The High Altitude Student Platform (HASP) Technology and Application

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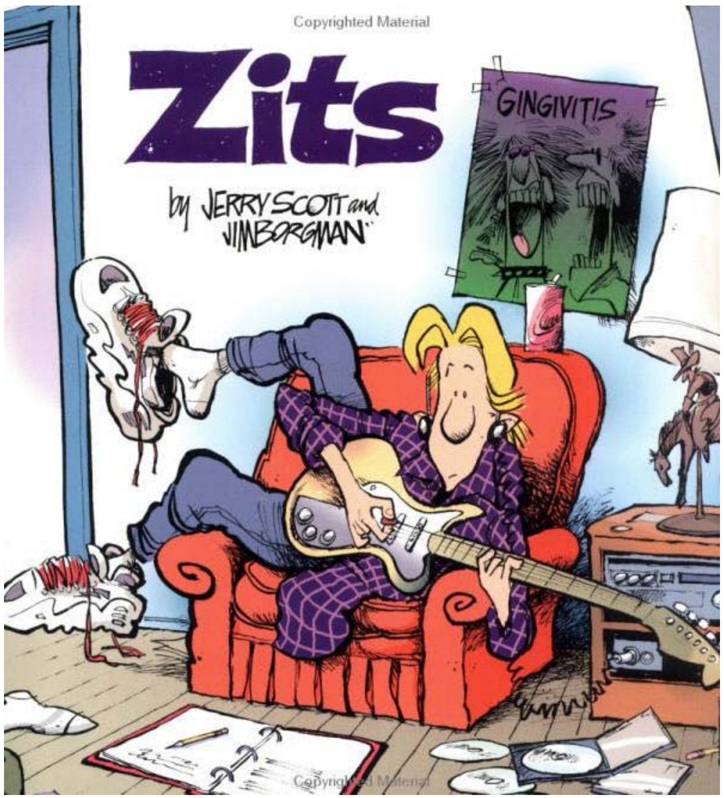
HASP Program Major Goals

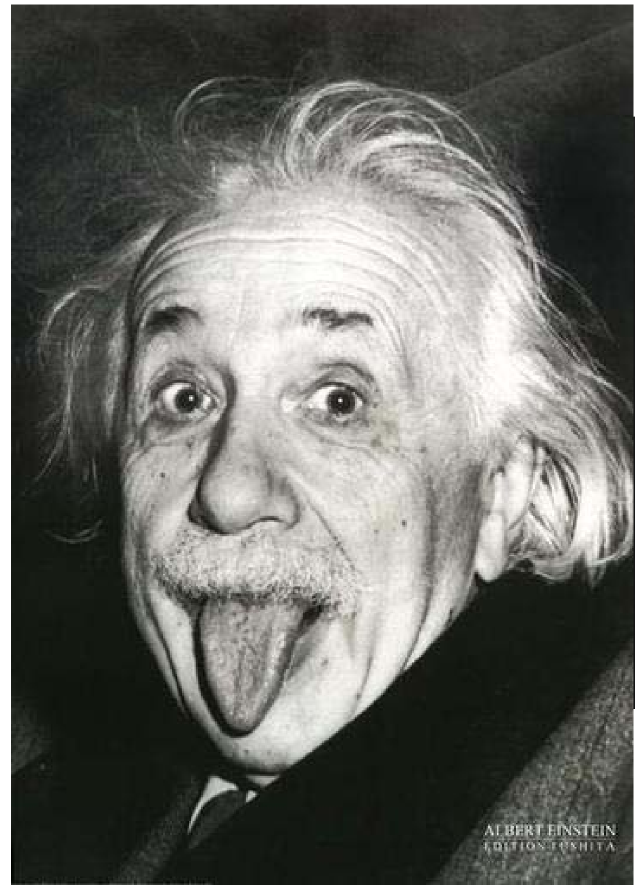
- Build student excitement in an aerospace related career
  - Help address workforce development issues
- Support student research and engineering projects
  - Thesis projects enhance research / technical skills
- Fill the gap between student-built sounding balloon payloads and small satellites
  - Keep development consistent with student schedule
  - Provide "space test" for prototype student satellites
- Help promote ballooning as a viable space research tool.

In other words ….

How do we get from …

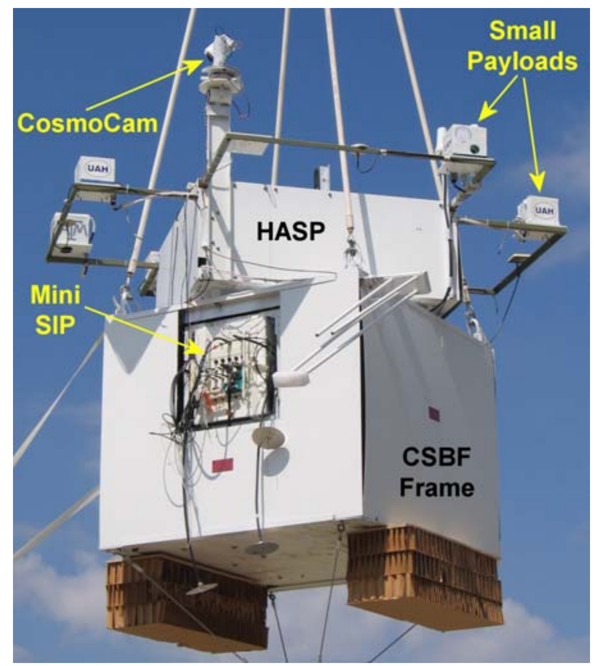


Or I'd even be happy with …



Major HASP Features

- Support & flight test up to 12 student built payloads
  - Eight small payloads < 1 kg & four large payloads < 10 kg
  - Fly to an altitude > 36 km for a duration of ~20 hours
- Provide payloads with serial uplink/downlink, discretes, 28 VDC power, & analog downlink
  - Downlink available in near real time
- Include CosmoCam for real time video during launch & flight
- NASA partnership supports three flights
  - First flight September 4, 2006
  - Two more flights, once a year

