

High Altitude Student Platform



Call for Payloads 2009

Issued October 1, 2008 by

Department of Physics & Astronomy
Louisiana State University
Baton Rouge, LA 70803-4001

and

Balloon Program Office
NASA Wallops Flight Facility
Wallops Island, VA

Application Due: December 19, 2008



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I. Introduction

The High Altitude Student Platform (HASP) was conceived to provide students with flight opportunities that are intermediate between those available with small latex sounding balloons and Earth orbiting satellites. HASP is a support vehicle, based upon flight proven hardware and software designs that uses a "few" million cubic foot, thin film polyethylene, helium filled balloon to carry multiple student built payloads to altitudes of ~120,000 feet (~36km) for durations up to 20 hours. The platform is currently designed to support eight small payloads of ~3 kg weight and four large payloads of ~20 kg weight (i.e. 12 experiment "seats"). A standard interface is provided for each student payload that includes power, serial telemetry, discrete commands and analog output. HASP will archive student payload data on-board as well as telemeter the stream to the ground for real-time access. **See the HASP website (<http://laspace.lsu.edu/hasp/>) for further information**

Construction of HASP was supported by the Louisiana Board of Regents, the Department of Physics and Astronomy at LSU and the Louisiana Space Grant program. The NASA Balloon Program Office, Wallops Flight Facility, has committed to one flight of HASP per year through 2011 from the Fort Sumner, New Mexico balloon launch facility.

This Call for Payloads, jointly issued by the LSU HASP team and the Balloon Program Office (BPO), solicits student groups to apply for a "seat" on the 2009 HASP flight. To apply, student groups will need to develop a proposal describing their payload, including science justification, principle of operation, team structure and management, as well as full payload specifications of weight, size, power consumption, mechanical interface, data requirements, orientation preference and drawings. The costs of hardware development and testing and travel to Palestine, TX or Ft. Sumner, NM for interface verification and flight operations are not covered by this application.

This application will be due at LSU on or before December 19, 2008. Preference will be given to payloads that are clearly demonstrated to be designed, built and operated by students. Notification of selection will occur during January 2009. The remainder of this document describes the HASP system, the student payload interface, the anticipated program schedule and information on how to prepare and submit your application.

II. Call for Payloads Summary

Application due date: December 19, 2008
Submit hardcopy application to: T. Gregory Guzik

Department of Physics & Astronomy
Louisiana State University
Baton Rouge, LA 70803-4001

and e-mail PDF version of application to: hasp@phunds.phys.lsu.edu
Application contents: Cover sheet (see attached)

Payload description including principle of operation
Team structure, members and management
Payload specifications including interface requirements
Drawings showing mechanical interface and payload orientation



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III. The HASP Website

The website for the HASP program can be found at <http://laspace.lsu.edu/hasp/>. This website contains details about the overall program, brief descriptions of payloads that have flown on previous missions, news announcements, a calendar of events and technical documents. During a flight, the website also provides access to real-time imaging, positional tracking of HASP, housekeeping status information plus datasets downlinked from the student payloads. It is recommended that you review the information on the HASP website as you develop your flight application.

IV. HASP Description

Figure 1 shows an image of HASP prior to the 2006 launch with student payloads integrated. The four large payload positions are on the top of the central structure while the eight small payloads are mounted on fiberglass outrigger booms. The small payloads may be mounted for nadir pointing. The core structure of the platform is a welded aluminum gondola frame with dimensions of 112 cm long, 91.5 cm wide, 51 cm tall. For flight, HASP is attached to the Columbia Scientific Balloon Facility (CSBF) Frame (see Figure 2) which provides support for the Mini Support Instrument Package (Mini-SIP) and attach



Figure 1: The HASP configuration

points for suspension cables, crush pads and the ballast hopper. Suspension cables run from each of the four corners of the CSBF Frame to a pin plate that attaches to the flight train. The Mini-SIP provides the CSBF with control over the balloon systems, as well as HASP uplink and downlink telemetry.

