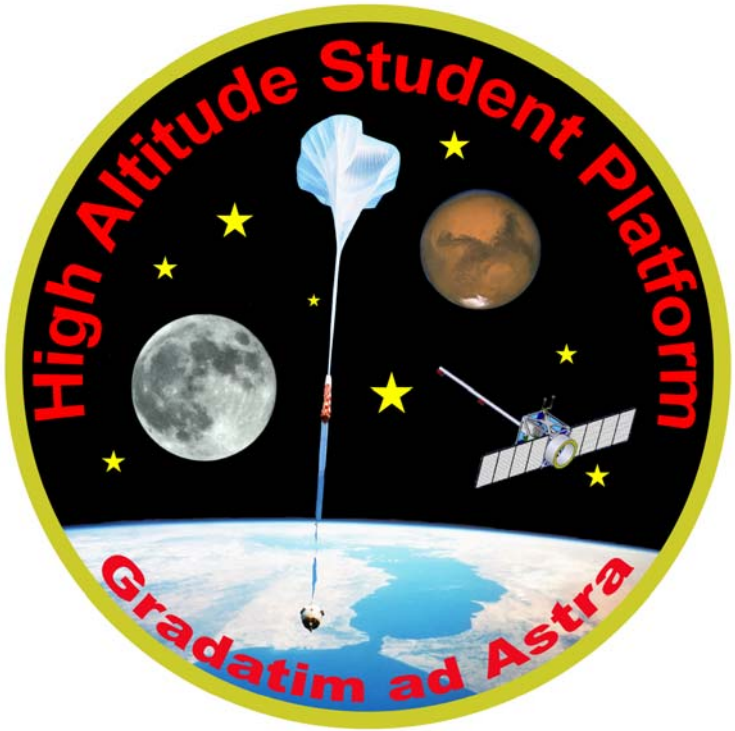
Student Ballooning and the High Altitude Student Platform



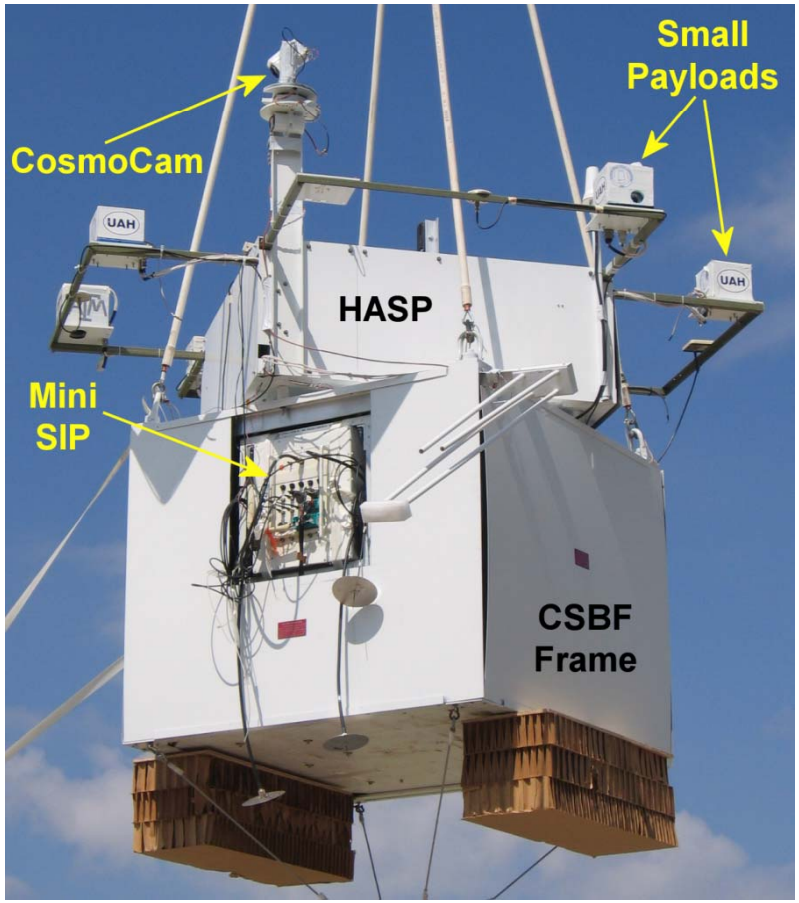
T.G. Guzik and J. P. Wefel
Louisiana Space Consortium,
Louisiana State University, Baton Rouge, LA U.S.A.