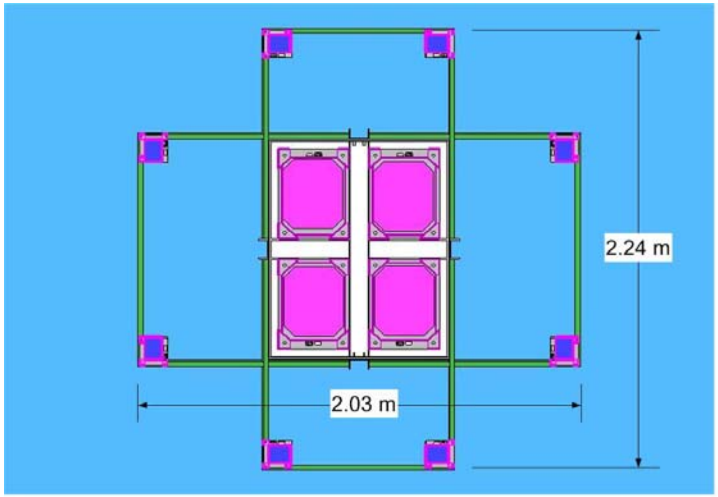


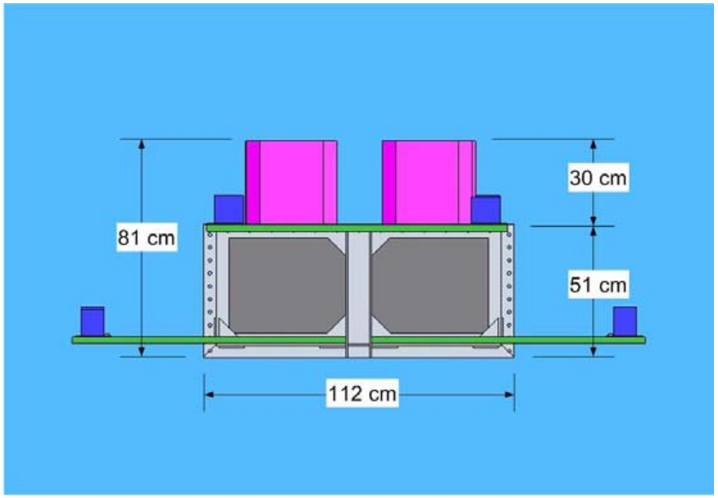
Structural System

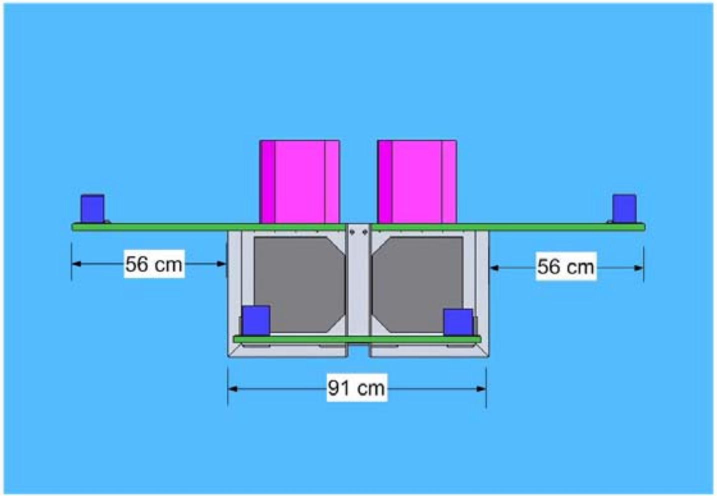
- Core aluminum frame provides platform integrity
- Interior used for control electronics, batteries and CosmoCam control

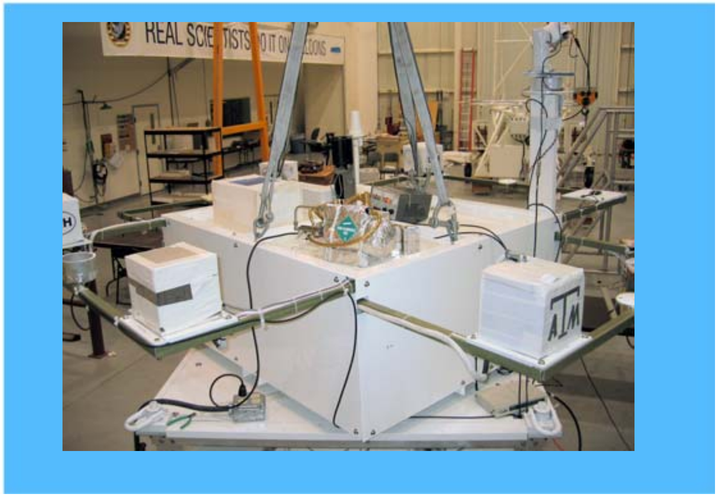
- Fiberglass extension wings support eight small student payloads
- Four large student payloads are supported directly on top of the core frame
- HASP frame is mounted on top of the CSBF frame that supports the mini-SIP vehicle control system, balloon train attach points and ballast hoppers