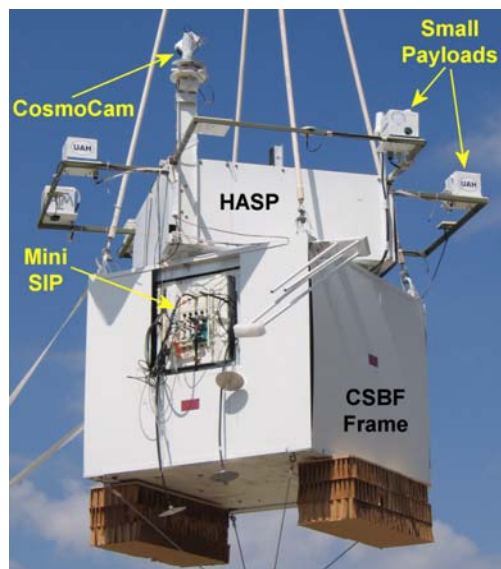


Figure 2: The HASP flight configuration

The Mini-SIP passes uplinked commands to and downlinked telemetry from the HASP control system, which consists of the Flight Control Unit (FCU), the Serial Control Unit (SCU), and the Data Archive Unit (DAU) with associated on-board data storage. The hardware design and controlling software for the FCU, SCU, and DAU were developed under the NASA supported Advanced Thin Ionization Calorimeter (ATIC) long duration balloon project at Louisiana State University and have been adapted to HASP. Also mounted in the interior of the frame are the lithium cells that supply power to the HASP systems, student payloads and the CosmoCam control electronics. Solar shields are mounted on the core frame to maintain the electronics and battery temperature as well as to



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thermally isolate the Mini-SIP from the rest of the HASP components.

Attached to the core structural frame are four composite material braces that are used to support eight small student payloads. Each brace extends about 55 cm away from the aluminum frame and supports two small student payload mounting plates. These braces minimize interference between the metal frame and any student payloads that may exercise data transmitters during flight, as well as maximizing the unobstructed payload field of view (FOV). Mounting plates for four large student payloads are located on the top of the HASP aluminum frame structure. Specific details about the payload mounting plates and the student payload interface are provided in the next section.

The HASP **command and control subsystem** provides the means for receiving and processing uplinked commands, acquiring and archiving the payload data, downlinking status information and controlling the student payloads. There are three primary modules in the subsystem; the Flight Control Unit (FCU), the Serial Control Unit (SCU), and the Data Archive Unit (DAU). The FCU "manages" the subsystem; decoding commands received from the CSBF supplied Mini-SIP and distributing them, watching for units that may need to be reset, and collecting status data for downlink. In addition, the FCU also monitors the power system, collects pressure and temperature information for housekeeping records and sends the student payload serial data to the Mini-SIP for downlink to the ground system. The SCU provides a serial communication link to each of the student payloads including collecting a telemetry bitstream from each payload and distributing uplinked payload serial commands as appropriate. The DAU controls the on-board recording of all data to a multi gigabyte compact flash drive. The existing design, including the mini-SIP, supports a ~36 kilobit per second downlink rate, which should be sufficient to telemeter all student payload and HASP status data during the flight. During a flight, the downlinked data is made available through the HASP website. In addition, on-board recording of these same data to the archive compact flash drive is a backup in case the Line-of-Sight (LOS) link is lost for any reason.

The primary **power source** for HASP will be 11 cell lithium battery packs, eight of which will supply ~29 to 32 Volts for ~270 Ahr. The HASP power system closely follows the ATIC experiment design so subsystem components can be readily reproduced. In this concept, the 30 V bus is run through the gondola and required voltages are converted locally. This approach simplifies the gondola wiring and minimizes power loss. Each supply in the power system includes a relay to control the flow of power via discrete on and off commands, an appropriate DC-DC converter and voltage / current sensors that are used to monitor the state of the power system. Voltage / current sensors are also placed on the main 30 V bus. Each student payload will have similar on/off control and voltage / current monitoring, but main bus power of 30 V will be supplied and the student payload will need to do local conversion as required. *Note that while we refer to this power bus as "30 V", the actual supply from the batteries is closer to 32 V to 33 V at the beginning of the flight, decreasing to 29 V to 30 V toward the end.*