HASP focuses on university students

- Operates as a partnership between the **NASA Balloon Program Office** (BPO) and **Louisiana Space Consortium** (LaSPACE)
  - BPO provides balloon, launch and flight services
  - LaSPACE maintains HASP & supports the student payloads
- Provide students with an annual near-space flight opportunity
- Support payloads that perform technology testing or scientific measurement
- Opportunity to test fly prototype student satellite components
- Provide students with real-world science / engineering project development experiences
- Keep students excited about a science, technology or engineering career

Major HASP Features

- Support 12 student built payloads
  - Eight small payloads < 3 kg
  - Four large payloads < 20 kg
- Fly to an altitude > 36 km for a duration of ~20 hours
- Standard interface for each payload
  - Mechanical plate interface
  - Serial downlink telemetry < 4800 bps
  - Serial uplink commands
  - Discrete commanding
  - 32 VDC power @ < 2.5 Amps
  - Analog (0 to 5 VDC) downlink
  - Downlink available in near real time



- Include CosmoCam for real time video during launch & flight

Typical Payload Development Schedule

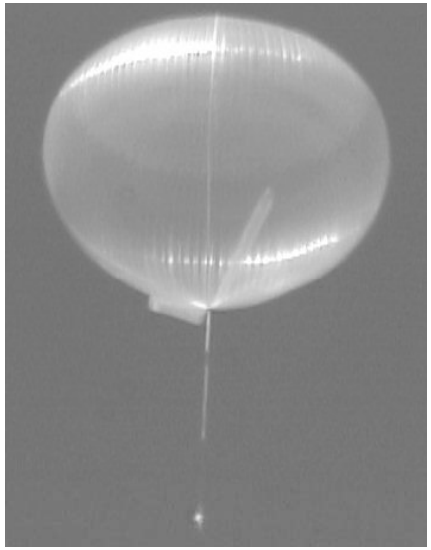
- Application process takes place in the fall
  - Release of CFP (Call for Payloads): October 1
  - Applications due: December 18
  - Selection announcement: mid-January
- Payload development takes place in the spring
  - Require monthly status reports and telecon meetings
  - Preliminary thermal / vacuum test the 3rd week of May

- Integration occurs during 1st week of August
  - Use the Columbia Scientific Balloon Facility (CSBF) in Palestine, Texas
  - Must pass a thermal / vacuum test to be flight certified
- Flight Ops take place around Labor Day
  - Use the CSBF balloon launch facility in Ft. Sumner, New Mexico

Typical HASP Flight

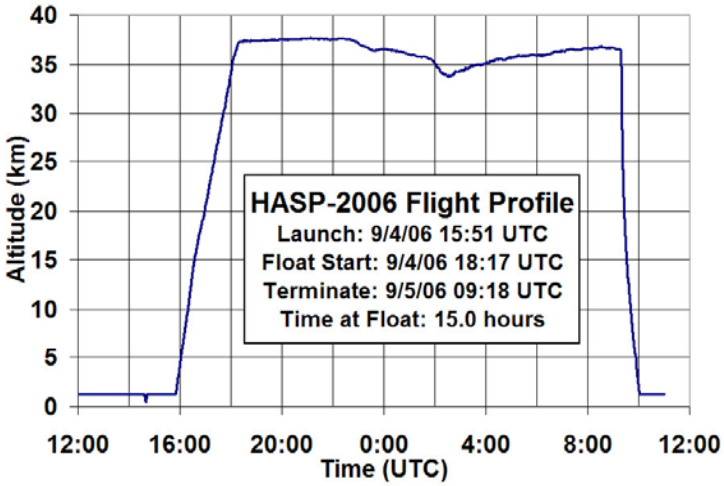
- HASP is a medium weight payload
  - Total suspended weight is 2,000 pounds
  - Use a 11 million ft^3 zero pressure balloon
- Usually launch just after dawn
  - Require ground, low level and high altitude winds to cooperate