Configuration & Dimensions

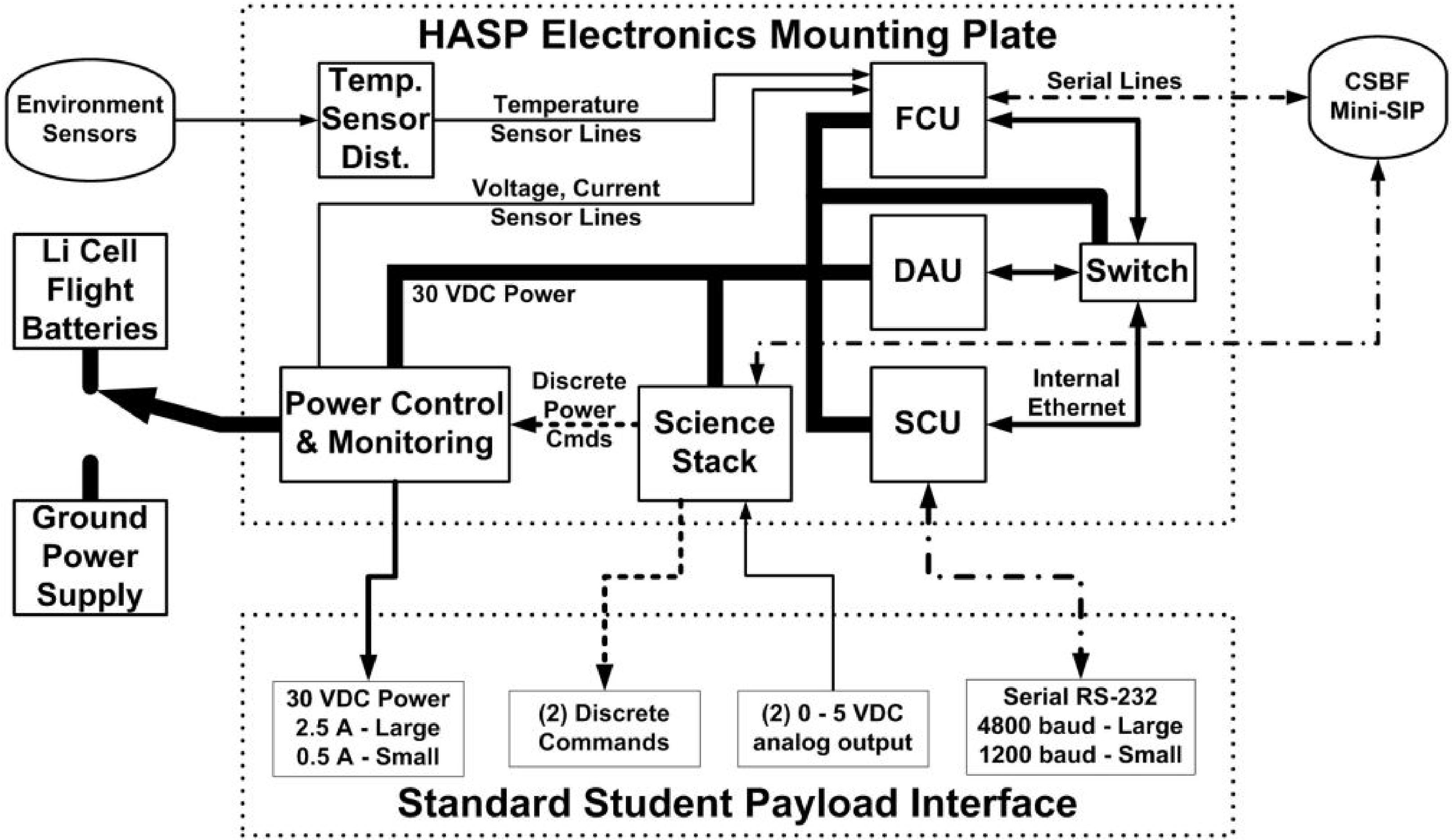




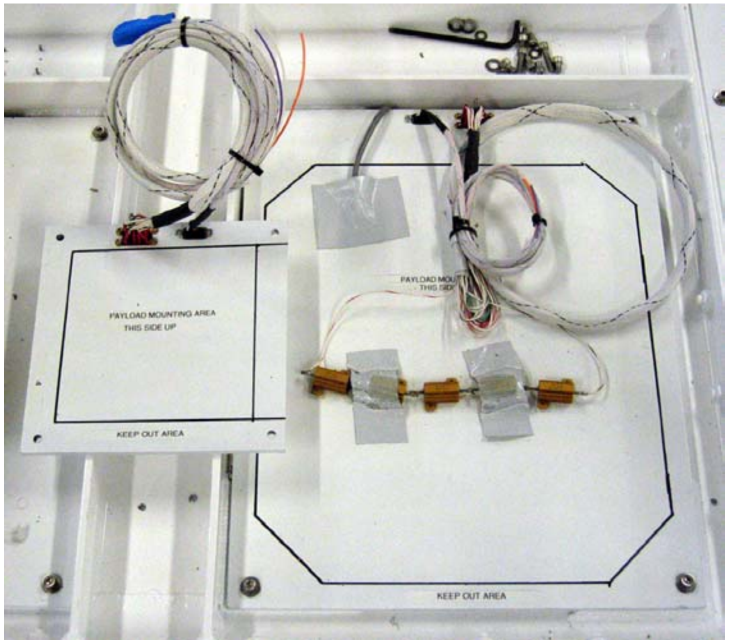




Major HASP Subsystems



Student Payload Interface

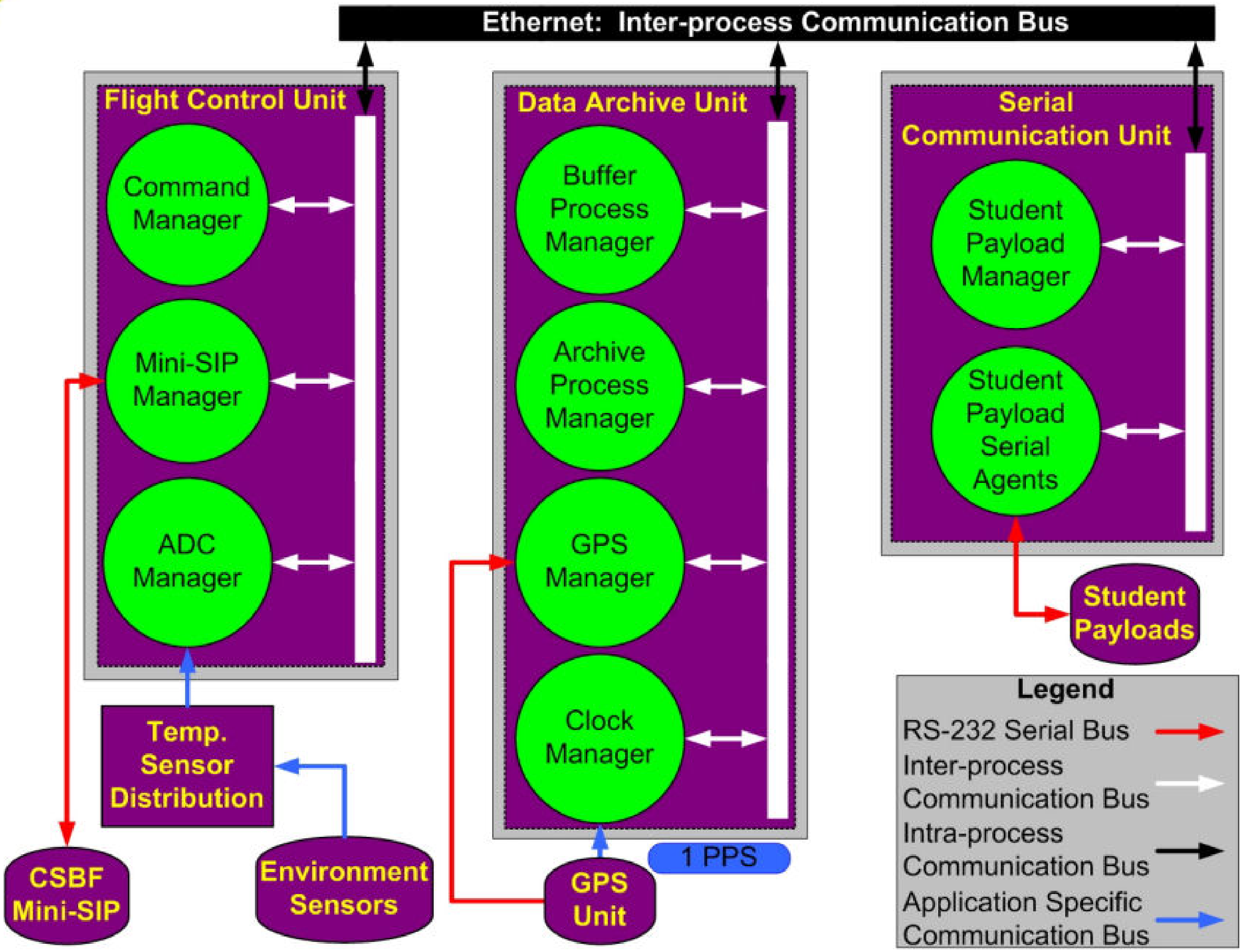


- Small and large versions are identical except for size
  - Base is 6 mm thick PVC plate with a bolt hole in each corner for mounting the plate to HASP
  - DB9 connector provides RS-232 serial communication
  - EDAC 516 connector provides +28 VDC power, two analog downlink channels and two discrete command channels
- Serial connection provides two way real time communication
  - Downlink at up to 4800 baud
  - Uplink serial commands to student payload
- Mounting plate with wiring pigtail and document provided to each student payload group
  - Students can mount and wire as they please within the allowed region
  - HASP wiring harness attaches to connectors and plate is bolted to frame during integration
- Small version for 15 cm x 15 cm (footprint) x 30 cm (tall), 1 kg payloads
- Large version for 38 cm x 38 cm (footprint) x 30 cm (tall), 10 kg payloads