HASP will be flown, with the support of the Columbia Scientific Balloon Facility, from the ConUS launch site in Ft. Sumner, New Mexico once a year. Launch will be scheduled for early morning (i.e. dawn) when surface winds are calm. The balloon will be inflated such that the ascent rate will be about 1000 feet per minute. Thus, ascent to the float altitude of about 120,000 feet will take roughly 1 ½ to 2 hours. The time at float will then directly depend upon the strength and direction of the high altitude winds. Typically, the vehicle can stay at altitude for 5 to 15 hours before the flight must be terminated to parachute HASP into a safe landing zone. Recovery of the full vehicle usually takes less than one day. The actual flight profile



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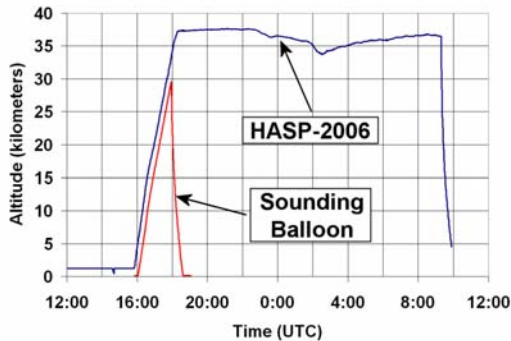


Figure 3: The HASP flight profile.

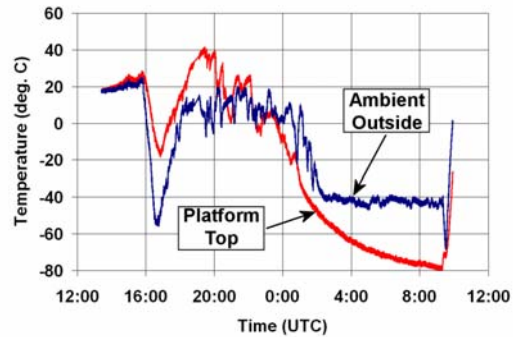


Figure 4: Typical temperatures during flight.

(altitude vs. time) for the 2006 HASP flight is shown in Figure 3 (blue curve) compared with the profile for a typical latex, sounding balloon flight. Temperatures encountered during the HASP 2006 flight are shown in Figure 4. The red curve is from a sensor placed in the location of a large payload and the blue curve is the temperature at a small payload. The dip in both curves at about 17:00 is due to passage through the tropopause, but the temperature will warm once float altitude is reached. After sunset, at about 2:00 UTC in the plot, temperatures again dip to very low values. Your payload must be designed to survive and operate under these conditions.

During the flight we intend to maintain LOS (line-of-sight) telemetry. The HASP ground system will receive and display the downlinked housekeeping status information and will archive the student payload serial data into disk files. Files with UTC time stamped GPS position and altitude information will also be generated. Student teams will be able to download these files from the HASP website in order to monitor their payload status in near real-time. In addition, HASP will fly the CosmoCam system (<http://www.cosmocam.com/>) that provides real-time views of the student payloads, the balloon and the Earth during launch, flight and termination (see Figure 5). If your payload undergoes a visible configuration change (i.e. you have moving parts or external indicator lights), CosmoCam can be used to monitor these changes throughout the flight. Student payloads will also have limited commanding capability during flight. This will include discrete commands (usually employed to turn the payload on or off) plus 2 byte serial commands (defined as desired). Prior to flight the student team will provide HASP operations with a listing of all commands, which will then be issued upon request by HASP flight support personnel. Following recovery, copies will be made of all the flight datasets and distributed to each group for their science data analysis.



Figure 5: Live CosmoCam view during the HASP 2006 flight

V. Student Payload Interface

Specifications for the mechanical, electrical and data interface between HASP and a student payload are provided in the latest version of the document “HASP – Student Payload Interface Manual” which can be obtained from the Participant Information page of the HASP website (<http://laspace.lsu.edu/HASP/Participantinfo.html>). It is highly recommended that you



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download and review this document prior to developing your payload application. A brief summary of the payload constraints and interface is provided in Table 1 and below. *Note that the HASP Interface Manual is updated periodically. In the event of conflicting information between this “Call for Payloads” and the “Interface Manual” the most recent document should be used.*

