibility of high altitude observatories.

1.3.1 Imaging

Viewing stars is an integral part of the BOWSER mission. DIEHARD in 2008 was able to view stars during sunset and during the night with relatively inexpensive CCD cameras. Also equipped with a telescope, this payload caught images of distant stars. Some recognizable constellations were found including Orion, figure 1.3.1a. However, DIEHARD was not able to see stars during the daytime. The CCD's produced blank gray images of the sky during this period. In fact, the first star wasn't seen until 7:02 PM, while the sun was setting, figure 1.3.1b.

Figure 1.3.1a: The constellation Orion is clearly visible from the onboard CCD wide angle Camera.

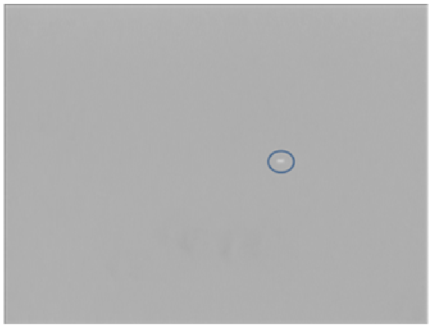


Figure 1.3.1b: The first star is seen during sunset.

However, it is possible to see stars during the daytime with

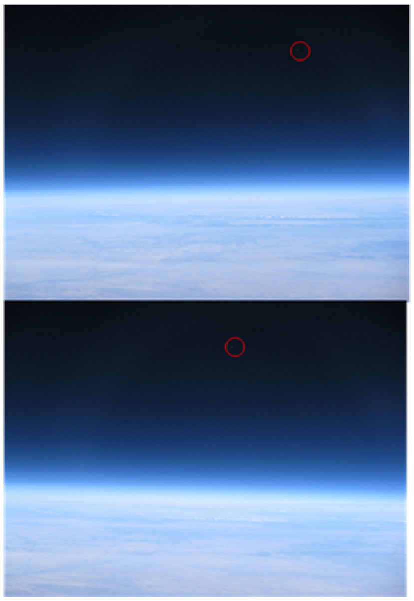


Figure 1.3.1c: Stars can be spotted above the horizon in broad daylight using simple Canon cameras.

different equipment. In fall 2008, members of the BOWSER team participated in a 2 hour sounding balloon flight. Payloads carrying seven megapixel Canon cameras ascended to 30,000 meters. Even from images that were aimed at the horizon, stars were visible, figure 1.3.1c. This provides support for our mission.

1.3.2 Light Sensing

The DIEHARD mission had three photometers on board. These photometers were designed by Dr. Yorke Brown and measured sky brightness during the day and night throughout flight. The results from these photometers proved that there was indeed light visible in the night sky. Of the three photometers, one incorporated a filter wheel which cycled through a broadband, red, green, and infrared filter. However, the design for this filter wheel was quite limiting. It returned a data reading from each filter every 2-10 minutes throughout flight, and it did not have the ability to sample sky brightness readings from each filter range at the same time. As a result, discovering the makeup of light from any one reading, a section of the sky at a moment in time, was impossible. The enormous time lapses between readings also made it difficult to make conclusions from the data.

During the DIEHARD flight, an error was received indicating that the filter wheel motor was not functioning properly. After analyzing the data, is it evident that the wheel may indeed have stalled on one filter, capturing a single frequency for the entire flight. In figure 1.3.2a below, it appears that every frequency shares the same basic trend.

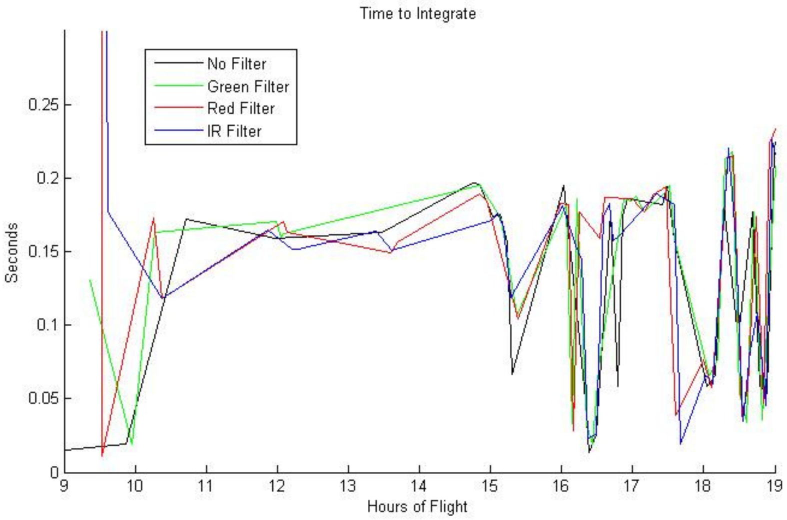


Figure 1.3.2a: There is no discrepancy between the different filters' integration time during the day.

Figure 1.3.2a shows the integration time of each filter during the day. It is very clear that there is a negligible difference between the four modes of spectral filtering. Thus it is probable that the filter wheel malfunctioned. This is very unfortunate, as this kind of data can show what frequencies of light are most prevalent in the upper atmosphere. BOWSER will improve upon this idea of quantifying the amount of light received from each part of the spectrum.

The use of LEDs as photometers was utilized by a high altitude science mission in the fall of 2008. This team, ZEPHYR (figure 1.3.2b), successfully captured light intensity data while viewing the cosmos from the stratosphere during the day time.

Figure 1.3.2b: ZEPHYR payload.

Their light intensity data is shown in the graph below, figure 1.3.2c.

While ZEPHYR was able to capture light intensity data between the ranges of 400 nm and 950 nm during the entire ascent and descent of a day-time, 2-hour sounding balloon flight, engineering faults in the baffling allowed direct sunlight to hit the LED photometers causing voltage spikes and therefore further noise. Due to design and mission limitations their experiment leaves unanswered questions such as how light intensity detected in the stratosphere varies from night to day, what altitude best suites a stratospheric observatory, and how stable said observatory is.