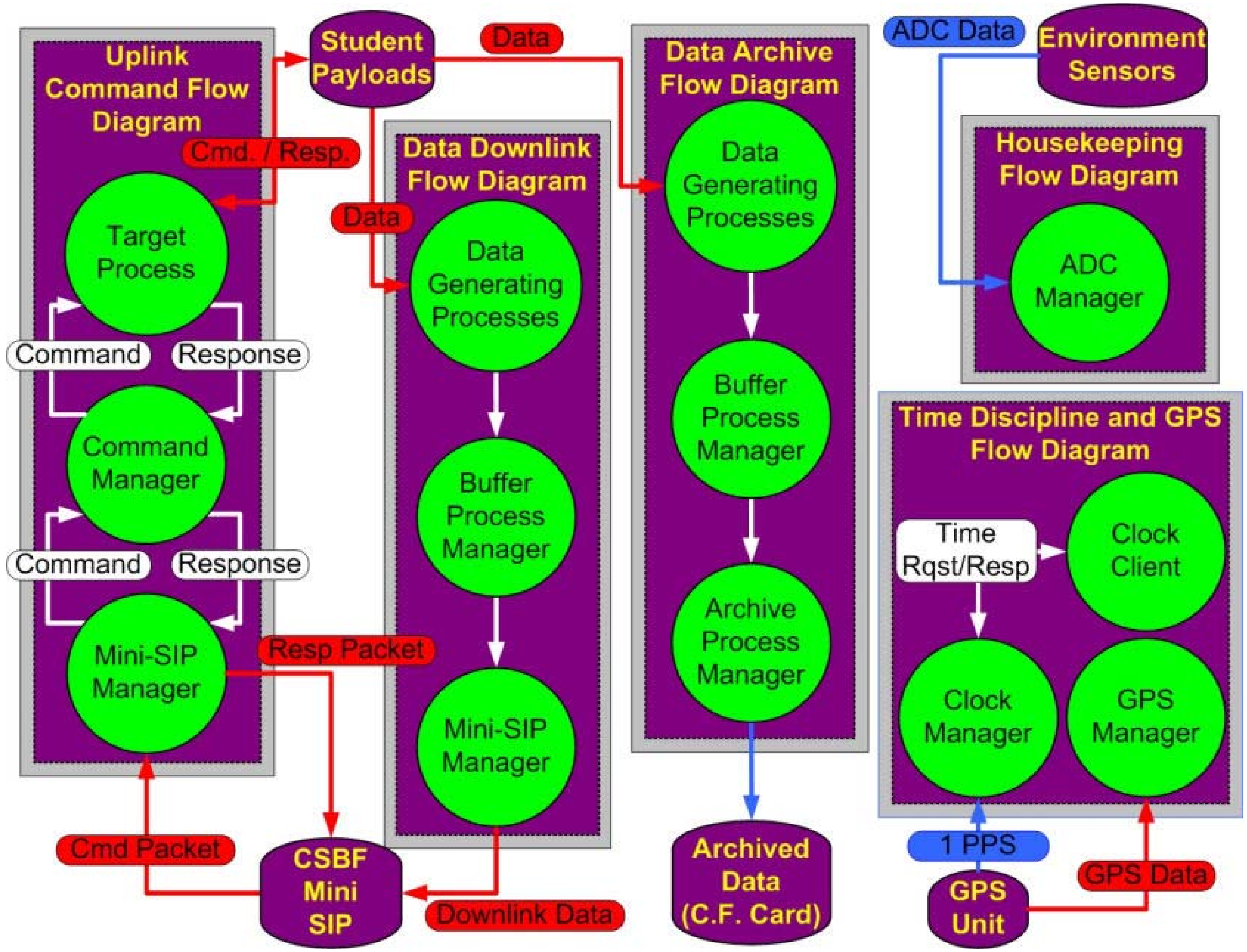
Command and Control

- Heritage from ATIC scientific balloon payload systems
  - Directly adopt flight proven hardware and software design
- Several enhancements learned from the ATIC experience
  - Significantly improved modularity and ease of maintenance
  - Use high density Compact Flash cards for data storage
  - Use modern, PC104 COTS single board computers to consolidate functionality
  - New electronics were developed to handle power switching as well as voltage, current and temperature monitoring
- Flight Control Unit (FCU) handles uplinked commands, downlinked housekeeping, and general system monitoring and control
- Data Archive Unit (DAU) handles on-board data recording, and GPS time stamp of records
- Serial Control Unit (SCU) handles serial uplink and downlink for all student payloads
- Interface to a CSBF supplied mini-SIP for vehicle communication and control
  - ATIC software was already coded and tested with the SIP
  - Simplify HASP software development and increase reliability
  - Opens possibility of a HASP LDB flight at some future date