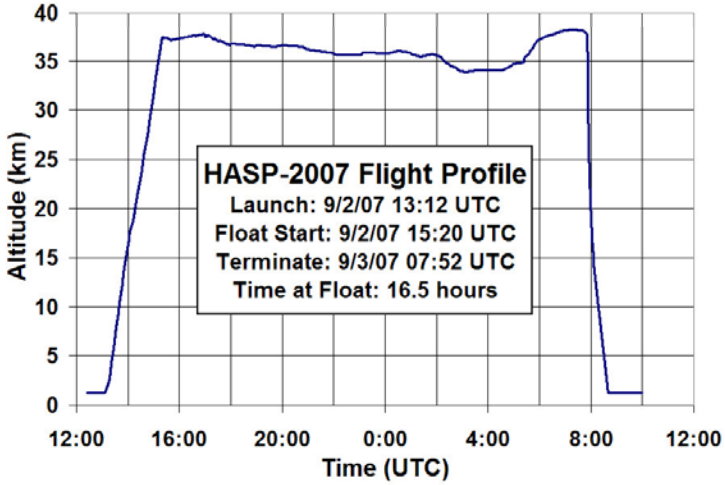
HASP launch at 8 times normal speed



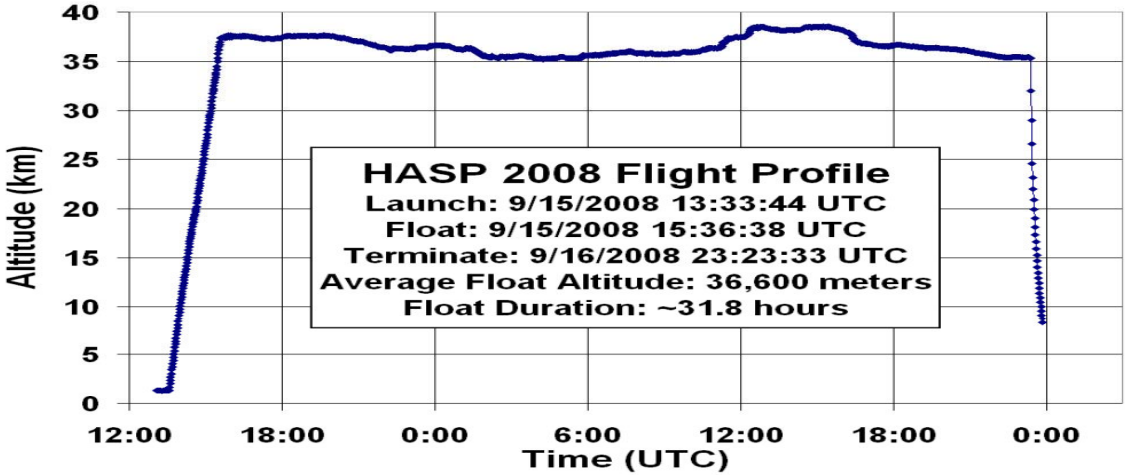
- Flight lasts about 17 hours
  - Takes about 2 hours to get to ~36 km (~120,000 feet)
  - Take about 45 minutes to come down on parachute
  - Get a day and some night in “space”
- HASP has now flown four times
  - Total time at float is more than 75 hours
  - Expect to continue flights each year