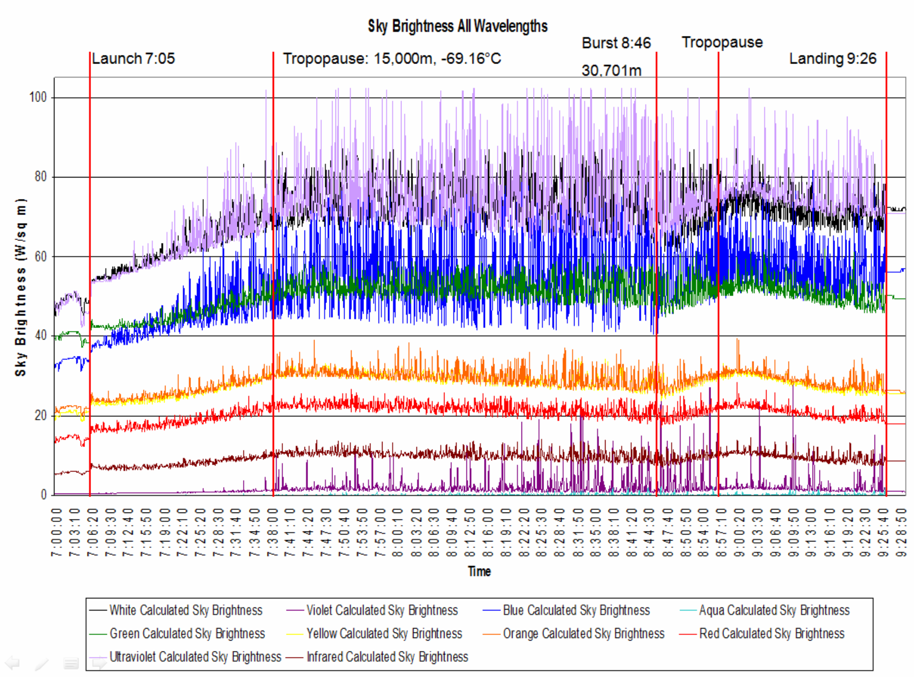


Figure 1.3.2c: This graph shows the relative light intensity from each spectrum as found by the ZEPHYR payload.

BOWSER's science mission will utilize the properties of a one-directional diode. When a voltage is applied to a diode – as found in LEDs – electrons travel from an anode into the diode's n-type material and jump (via the conduction band) to a p-type material which is attached to a cathode. The p-type material contains a valence band that is deprived of electrons. As electrons fill the valence shell, energy in the form of light is emitted. LEDs are controlled to only emit energy in specific wavelengths by restricting the size of the jump between the conduction band and the valence band in the p-type material.

What makes LEDs such a good choice for photometers is that the entire process can be run in reverse. When a photon from the LED's corresponding output wavelength range strikes the p-type material of the diode, it excites an electron. The excited electron compensates for its excited state by moving into the conduction band. The building charge in the conduction band can be relieved if a

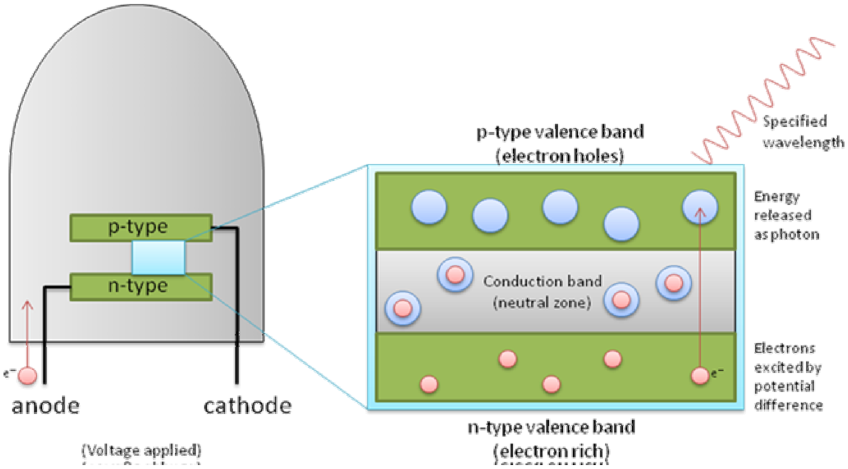


Figure 1.3.2b: Diagram created by Andrew Zizzi, representing the functionality of an LED in the forward direction.

connection exists between the anode and the cathode. Completing this circuit with a device such as a voltmeter allows the user to measure the voltage created by photons striking the diode. BOWSER will use multiple LEDs to observe wavelength light intensities between 350nm and 1000nm.

1.3.3 Platform Stability

DIEHARD provided a great profile for the overall stability of the platform. However, it also experienced problems. Unfortunately, the compass did not function during flight because of the electromagnetic interference from the computer, figure 1.3.3a. This error must be fixed for the BOWSER payload, as it provides the direction that the payload is pointing at any given time. A Faraday cage made of brass wire mesh will surround the computer in order to conceal the electromagnetic interference away from the science instruments of the payload. Having a functioning compass will provide data such as rotational velocity and span as well as the direction of the payload at any time.

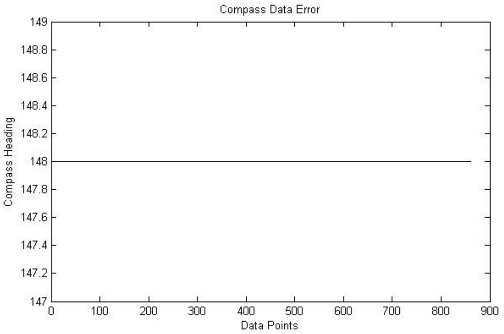


Figure 1.3.3a: The DIEHARD 2008 compass data.

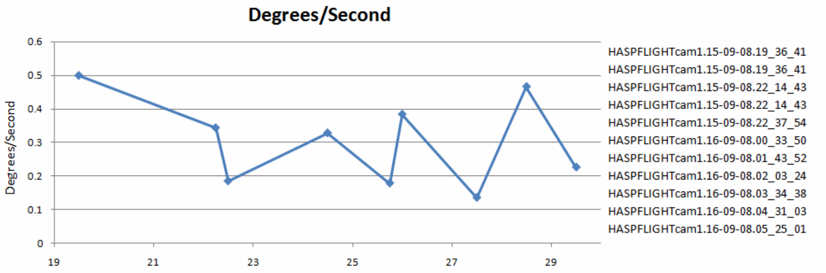


Figure 1.3.3b: The rotational velocity of the HASP platform is extremely mild at peak altitude.

The DIEHARD payload did answer many questions about the rotational velocity of the platform. Analyzing the videos from the onboard CCD camera, it was determined that the maximum rotational velocity was about 0.5 degrees per second, figure 1.3.3b. This is a very mild rotational rate, which supports the feasibility of a balloon observatory at this altitude.

The DIEHARD payload also incorporated an accelerometer, data shown in figure 1.3.3c. An error was encountered with the X axis. After comparing this considerable noise with temperature data from the payload, it was determined that the extreme temperatures experienced correlated directly to the error found in this axis. The BOWSER payload will thoroughly test its accelerometers in order to fix this error. The payload will have an accelerometer as well as two triple-axes gyroscopic acceleration sensors in order to determine attitude determination.