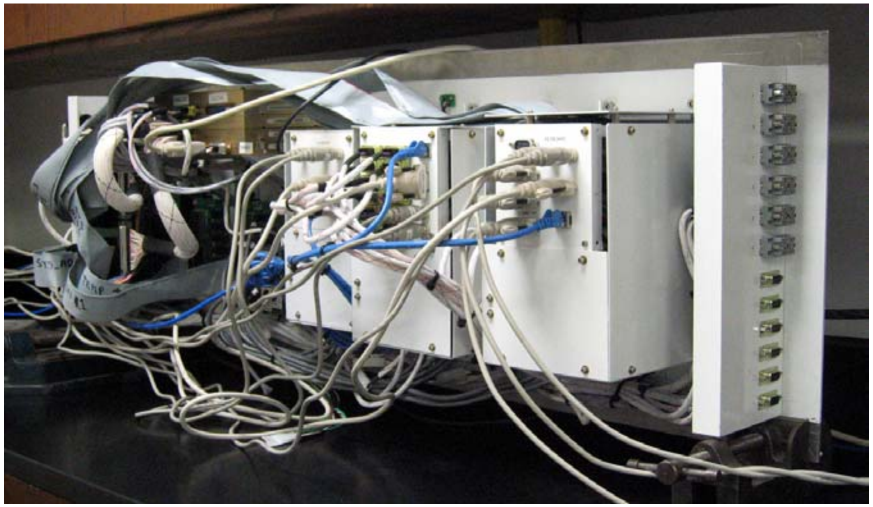
Flight Software Systems

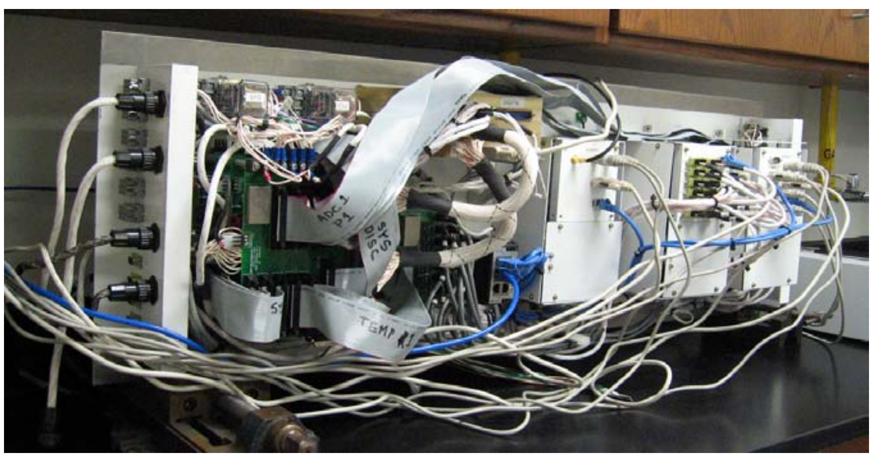


Flight Software Functions



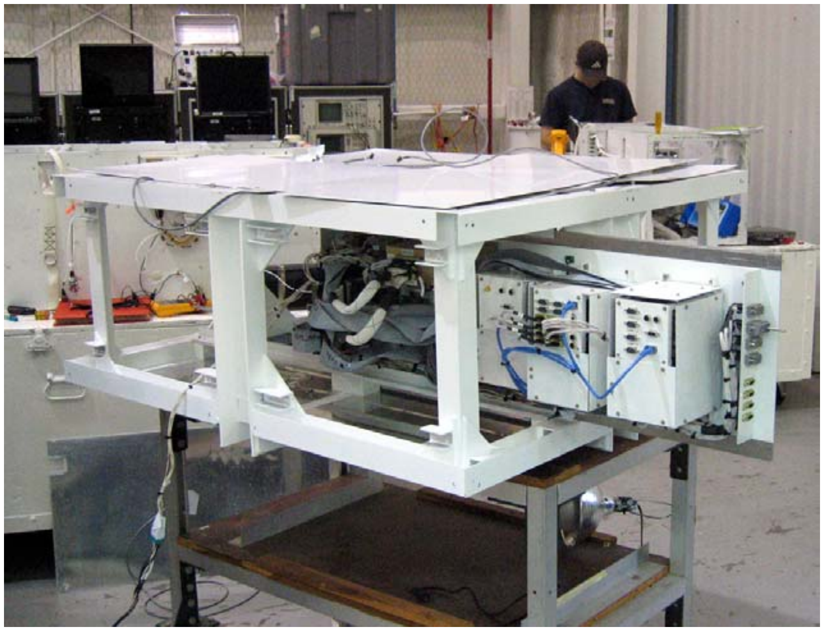
Electronics Mounting Plate (EMP)

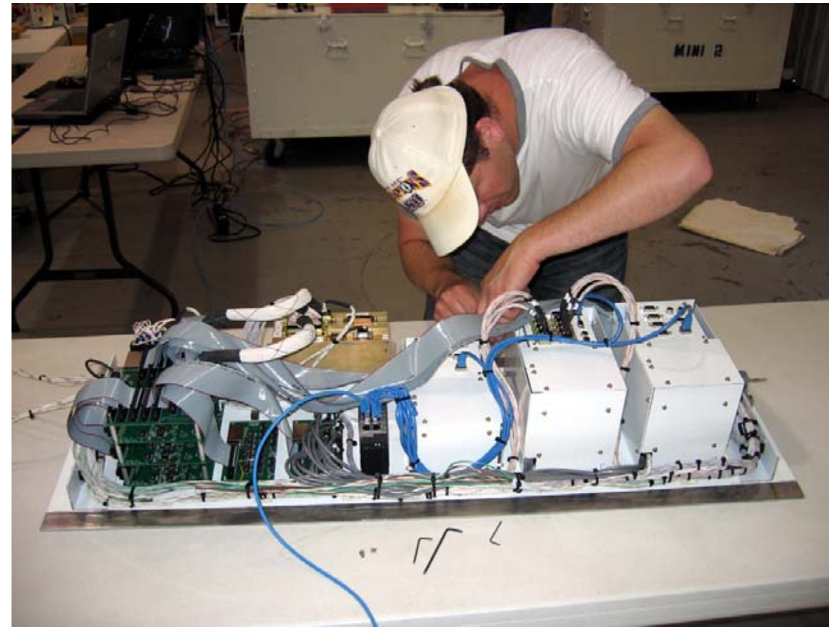




- All HASP control electronics are mounted on a single 110 cm x 42 cm Aluminum plate
- Includes all CPU stacks, power switching relay boards, temperature sensor board, science stack, network switch and internal wiring
- PC104 stacks are mounted as units
  - Enclosed in thermal shield “boxes”
  - Connector panels for easy access
- External connections are on two interface panels on both sides of the plate
  - Connections to the student payloads
  - Power connectors on left panel for quick switching between external supply and internal batteries
  - Greatly simplifies wire handling

Enhanced Setup & Maintenance

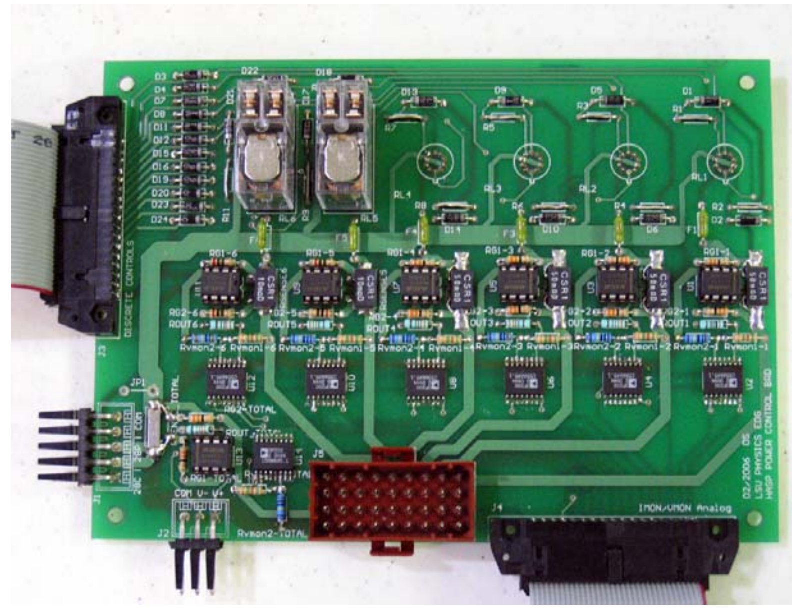




- Entire EMP can be easily removed from the HASP frame
- Enables easy access to all components on a desktop
- Two identical EMPs are available for emergency "plug and play" service if necessary