Mechanical: HASP supports two classes of student payloads. **Small** payloads have a maximum weight of 3 kg and are located on the HASP “outrigger” braces. **Large** payloads can weigh up to 20 kg and are located on the top of the HASP aluminum frame. In your payload application you will need to indicate your payload class as either small or large. If your application is accepted for flight your team will be sent the payload mounting plate appropriate for your class. These plates, shown in Figure 6, are constructed from ¼” thick PVC, include wiring for the electrical / data connections and are marked to indicate the allowed footprint for your payload. Within the allowed region the plate can be modified for payload support structure and, if needed, downward pointing apertures. [Note that located immediately below each large payload will be the HASP thermal and EM insulation plates, so downward pointing apertures would not be appropriate.] All components attached to the mounting plate by the student team (e.g. payload, support structure, bolts, DC converters, antennas, etc) must be included in the weight budget and total less than the maximum allowed for the payload class. The size of the allowed footprint and payload height is given in Table 1.

Note that the payload must be secured so that it remains intact and attached to the mounting plate under a 10 g vertical and 5 g horizontal shock. It is advised that appropriate analyses and/or test data be collected to provide evidence that your payload and mounting will satisfy this requirement.

Electrical: A twenty pin EDAC 516 (manufacture number 516-020-000-301) will be used to interface with HASP system power and analog downlink channels. Power is supplied as +30 VDC with a maximum current draw for small payload limited to 0.5 amps, and for large payloads to 2.5 amps. It will be the responsibility of the payload to convert internally the +30 VDC to whatever voltages are required. In addition, two 0 to 5 VDC analog channels will be accessible through the EDAC 516 connector. These channels are digitized and transmitted by the Mini-SIP systems every minute to provide real-time monitoring of two key payload parameters. For large payloads it may also be possible to negotiate swapping some of the EDAC 516 power and ground pins for additional pairs of discrete commands. Discrete commands are transmitted to and routed through the ballooncraft via highly reliable systems and are generally used to control critical, basic functions. Every payload will already have one pair of discrete commands

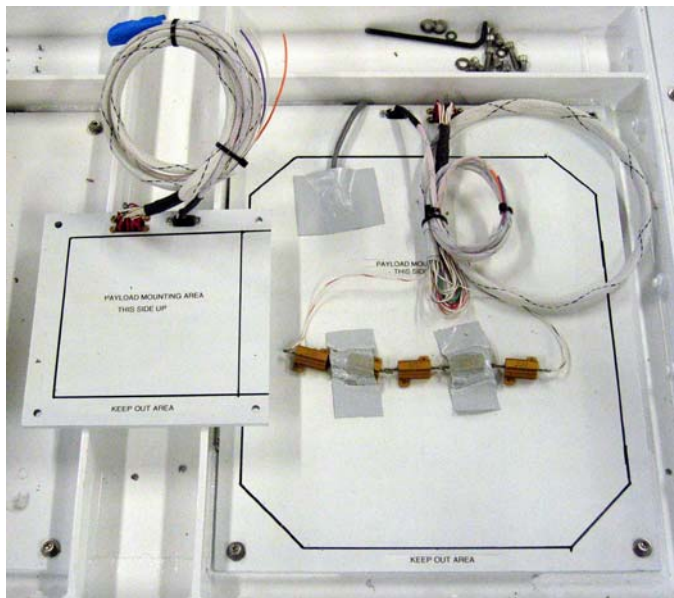


Figure 6: The small (left) and large (right) student payload mounting plates.



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assigned to turn on and off the payload power.