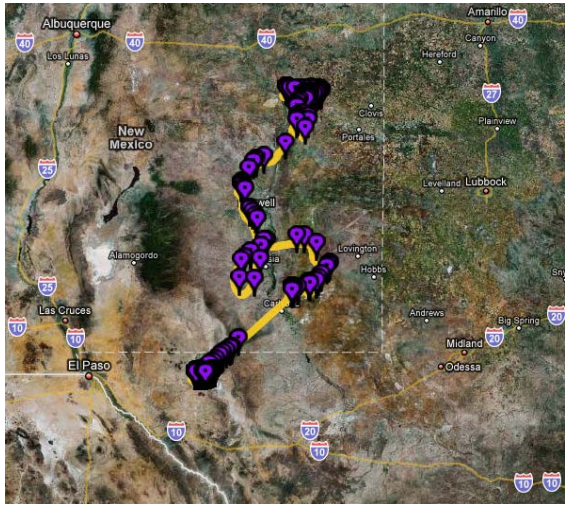
HASP 2006 & 2007 Flights

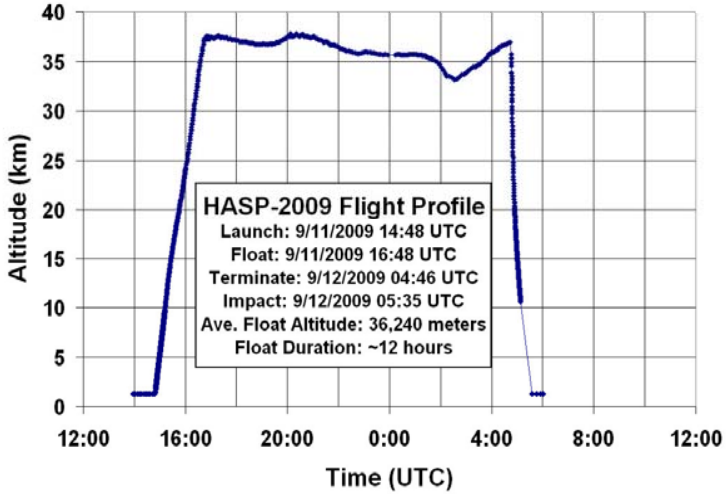




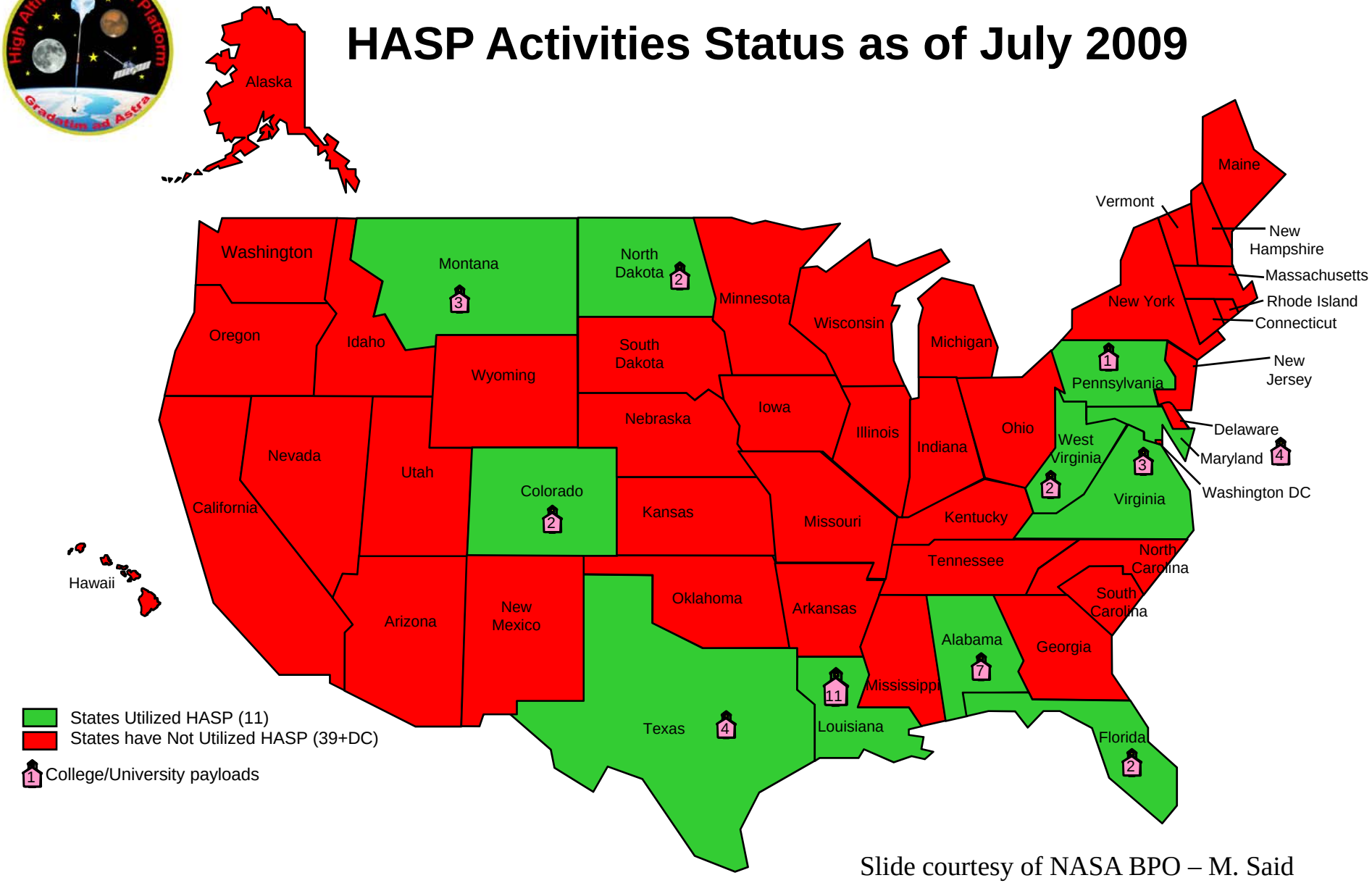
HASP 2008 & 2009 Flights







HASP Activities Status as of July 2009



Slide courtesy of NASA BPO – M. Said

HASP has involved many students from across the country

- 44 student payloads have been accepted for flight since 2006
  - 8 flown on HASP 2006
  - 11 selected (10 flown) for HASP 2007
  - 13 selected (10 flown) for HASP 2008
  - 12 selected (6 flown) for HASP 2009
- Greater than 70% success during 2006, 2007 & 2008
- A total of 191 students have been involved with HASP
  - 25 in 2006, 70 in 2007, 96 in 2008
- Participants from 17 institutions across 11 states
- Payloads cover a broad range of subjects

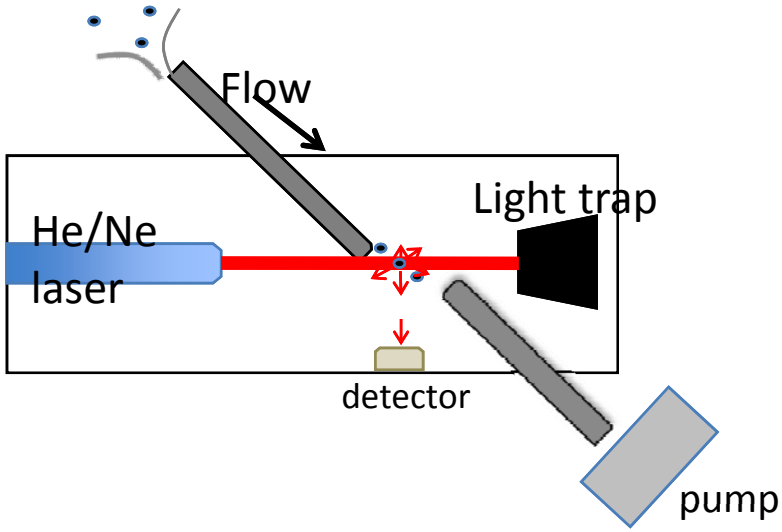
Examples of flown payloads

- **Louisiana State University – Baton Rouge (2006, 2007):** Study the flow characteristics of various rocket nozzles as a function of altitude
- **Montana State University (2007, 2008, 2009):** Passive high altitude particle capture experiment
- **West Virginia University (2007):** High altitude cosmic ray detector
- **Virginia Polytechnic Institute & State University (2007, 2008):** Prototype for a Lunar magnetic field instrument, **(2009):** Flying InfraRed Experiment for Lunar Investigation (FIREFLI)
- **University of Alabama – Huntsville (2006, 2007, 2008):** Infrared imaging of the balloon thermal characteristics
- **University of Colorado (2008, 2009):** Assessment of astronomical observations from balloons
- **University of Maryland (2008, 2009):** Flight test of compact radio telemetry system
- **University of North Dakota / University of North Florida (2008, 2009):** Development and test of a micro scale ozone detector – Resulted in publication and Masters Thesis

Montana Particle Capture Experiment

- Experiment to capture cosmic particles and analyze their morphology and composition in the laboratory
  - Trap particles on optically clear plates coated with silicone oil
  - Flew in 2007 (success), 2008 (not so good) and 2009 (looks good so far)
- Light scattering particle detector to examine vertical distribution of >1μm size dust particles
  - Test homogeneity of stratosphere during particle capture
  - New for 2009