Power System

- Route 28VDC bus and convert power locally
- Student payloads supplied with 28 V only
  - Must do their own conversion
- New power relay board
  - Switch 2 large & 4 small
  - Integral I and V sensing



- New compact Lambda external power supply for pre-flight operations
- Use eight B7901-11 lithium cell battery packs for flight
  - Power HASP systems for > 30 hours and payloads for ~20 hours even when derated for temperature ~ -20^{o} C

HASP-06 Weight & Power

- Total launch weight was about 910 kg (~2,000 lbs.)
- Average power consumption was a bit over 66 Watts.

Table 1: HASP-06 Mass Budget

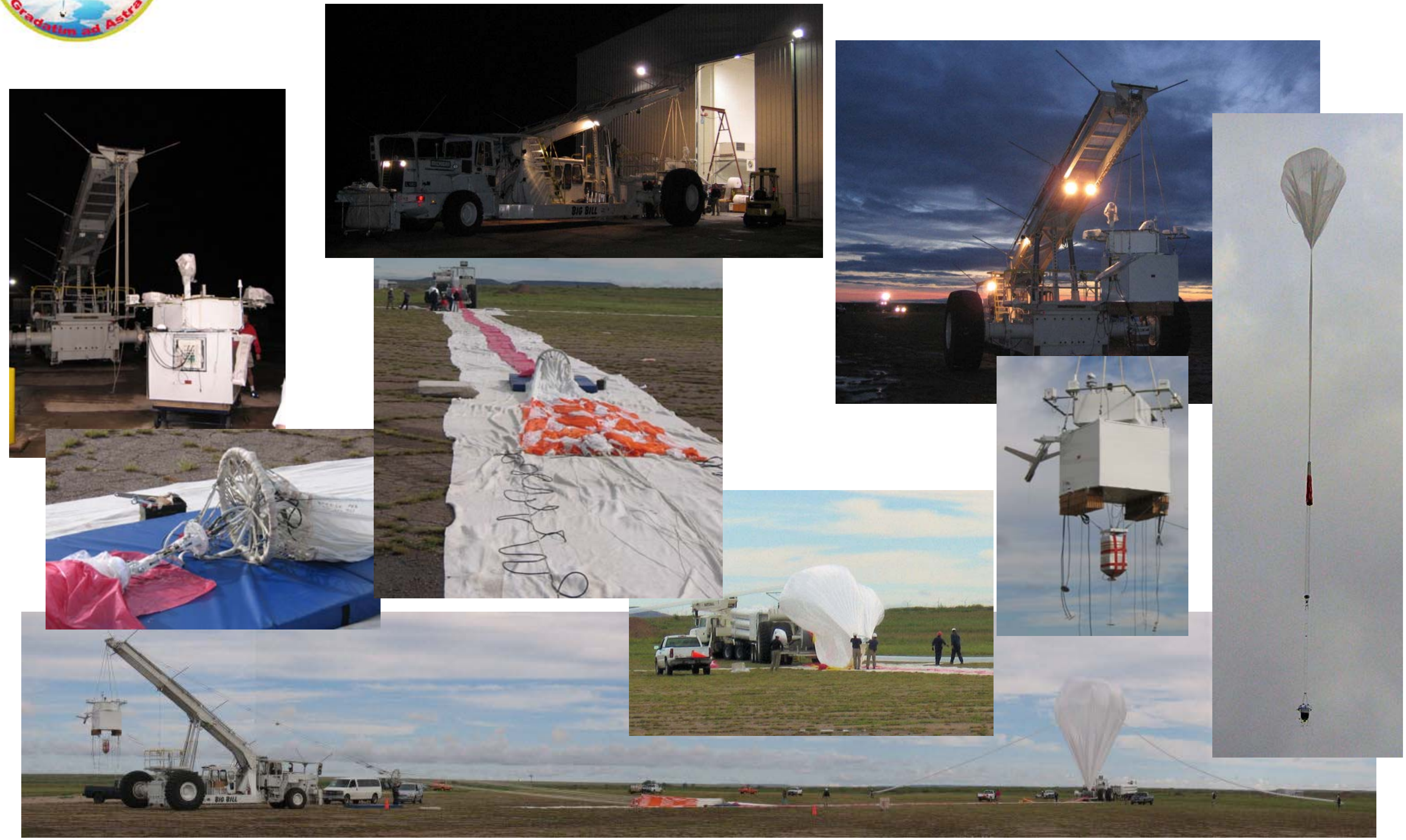
Component	Weight (kg)
HASP System	108.2
CosmoCam	10.0
HASP Batteries	43.6
Student Payloads	28.6
Mini-SIP & Batteries	110.9
Mini-SIP Frame	113.6
CSBF Test Articles	41.4
Parachute, Train, UTP, Pad	207.3
Ballast	245.5
Total	**909.1**