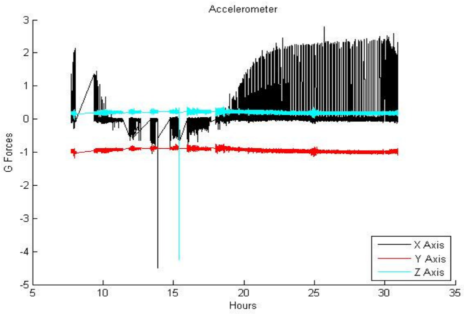


Figure 1.3.3c: The accelerometer produced an error in the X axis.

2.0 Payload Design

The following sections discuss how the experiment is installed and operated within the BOWSER payload and the specifications of the payload design.

2.1 Principle Operation of Experiment

The three major systems operating on the BOWSER payload will be primarily independent of one another. The first system, platform conditions and behavior, will be comprised of a pressure sensor, twelve temperature sensors, a compass, an accelerometer and two triple-axis gyroscopes. The accelerometer measures acceleration along three axes, and the two triple axis gyroscopes each measure angular acceleration in all directions. The gyroscopes will be aligned perpendicular to one another, creating a profile of the payload's rotational behavior. Both the accelerometer and the gyroscopes will comprise an inertial measurement unit (IMU) that records pitch, roll, yaw, and acceleration on the x, y, and z axes. All of the instruments for the conditions and behavior system will be set within the payload, run continuously throughout the flight, and store their data in the onboard computer.

The light sensing equipment will be comprised of twelve LEDs, each one covering a different part of the spectrum. They will all be pointed in the same direction as the imaging equipment. Each will incorporate a separate baffling tube in order to eliminate stray light outside the intended field of view. Like the other system, the imaging equipment will be taking readings for the duration of the mission. Each LED voltage will be monitored by the computer, which will store all the raw voltage data. Taking voltage readings with a resistor in the circuit allows for the determination of the power output from the observed light. Dividing the power produced by a specific wavelength by the area of sky contacting the lens gives light intensity readings in watts per square meter steradian. Simultaneous data points from each LED will be taken every 5 seconds throughout the flight.

The imaging system will be comprised of four Lumenera high-resolution CCD digital cameras. Three of the cameras will be stationed on one side of the payload, each of them being angled upward at thirty degrees. They will be arranged with slightly differing horizontal angles so as to create a panoramic image of the sky. The fourth camera will be mounted at the viewing end of a 105mm Maksutov-Cassegrain telescope, which will also be at thirty degrees above the horizontal and the field of view will be positioned directly above the middle of the other three panoramic cameras. It will also be aligned with the LED array, meaning the images seen through the telescope will closely correspond to the wavelength and intensity readings obtained from the LEDs. The telescope will have a sun shade mounted at the telescope opening in order to shield the camera from direct exposure to the sun, an incident that would likely destroy the camera's imaging chip. As a whole, the imaging system will take pictures every five seconds during ascent, and every twenty seconds for the rest of the flight. These images will be sent to the onboard computer for storage.

During the flight, it will be important to send down health and status packages, providing information of the BOWSER payload and all it instruments, in order to see that everything is working correctly. To that effect, the computer will send packets of all diagnostic data as well as intermittent photometric and imaging data to the HASP mission control. A small amount of control will be maintained from the ground in the form of byte commands to the computer and sun shade.

The science mission of BOWSER requires not only the study of the float altitude that the HASP platform reaches, but all altitudes passed during ascent. The ideal spot for a balloon stationed observatory may not be at the typical HASP float altitude. For this reason, the ascent of the HASP balloon is essential to the experiment. To optimize the data retrieved during ascent, two flight modes will be programmed into the flight computer. The first will be ascent mode, and the second will be float mode. The ascent mode will take pictures every five seconds in order to obtain more data. Using a ground command, the payload will be switched to float mode after maximum altitude is reached. In float mode the payload will take pictures every 20 seconds in order to conserve data storage for the duration of the flight.

2.2 Requirements Flowdown

The following tables represent preliminary requirements.

Level	Objective Number	Objective
0	O1	Team BOWSER shall comply with all HASP requirements.
	O2	Team BOWSER shall determine the feasibility of high altitude observatories.
	O3	Team BOWSER shall have a fully functioning payload by 6/22/09.

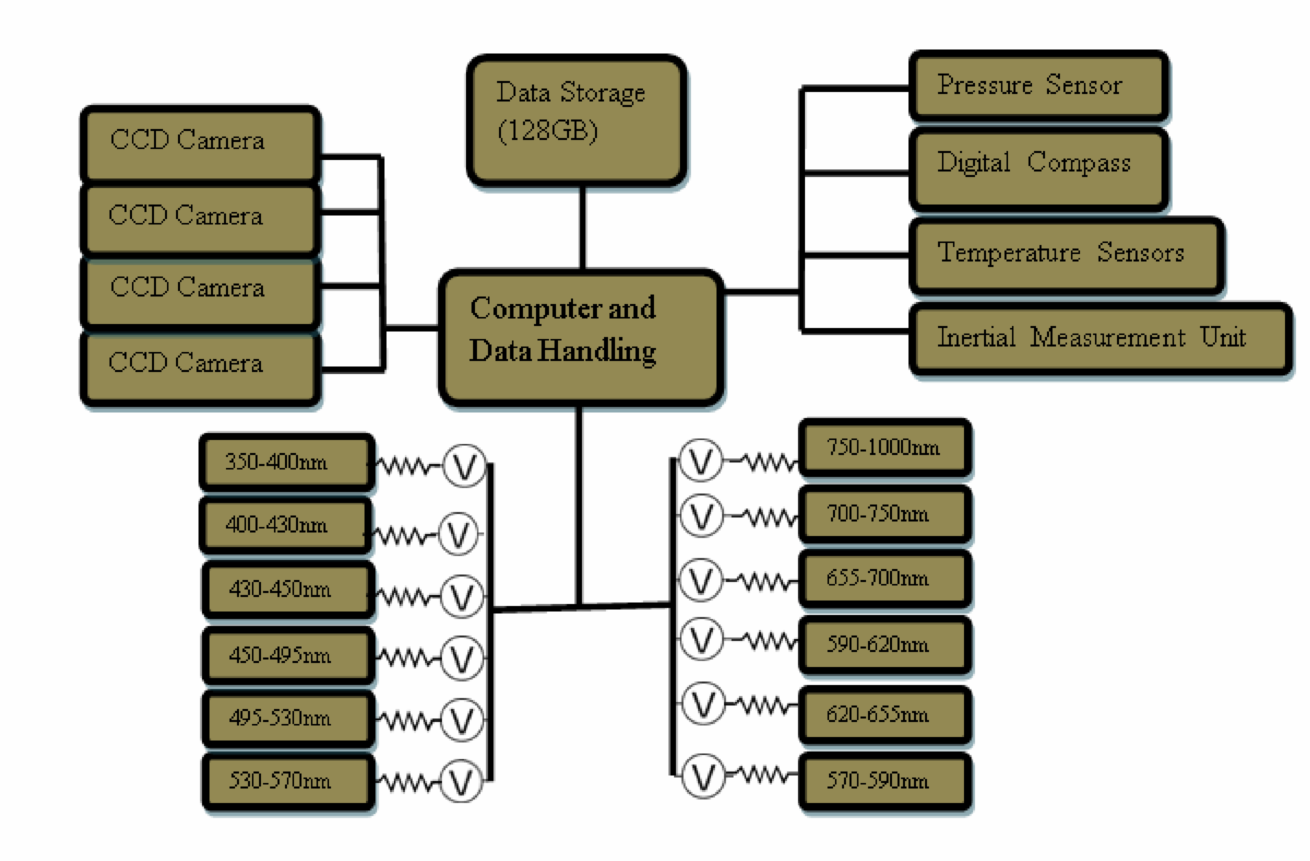
Level	Requirement Number	Level 1 Requirement	Reference
1	R1.1	All HASP mechanical requirements shall be met.	O1
	R1.2	All HASP electrical requirements shall be met.	O1
	R1.3	All HASP data requirements shall be met.	O1
	R1.4	The payload shall provide its own thermal control.	O1
	R2.1	The payload shall take quality images of celestial bodies.	O2
	R2.2	The payload shall take light intensity readings ranging from 350 nm to 1000 nm.	O2
	R2.3	The payload shall sense platform stability and orientation.	O2
	R3.1	A detailed schedule shall be made for design, ordering hardware, and building.	O3
	R3.2	The schedule shall be kept and the team shall work cohesively together.	O3