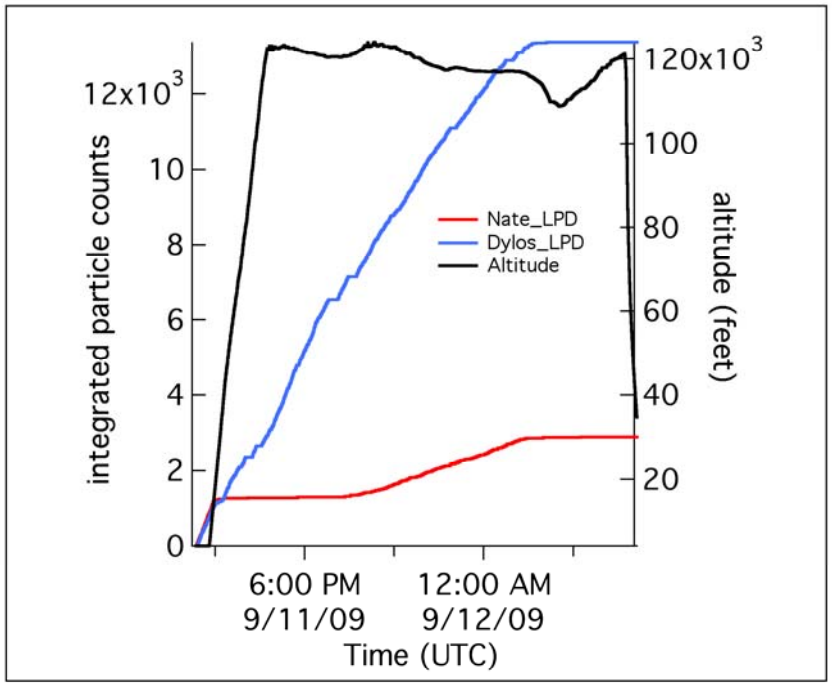
Opening of MSU experiment (8 times normal speed)



Images courtesy MSU team

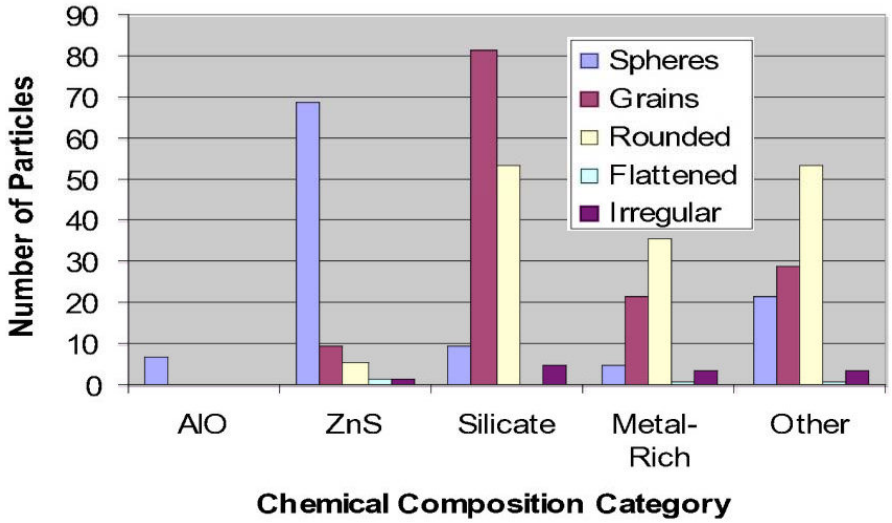
Particle Capture Preliminary Results

Laser Particle Counters



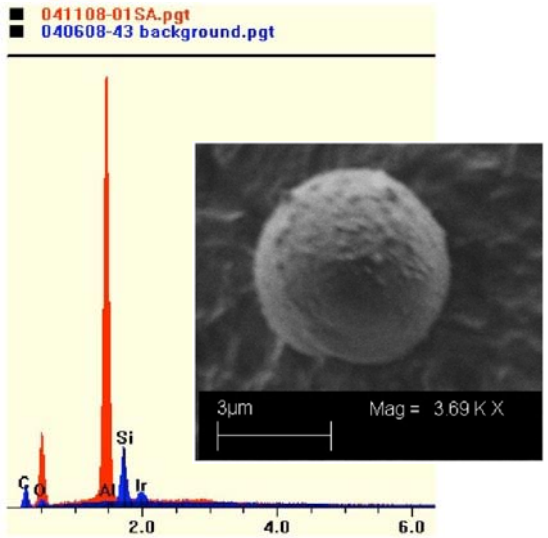
- Both particle counters gave similar readings – ground – 36,000 feet.
- Uncertain as to why the measurements diverged after that.