Data: Serial communications use a DB9 connector with pins 2 (receive / transmit), 3 (transmit / receive) and 5 (signal ground) connected. The protocol is RS232 and the port setup is 8 data bits, no parity, 1 stop bit and no flow control. The serial port is set to 1200 baud for small payloads and 4800 baud for large payloads. HASP will collect data from the student payload as a bitstream: listening for and receiving data until the internal buffers fill, then packaging this buffer as a record for on-board archiving and telemetry to the ground system. On the ground, the HASP records will be unwrapped and written to disk in the order the bits were received from the payload. It is quite feasible that payload records can be split across HASP buffers and that, on occasion, a transmitted packet can be corrupted. Therefore, it is strongly advised that the payload adopt a record structure of its own that includes a unique header identification, record

Table 1: Payload Interface Specifications (v2008)

Small Student Payloads:

Total number of positions available:	8
Maximum weight:	3 kg (6.6 lbs)
Maximum footprint (must include mounting structure):	15 cm x 15 cm (~6" x 6")
Maximum height (may need to be negotiated with neighbor payloads):	30 cm (~12")
Supplied voltage:	29 - 33 VDC
Available current:	0.5 Amps @ 30 VDC
Maximum serial downlink (bitstream):	1200 bps
Serial uplink:	2 bytes per command
Serial interface:	1200 baud, RS232 protocol, DB9 connector
Analog downlink:	two channels in range 0 to 5 VDC
Discrete commands:	Power On, Power Off
Analog & discrete interface:	EDAC 516-020

Large Student Payloads:

Total number of positions available:	4
Maximum weight:	20 kg (44 lbs)
Maximum footprint (must include mounting structure):	38 cm x 30 cm (~15" x 12")
Maximum height (may need to be negotiated with neighbor payloads):	~30 cm (~12")
Supplied voltage:	29 - 33 VDC
Available current:	2.5 Amps @ 30 VDC
Maximum serial downlink (bitstream):	4800 bps
Serial uplink:	2 bytes per command
Serial interface:	4800 baud, RS232 protocol, DB9 connector
Analog downlink:	two channels in range 0 to 5 VDC
Discrete commands:	Power On, Power Off
(It may also be possible to negotiate up to 4 additional command pairs; i.e. F1 on, F1 off)	
Analog & discrete interface:	EDAC 516-020



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byte count and checksum. A suggested record format is provided in the “HASP – Student Payload Interface Manual”.

It will also be feasible to uplink a two-byte serial command to your payload. Any number of two-byte commands can be defined, but each command will need to be entered into the ground system and uplinked separately by a HASP operator. As the same serial port will be used for both downlink and uplink, the payload will need to periodically check the port to



Figure 7: Student team integrating with HASP

determine if any commands are being uploaded from the HASP SCU. Every time a command for a particular payload is identified, that two byte command regardless of content will be passed to the student payload. Therefore, it is the payloads responsibility to determine the validity and contents of the serial command. Uplink commanding can be unreliable and you should minimize the number of commands you plan to use during flight. The format of the command string sent to a student payload as well as suggestions on how to improve commanding reliability is provided in the “HASP – Student Payload Interface Manual”.

Thermal: The HASP platform provides **no** thermal control to the student payloads. It is the responsibility of the payload developers to ensure that their experiment will remain within acceptable temperature limits.

VI. Anticipated Schedule

During 2008 the third HASP flight will be complete. Refurbishing the platform will be done in late-08 and early-09. For the 2009 flight, the anticipated schedule is illustrated in Table 2. We expect that HASP refurbishment will be completed by June, at which time the subsystems will be re-integrated and tested. The first opportunity for students to integrate and test their payloads with HASP will occur during early August at the Columbia Scientific Balloon Facility (CSBF) in Palestine, Texas. If student payloads are ready within this time frame, then there will be about two to three weeks to correct any interface issues uncovered during testing. The only other time for interface testing will be in August/September shortly before launch, at which time there will be little flexibility to resolve any problems that are discovered.



Figure 8: HASP and student payloads in the CSBF BEMCO chamber in preparation for thermal / vacuum testing.

Integrating your payload at the CSBF has several advantages. First, the facility is the center of the NASA world wide scientific ballooning effort and, as such, has personnel with expertise in all areas related to ballooning. Second, the CSBF has a thermal-vacuum chamber that can be used to simulate the temperature



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and pressure extremes that your payload will experience during a HASP flight (see Figure 8). Participating in a thermal/vacuum test during integration will enable you to significantly improve your chances of having a successful flight.