Table 2: HASP-06 Power Budget

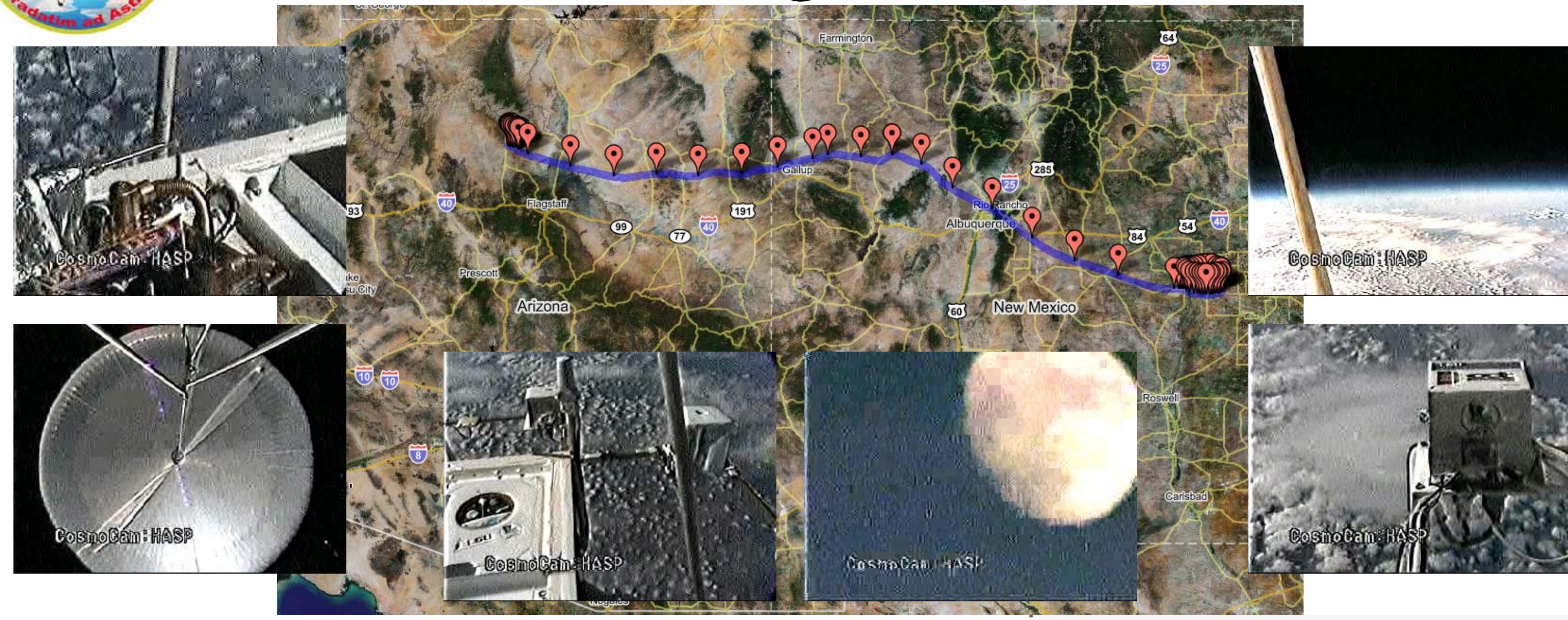
Component	Volts	mA	Watts
FCU	30	340	10.2
DAU	30	250	7.5
SCU	30	380	11.4
Other HASP	30	125	3.8
CosmoCam	30	190	5.7
Student Payloads	30	920	27.6
Total			**66.2**