Level	Requirement Number	O1 Level 2 Requirement	Reference
2	R1.1.1	The payload shall weigh no more than 20 kg.	R1.1
	R1.1.2	The payload shall be no bigger than 38 cm x 30 cm x 30 cm.	R1.1
	R1.1.3	The payload shall allow for secure mounting to the HASP frame, remaining intact up to 10 g vertical and 5 g horizontal shock.	R1.1
	R1.2.1	The payload shall have a twenty pin EDAC 516 interface to the HASP system power and analog downlink channels.	R1.2
	R1.2.2	The payload shall draw no more than +30 VDC or 2.5 amps and shall convert the provided +30 VDC to the necessary voltages required inside the BOWSER payload.	R1.2
	R1.3.1	The payload shall allow for three discreet command functions from HASP payload using EDAC 516-020 interface. One shall be for powering the payload on and off. The other shall be for opening and closing the	R1.3

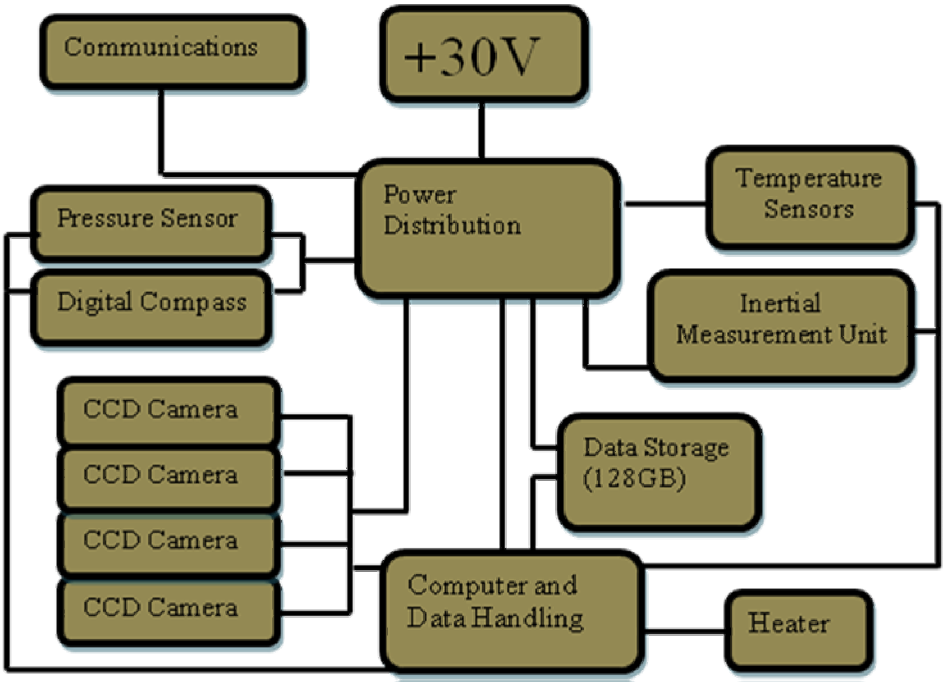
		telescope sun shade. The final shall be for changing between ascent science mode and float science mode.	
	R1.3.2	The payload shall use a DB9 connector, RS232 protocol, with pins 2, 3, and 5 connected.	R1.3
	R1.3.3	The payload shall allow for a serial downlink functioning at 4800 baud.	R1.3
	R1.3.4	The payload shall transmit data packages that show the payload's health status using a unique header identification.	R1.3
	R1.3.5	The serial uplink shall allow for 2 bytes per command.	R1.3
	R1.4.1	The payload shall have heaters installed to supplement the heat produced by the computer.	R1.4
	R1.4.2	The payload shall be well insulated and painted white in order to reflect solar radiation.	R1.4
	R1.4.3	There shall be 12 temperature sensors installed throughout the payload to provide an accurate thermal portrait.	R1.4

Level	**Requirement Number**	**O2 Level 2 Requirement**	**Reference**
2	R2.1.1	The payload shall have three cameras installed at 30 degrees, and mounted relative to each other in order to provide panoramic imaging.	R2.1
	R2.1.2	The payload shall have one camera mounted behind a 105 cm Muskatov-Cassagrain telescope to provide telescopic imaging within the panoramic window.	R2.1
	R2.1.3	The cameras shall take synchronized pictures every 20 seconds during flight. They shall be stored on the computer hard drive.	R2.1
	R2.2.1	The payload shall equip twelve LEDs covering the wavelength ranges: 350-400 nm, 400-430 nm, 430-450 nm, 450-495 nm, 495-530 nm, 530-570 nm, 570-590 nm, 590-620 nm, 620-655 nm, 655-700 nm, 700-750 nm, 750-1000 nm.	R2.2
	R2.2.2	Each LED shall be protected by a solid aluminum baffling tube lined with black felt to absorb stray light.	R2.2
	R2.2.3	The inside of each baffling tube shall contain a convex lens with an LED placed at the focal point.	R2.2
	R2.2.4	The payload shall measure voltage readings from the LEDs for the duration of the flight.	R2.2
	R2.3.1	The payload shall have an accurate compass that takes directional readings every 2 seconds.	R2.3
	R2.3.2	The payload shall have a triple-axis accelerometer in order to give acceleration readings for the x, y, and z axis.	R2.3
	R2.3.3	The payload shall have two dual-axis gyroscopic movement sensors in order to determine the pitch, roll, and yaw of the platform.	R2.3
	R2.3.4	The payload shall have a pressure sensor so that the relative pressure of the platform can be determined accurately.	R2.3