Flight operations for 2009 are planned for Ft. Sumner, New Mexico during late August/early September and the HASP vehicle and support crew will be arriving on site in late-August. Any student payloads that have already integrated with HASP (i.e. in early August) can be flown without any further intervention by the student team. Data during the flight will be available for access via the HASP website. The payload will be returned to the group following the flight. If the full dataset is desired it will be in zipped format on the HASP website sometime after the flight. (If the raw data from HASP's flight disks is desired, you will need to request a copy.) Payloads that have not integrated earlier will need to send at least one representative to the flight line to take responsibility for the payload during final integration testing.

Exact launch dates are impossible to predict, and it is highly dependent upon the local weather conditions and the number of experimenters waiting for launch. At this time we are targeting early September, but this could easily be one week earlier or several weeks later.

Table 2: Anticipated HASP 2009 Schedule

~January 15	Announce student payload selection
June 15	Complete HASP refurbishment
June 18 – July 19	HASP system integration and testing
July 22 – July 26	Packing and shipping to CSBF
August 3 – August 7	Student payload integration at CSBF
August 27	Arrive Ft. Sumner
August 28 – September 4	HASP flight preparation
September 5	Target flight ready
September 7	Target launch date and flight operations
September 8 – September 11	Recovery, packing and return shipping

VII. Possible Early Palestine Launch

For the past three years, HASP has launched from Ft. Sumner, New Mexico in early September. The flights have been anywhere from 17 to 32 hours long. For the first time, we are considering an early summer Palestine, Texas launch. This launch would most likely take place sometime in June as opposed to an early September Ft. Sumner launch. The upside to a Palestine campaign in June is that more students may be able to spend a longer period of time participating in integration and flight operations. The downside is the significantly shorter flight times (~6 hours versus 20 hours for a Ft. Sumner launch). Another downside to a Palestine launch is that payloads would need to be integrated in May and, thus, fully completed during the spring semester. A fall Ft. Sumner launch would allow payload work to take place during most of the summer which is when students are more likely to dedicate large amounts of time to complete their payloads. Currently, we are gathering information to assist us in planning future HASP flight operations. Assuming only one HASP flight each year, please include a short



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paragraph in your proposal describing whether a June Palestine or September Ft. Sumner launch would be more suitable to your group and why.

VIII. Deliverables

Even if your payload is accepted your seat on the next HASP flight is contingent on providing documentation describing your payload as well as your plans for integration and flight operations. In addition, application for a future HASP flight will be contingent on delivery of a Final Flight / Science Report. These documents are described below and templates are available on the HASP website. *Note that filling out these documents are not necessary for your application, but they will give you an idea of the kind of information that you might include in your application and what we will require once your payload is developed.*

Payload Specification & Integration Plan: This document provides technical details on the final flight configuration of your payload including measured weight, measured current draw (@30 VDC), downlink data format and rate, uplink commands, analog output usage, discrete command usage, and dimensioned mechanical drawings. In addition, your plans for integration with HASP should be detailed including, at least, all test procedures and test procedure validation results, requested test equipment, schedule and personnel participating in integration.

Payload Integration Certification: At integration all interfaces will be documented and validated, correct operation of the payload will be verified and any issues identified will be detailed. This certification will be handled by HASP management during integration. A sample form, customized for your payload, will be sent to you following receipt of your Payload Specification & Integration Plan. Note that you will not be able to fly until this certification is complete.

Flight Operation Plan: This document will detail procedures for flight line setup, pre-launch checkout, flight operations, error recovery, safeing and payload recovery including a timeline showing specific events relative to launch at $T=0$ and identifying personnel participating in flight operations. Note that any operations requested to be performed by HASP flight personnel other than power-up ~one hour prior to launch ($T - 1$ hr) and power down prior to terminate must be specified in this document.

Final Flight / Science Report: A final report on the results from the flight of your payload is due by the end of the calendar year. This report should include an assessment of the payload performance, problems encountered, lessons learned as well as the science / technical results from the flight.

IX. Special Requests

We will entertain requests for your payload to exceed one or more of the constraints on weight, dimensions, telemetry **if** such a request is fully described in your application and is clearly justified by your science. Such applications will be accepted **only** if we feel that the request is fully justified and if we feel that we can provide the additional resource. Thus, it is



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strongly advised that if you decide to make a special request, you should also include a section discussing the implications if your request is not granted.