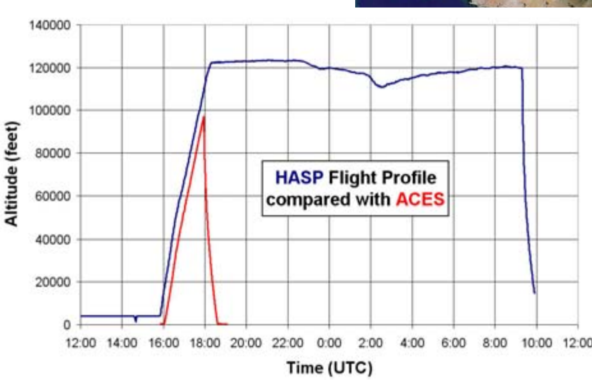
On-site Assembly & Testing

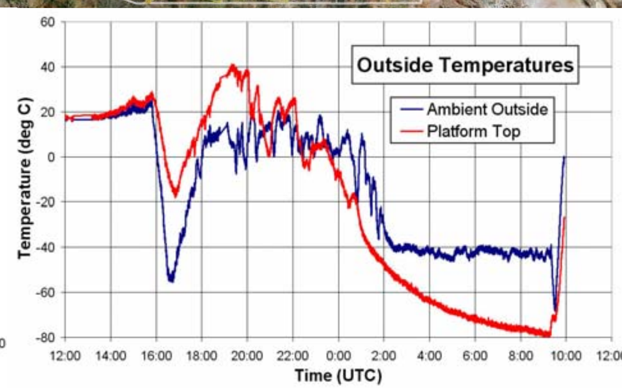
Launch: Sept 4, 2006 at 15:51 UTC

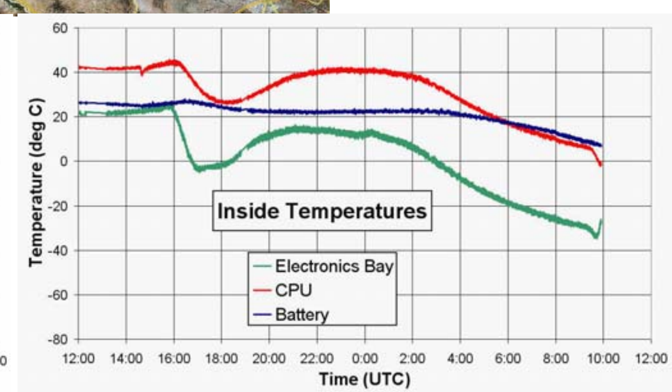


18 hour flight, 15 at float

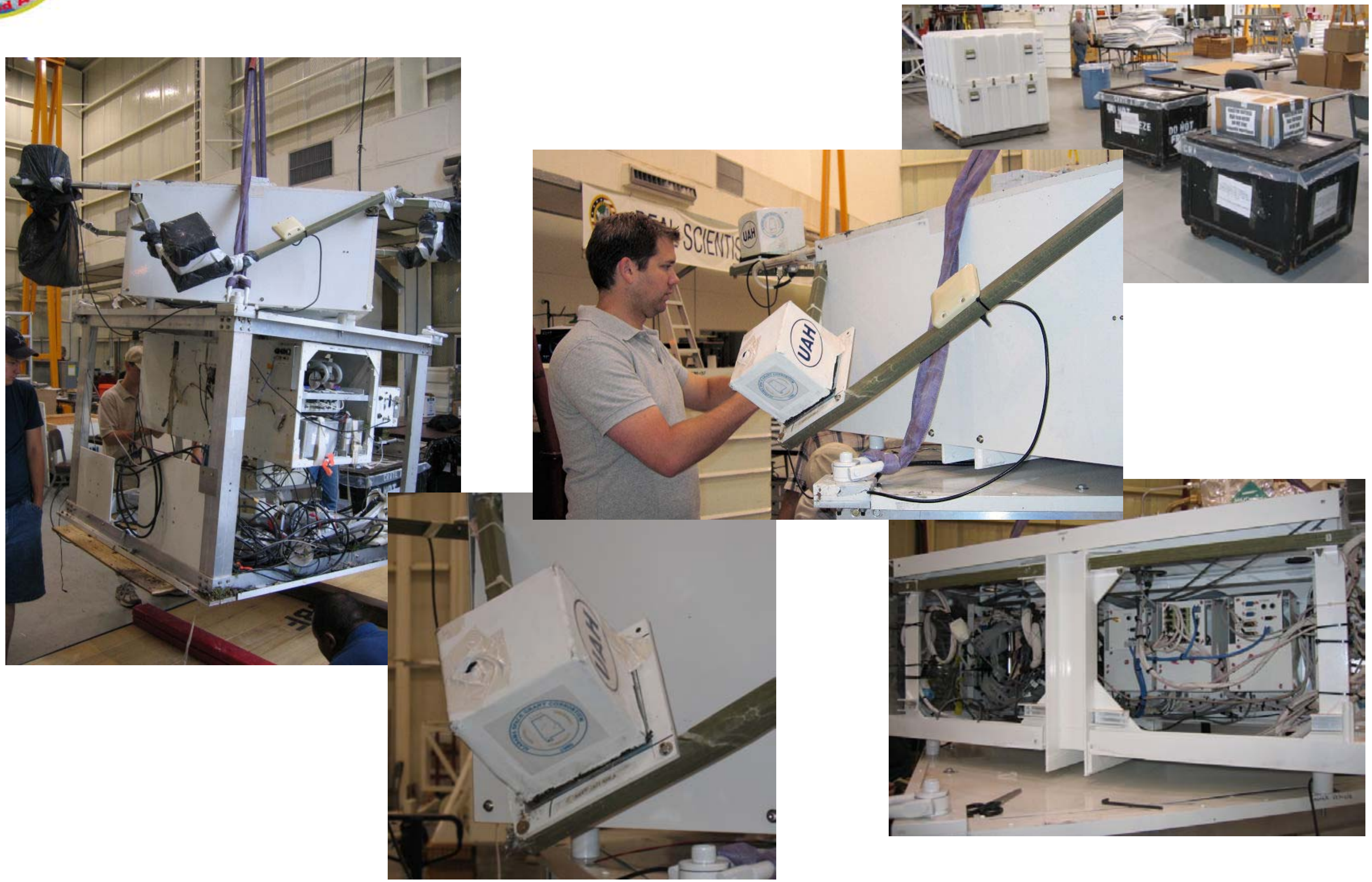






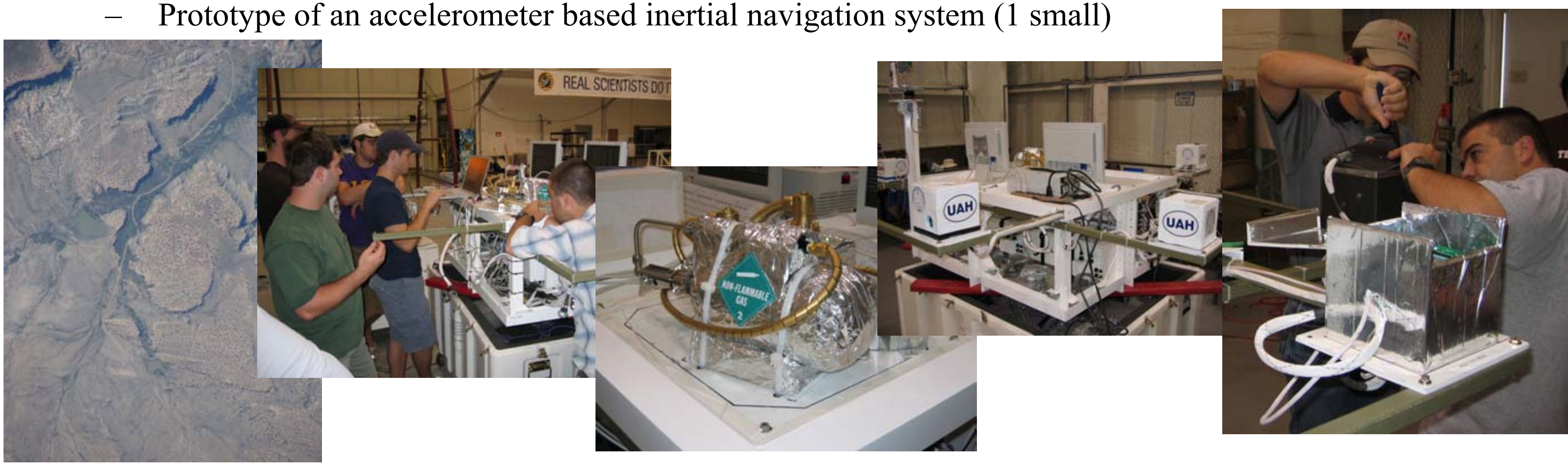


Little damage on recovery



Student Payloads for 2006

- During 2006 HASP flew 8 student payloads from 4 institutions.
- **University of Alabama – Huntsville:**
  - Infrared telescopes to remotely study the thermal characteristics of the balloon envelope (4 small payloads)
- **Texas A & M University:**
  - Video camera system to study remote sensing from high altitude (1 small)
- **University of Louisiana – Lafayette:**
  - Nuclear emulsion stack to investigate high energy cosmic rays (1 large)
- **Louisiana State University (Mechanical Eng.):**
  - Study the flow characteristics of various rocket nozzles as a function of altitude (1 large payload)
- **Louisiana State University (Physics):**
  - Prototype of an accelerometer based inertial navigation system (1 small)



Student Payloads for 2007

- During 2007 we anticipate at least 10 payloads from 8 institutions across the country.
- **Hawk Institute for Space Science (UMES):**
  - Multi-sensor CubeSat prototype test (1 small)
- **Louisiana State University – Baton Rouge:**
  - Study the flow characteristics of various rocket nozzles as a function of altitude (1 large)
- **Montana State University:**
  - Passive high altitude particle capture experiment (1 large)
- **Texas A & M University:**
  - Multi-spectral camera system to study remote sensing from high altitude (1 small)
  - Reflight of 2006 GeoCam remote imager system (1 small)
- **University of Alabama – Huntsville:**
  - Infrared imaging of the balloon thermal characteristics (1 large)
- **University of Alabama - Tuscaloosa:**
  - Student high altitude power system testing (1 small)
- **University of Louisiana – Lafayette:**
  - Nuclear emulsion stack to investigate high energy cosmic rays (1 large)
  - Super capacitor driven CubeSat power system (1 small)
- **West Virginia University:**
  - High altitude cosmic ray detector (1 small)

Summary

- HASP designed to be flexible, maximize reliability and minimize support
  - Use COTS PC/104 electronics where ever possible
  - Both hardware and software is highly modular
  - All platform system are mounted on a single Electronics Mounting Plate (EMP)
  - The EMP can be removed for desktop maintenance or “plug & play” replacement
  - Standard power, telemetry and command interface support a broad range of experiments
- The 2006 first flight of HASP was very successful
  - System was assembled, tested and flight ready about one week
  - ~18 hours from launch to landing, ~15 hours at altitudes > 110,000 feet
  - No glitches in telemetry and commanding throughout the flight
  - Thermal performance exceeded expectations (e.g. battery temp remained above 10^{o} C for most of the flight)
  - Only very minor damage upon landing
- Yearly flights will support timely student payload development
  - NASA BPO will support HASP flights in 2007 and 2008
  - Anticipate continuing support if sufficient demand is shown
- HASP website at http://laspace.lsu.edu/HASP/