2.3 Data Acquisition Block Diagram



2.4 Power Systems Block Diagram



2.5 Mechanical Drawings

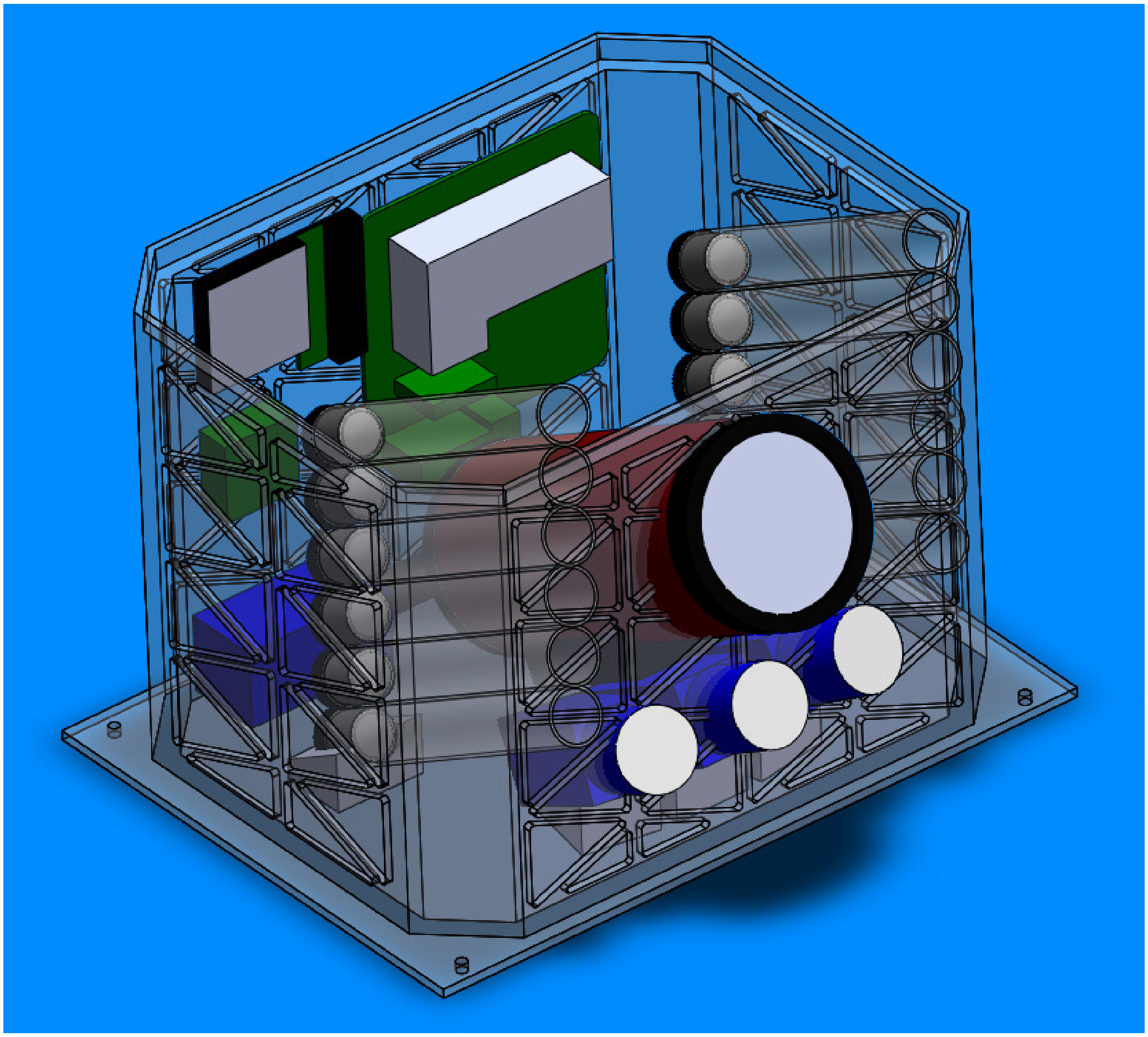


Figure 2.5a: An isometric view of a volumetric drawing of the BOWSER payload.

Figure 2.5a shows the entire BOWSER payload, including all major parts and systems. Represented are the instruments encompassed by the imaging, light sensing and platform stability systems.