X. Application Preparation and Submission

For the 2009 HASP flight, eight small and four large payload seats will be available for student groups. To be considered for the 2009 HASP flight, all teams must submit a complete payload application on, or before, **December 19, 2008**. These applications will be reviewed and seat awards will be announced by January 15, 2009.

The application package consists of a cover sheet, payload description, team management and structure, payload interface specifications and preliminary drawings. It can be submitted in either MS Word (.doc format compatible with MS Word 2003 not .docx) or PDF, **plus** in hardcopy format.

The **cover sheet** form is attached here. The boxes on the cover sheet should be self-descriptive with the following exception. Identify in “Payload Class:” whether you are applying for a **small** or **large** payload seat. The “Project Abstract” is limited to 200 words and should provide a brief summary of your payload “science” objectives, team structure and interface requirements. If your team has a name different from the project name you can enter it in the “Team Name” box, otherwise enter the payload acronym or leave blank. If your team or project has a website enter the URL in the next box. Finally, we will need full contact information for the student who will be the interface through flight operations between the student team and HASP management. The cover sheet is limited to one page.

The **payload description** provides a one to two page summary of your scientific objectives, a high level review of your payload systems plus a statement of the principle of operation of your experiment. This section should provide the reader with a reasonable understanding of the “why, what and how” of your payload. Be sure to include a thermal control ‘plan’.

The application should also include a description of **how your team is structured and managed**. This could include an organization chart and / or a listing of the team leads. Full contact information (including e-mail address) should be provided for the principle team leads plus faculty advisors. Also include a description of how the team effort is organized and managed as well as a preliminary timeline leading to integration with HASP and flight operations. We will also need to know how many personnel are anticipated to participate in the integration at CSBF and the flight operations in at Ft. Sumner. Please also be sure to include a **brief description of which launch site would be more preferable to your group and why** (see section VII).

The **payload specifications** section should describe what HASP resources you will use and how your payload will fit within the HASP constraints. This section should include your weight budget with uncertainties, mounting plate footprint, payload height, power budget, downlink serial telemetry rate, uplink serial command rate, anticipated use of analog downlink channels or additional discrete commands as well as the desired payload location and orientation. Also include a brief description of your anticipated procedures during integration with HASP and flight operations. You may also request resources that somewhat exceed those specified for your payload class or those that are not mentioned in this document. However, each such request must be accompanied by a description of the impact if the requested resource is not granted.



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Payloads that are significantly impacted by the limited resources available are unlikely to be good candidates for a HASP flight.

Finally, a collection of **preliminary drawings** illustrating particular aspects of your payload will be needed. Typical items to include here would be a dimensioned drawing of your payload, anticipated modifications to the payload mounting plate, sketches of your mounting structure, and illustrations of your preferred payload orientation and location on HASP.

Once completed your application should be submitted both electronically as PDF or MS Word (compatible with 2003) and in hardcopy to the address listed in section II by December 19, 2008. As the applications are reviewed, priority will be given to those payloads that are clearly student designed, built, managed and operated, but projects with only a partial student component are also welcome to apply. The application will also be reviewed for completeness, consistency, scientific or technical justification, and ability to fit within the HASP constraints. Seat awards will be announced by about January 15, 2009.

XI. Financial Support

Each applicant for a HASP seat must provide their own financial support for payload development, testing, integration, flight operations in New Mexico and subsequent data analysis. It is **highly** recommended that a team seek / develop the needed financial resources at the same time as completing this application.

Louisiana based teams may apply for such support to The Louisiana Space Consortium. To request support, a Louisiana team should follow the instructions on the LaSPACE website. For further details, questions or copies of budget forms, please contact the LaSPACE office at 225-578-8697 or eads@phys.lsu.edu.



HASP Student Payload Application for 2009

Payload Title:		
Payload Class: (circle one) Small Large		Institution:
Submit Date:		
Project Abstract		
Team Name:		Team or Project Website:
Student Team Leader Contact Information:		Faculty Advisor Contact Information:
Name:		
Department:		
Mailing Address:		
City, State, Zip code:		
e-mail:		
Office telephone:		
Cell:		
FAX:		