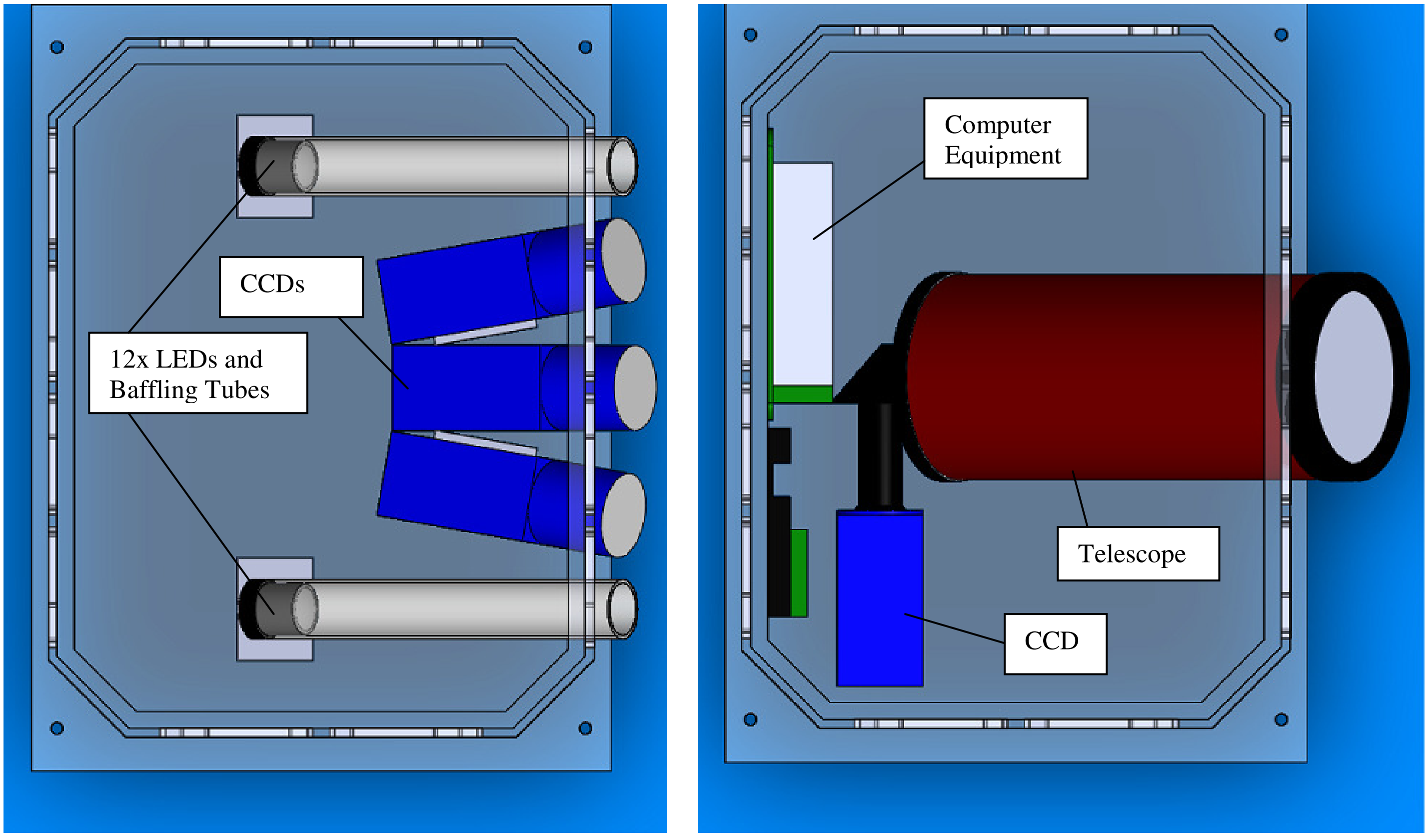


Figure 2.5b: A labeled view of the BOWSER structure. The left side is the lower portion, and the right side is the upper part of the payload.

Figure 2.5b shows a detailed view of the parts that make up the structure of BOWSER. On the left are the parts that are mounted lower in the payload, which includes the light sensing equipment and the three CCD cameras. On the right are the parts on the upper level, including the telescope, its corresponding CCD and the computer and related equipment.

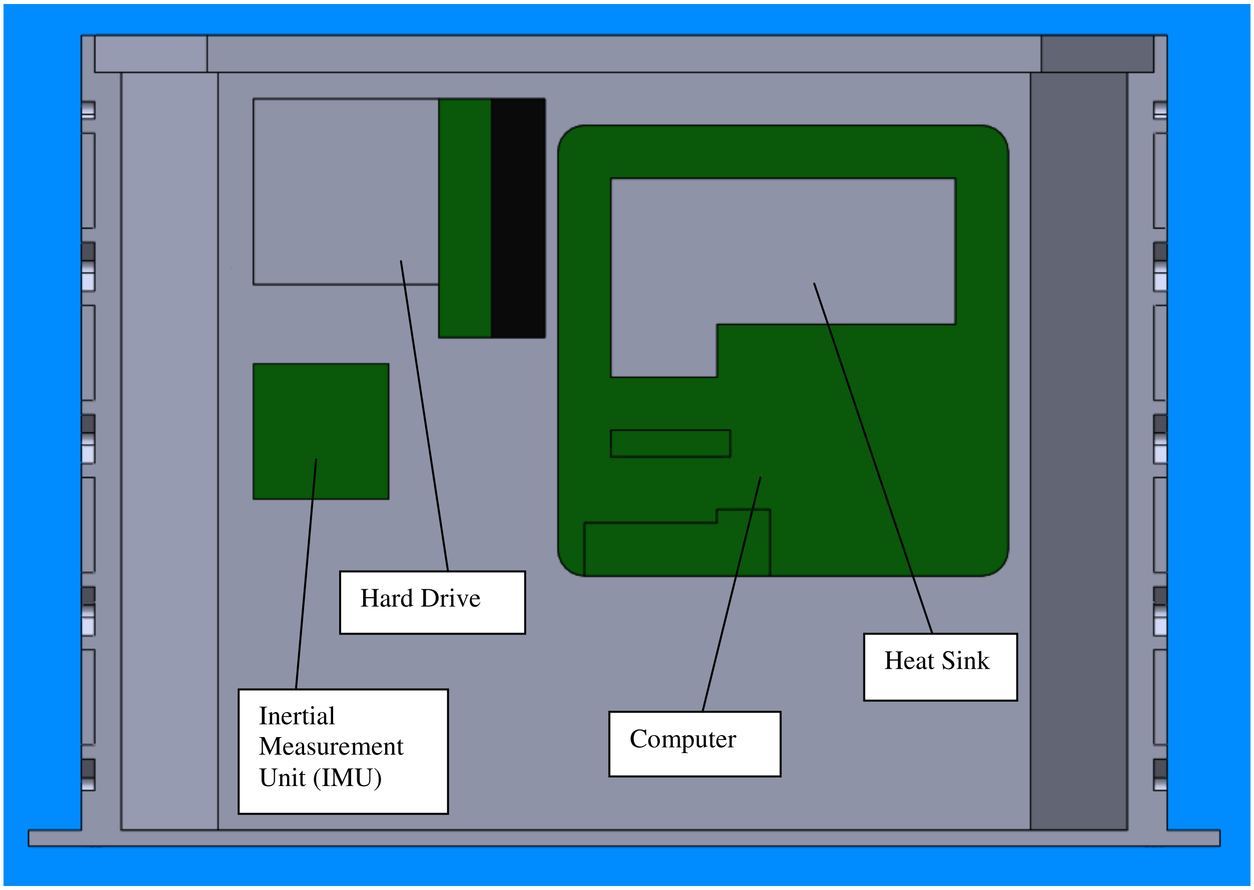


Figure 2.5.c: A blown up view of the long inside panel, which houses the computing equipment.

Figure 2.5c shows the computing components, including the IMU, the hard drive and the computer itself. The grey area on the computer is the heat sink, which will be solid metal in order to sink as much of the excess heat during the day as possible. Heaters will insure the payload remains warm during the night.

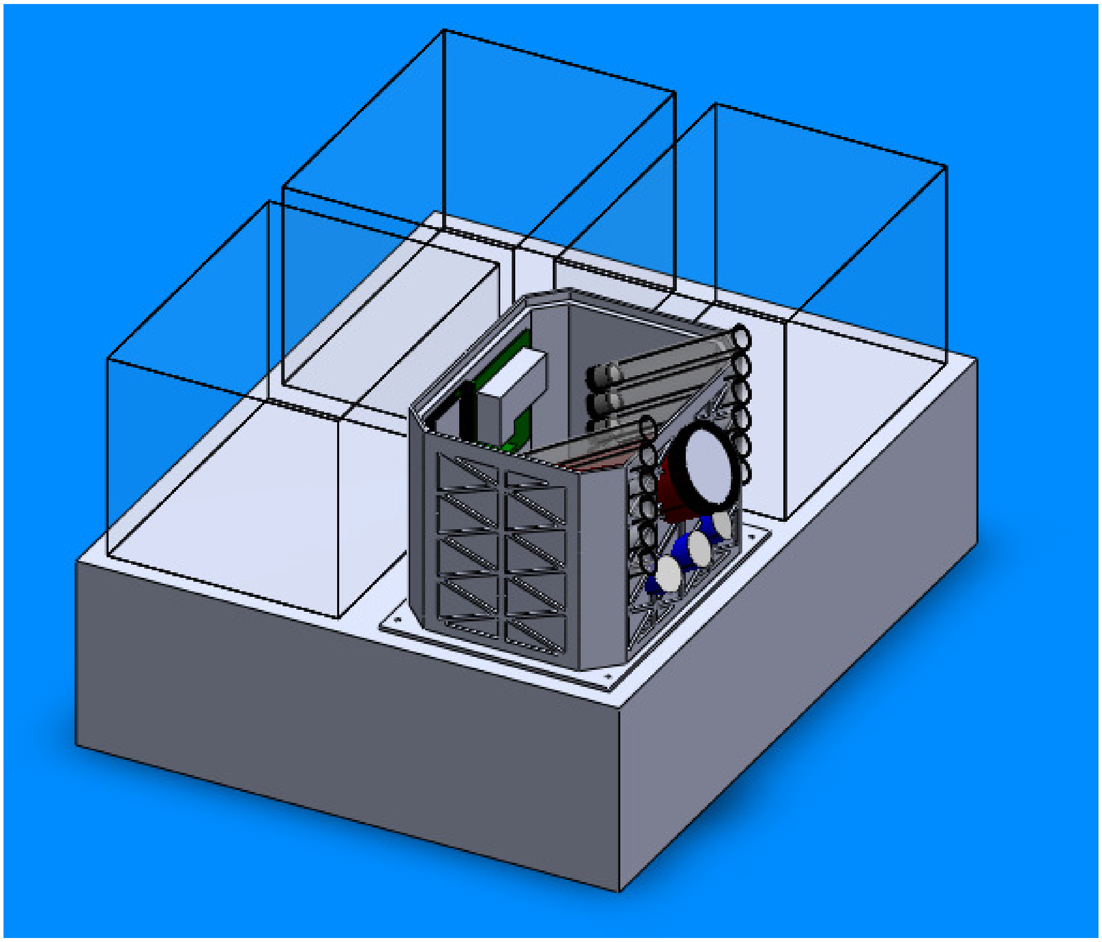


Figure 2.5d: A zoomed out view of the HASP payload and where BOWSER could be situated.

Figure 2.5d shows the BOWSER payload in one of the four possible large payload spots. Because BOWSER's instruments are all facing out of one side of the payload, it can be positioned in any of the large payload slots, so long as the sensing equipment aims at an unobstructed view of the sky.

2.6 Thermal Plan

The internal temperature will remain within the thermal envelope of all components aboard the payload. To accomplish this no heater is planned to be necessary, however the system will have a heater in case the temperature at night goes below what is expected. The DIEHARD computer will be reused for the BOWSER mission. This computer was extremely efficient in heating the entire payload. However, during the daytime, the computer experienced overheating and was thus shut down periodically. This caused a loss of experimental data for this portion of the flight. To counteract this, many modifications will be made. Figure 2.6a shows the computer temperature graph for the entirety of DIEHARD 2008 flight. This graph shows peak temperatures of around 60 degrees Celsius followed by downward diagonal lines. These lines were produced when the computer was shut down in order to prevent overheating.

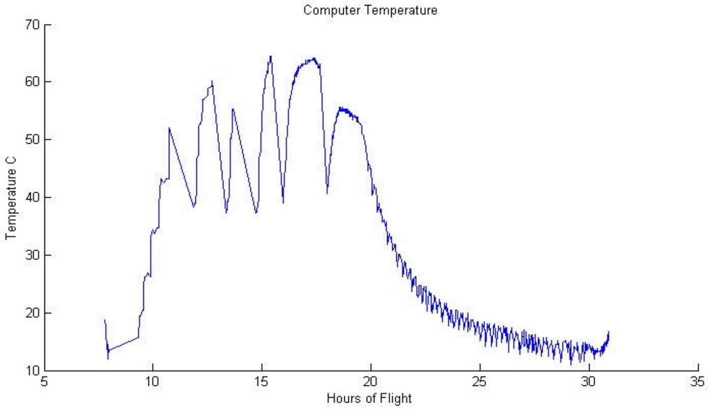


Figure 2.6a: This figure shows the durations during flight that the computer was powered off.

The thermal design flaw was quickly discovered post flight. It was evident that the heat sink for the computer, mounted on the ceiling of the payload, was not sufficient in conducting the heat out of the computer. The thin aluminum strip connected to the radiator was not sufficient in keeping the computer at a reasonable temperature in near vacuum conditions.

Greater thermal sinking design and testing will be done to ensure the computer remains in the opporating envelope of the computer. This will include a more substantial heat sink to keep the computer cool and the rest of the payload warmer.

As a safety measure, a heater will be installed on the platform in case of extremely cold internal temperatures. Although it is not expected that these will need to be operated during flight, they will be installed as a safety measure.

2.7 LED Calibration

Before LEDs can be used as photometers they must be calibrated to determine how current output changes with temperature. LEDs become more efficient at cooler temperatures because electrons experience less resistance as particles slow down. This increase in efficiency correlates to an increase in current output from a constant light source. It is critical that team BOWSER understand this relationship in order to relate light intensity data as temperature changes with altitude. Testing and calibration will be an integral part of the BOWSER mission.

2.8 Mass Budget

Component	Mass (kg)
Hard Drive	0.1
Computer System	2.0
Inertial Measurement Unit	0.1
CCD High Resolution Cameras (4)	3.4
Lenses (x12)	0.1
Temperature Sensors (x12)	0.1
Telescope	2.3
Aluminum Baffling (x12)	1.0
Heater	0.5
Power Converter	1.0
Structure (Aluminum)	6.2
Pressure Sensor	0.1
Compass	0.1
Circuitry	1.0
TOTAL	**18.0**

The current mass budget is below the 20kg requirement and currently has a 2 kg margin.

2.9 HASP Resources

This payload will stay within the power requirements provided by the HASP platform. The payload will use no more than 27-32V and 2.5 Amps, during any point of flight. The power distribution among the payload sub-systems can be seen below.

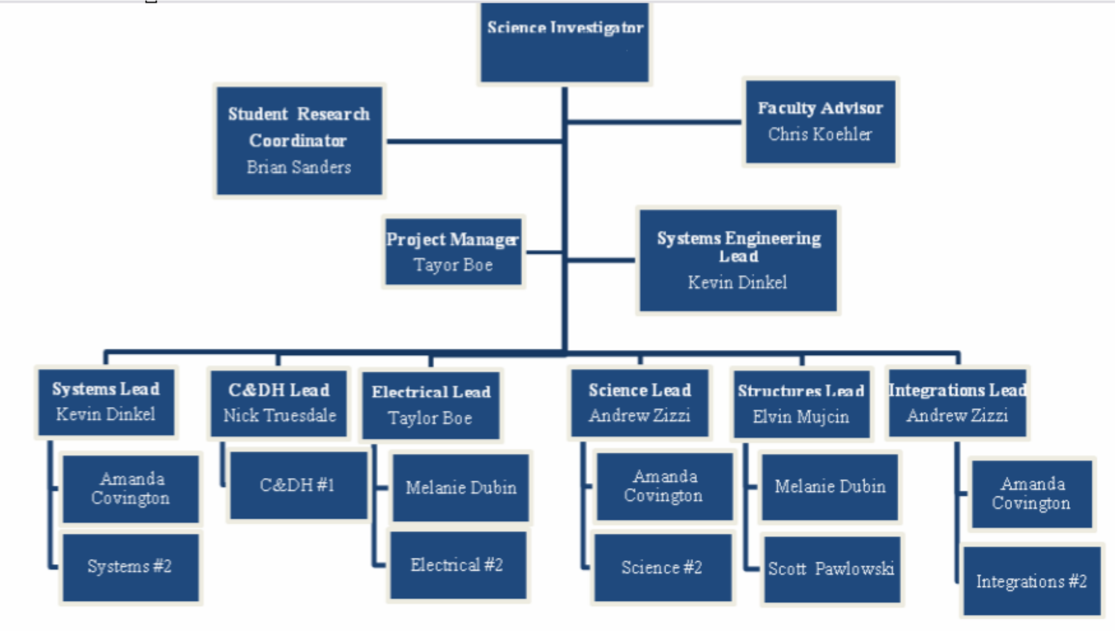
Component	Volts	Amps	Watts
CCD High Resolution Cameras (4)	12 V	1.56A	18.7
Computer System	12 V	2 A	2.5
Heaters	9 V	800 mA	7.2
Hard Drive	5.5 V	444 mA	2
Sensors (IMU, Temp, etc.)	5V	100 mA	.5
TOTAL POWER			**30.9 Watts**

BOWSER will only need the basic discrete commands of on, off and a reset input. These commands will simply turn the power distribution system on and off and reset the computer if necessary. Two analogue channels will send down a sample thermal and photometer reading to help determine whether the experiments are functioning properly. The uplink serial link will be used to change the photodiode sampling rate and command other housekeeping functions. The serial downlink will contain data health and status information and abbreviated science data for evaluation during the mission to insure proper system operation.

3.0 Team Management and Structure

Team BOWSER proposal team currently consists of eight students. The team will likely grow to ten students in the spring semester to brainstorm, design, build and test the payload for BOWSER. Faculty advisors and science investigators will play a vital role in offering guidance and advice. The facilities and logistical support of the Colorado Space Grant Consortium will also be made available to the project. The CU-Boulder team will continue to work with the Science Investigators from DIEHARD, Dr. Yorke Brown, Dr. Robert Fesen and Dr. Eliot Young to continually insure scientific objectives are being met.

3.1 Management Chart



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3.2 Scheduling

The BOWSER team will be structured so that meetings with our faculty advisor will occur once a week. During these meetings all team members will be present to discuss the project at all levels. Meetings with technical investigators will occur monthly to ensure that all systems and components are progressing at a satisfactory pace.

Individual team leads will determine when and how often their teams will meet. Team leads will assign common working hours every week to perform research, construction, and testing.

Date	Description
12/19/08	Proposal Due
1/15/09	Results of Proposal Announced (approx)
2/13/09	Critical Design Review and Finalize Hardware Orders
2/27/09	Begin Sub System Construction
3/20/09	Begin Integration
4/10/09	Begin System Testing
4/14/09	Flight Test Simulation
5/1/09	Mission Simulation
5/29/09	Finish Integration
6/5/09	Finish Final System test and Fight Simulation testing
8/3/09 – 8/7/09	Student Payload Integration at CSBF
8/28/09 – 9/4/09	HASP Flight Preparation
9/5/09	Target Flight Ready
9/7/09	Target Launch Date

4.0 Integration and Launch

The BOWSER Integration Lead, Systems Engineering Lead, Structures Lead, and C&DH lead will be at the Columbia Scientific Balloon Facility during integration. The Integration Lead will supervise the overall integration procedure. The Systems Engineering Lead will connect the necessary wires from HASP to our structure. Additionally, the Systems Engineer will make sure all systems are operational after integration. The Structures Lead will properly attach the structure to HASP. The C&DH Lead will test communication equipment during integration.

4.1 Interface Specifications

Position	1 Large Student Payload
Approximate Weight	20 kilograms
Mounting Footprint	See Figures
Height	30 cm
Length	40 cm
Width	31 cm
Power	31W (1.15A @ 27 V worst case)
Telemetry Rate	1200 bps

4.2 Flight Procedures

Time	Satellite Subsystem	Function
T- 02:00:00	Electrical and Computer	Computer: Turn On Hard Drive: Turn On IMU: Begin Recording
T- 00:10:00	CCD Cameras	Begin Ascent Recording Mode
T 00:00:00	HASP Launch	Launch
T+ 00:10:00	Communication	Packets of data will be sent down every fifteen minutes to be analyzed by mission control.
TBD	Telescope	Open Sunshade
Peak Altitude Reached-TBD	CCD Cameras	Terminate Ascent Recording Mode Begin Float Recording Mode
T+ ~25:00:00	Satellite	Satellite Touchdown and Recovery

The payload BOWSER will be fully automated during the flight leaving the operation team with limited responsibilities during flight. Team BOWSER will analyze photometer, imaging, and thermal data sent from the payload to verify that all systems are working and take appropriate action as necessary. Once the balloon reaches its maximum altitude, the team will use an uplink command to change data collection rates for the cameras. Team BOWSER will view the downlink packages primarily to ensure that the payload is not outside of its operating temperature and that the cameras are taking photos.

5.0 Conclusion

The primary objective of BOWSER is to provide conclusive evidence that imaging stars from a high altitude observatory is feasible. By imaging stars during the day and night, collecting stability data and collecting spectral emission readings to determine the wavelength at which light is most intense throughout the ascent through the atmosphere and during float, BOWSER will return valuable data that will help perpetuate a future mission on a lighter than air vehicle designed to capture high quality images of celestial bodies.