Cosmic Dust Capture Box



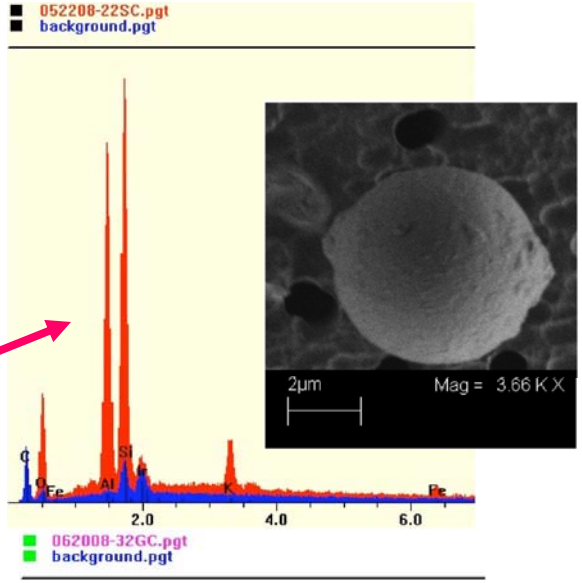
- Analysis of 2007 data has examined 400 particles so far
- HASP 2009 capture plates exposed for 12-hours and the optical analysis of the plates has started

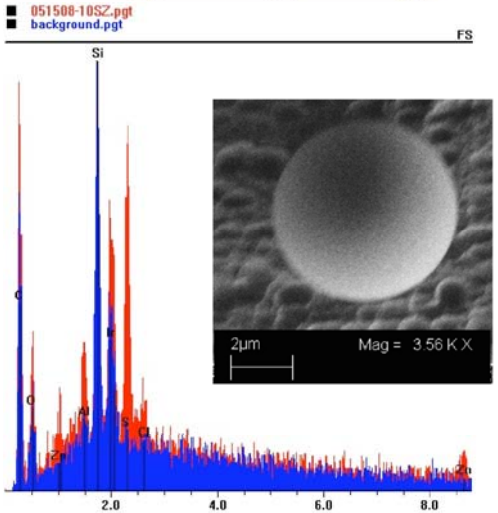
Found Different Types of Particles



Rocket Exhaust

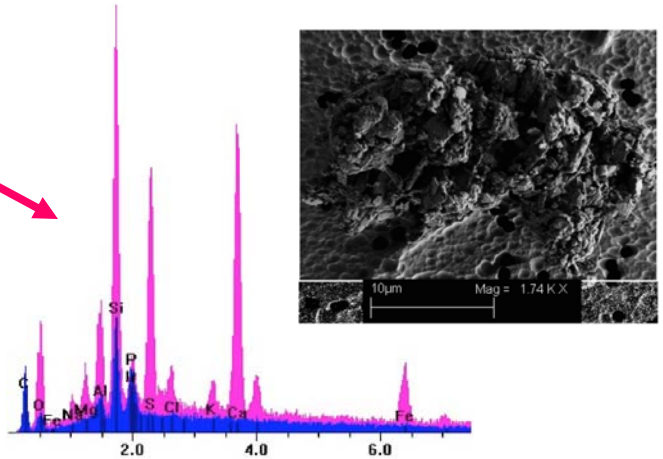
Volcanic Dust ?





Cosmic Dust ?

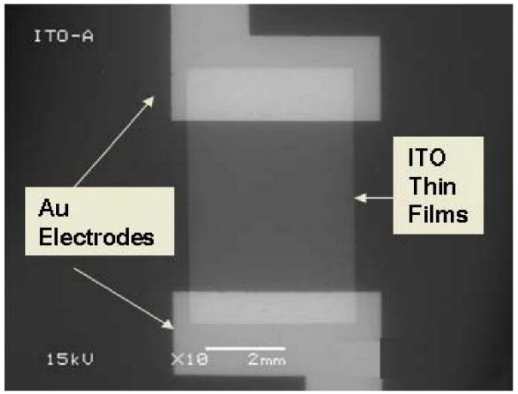
Lab Contaminant



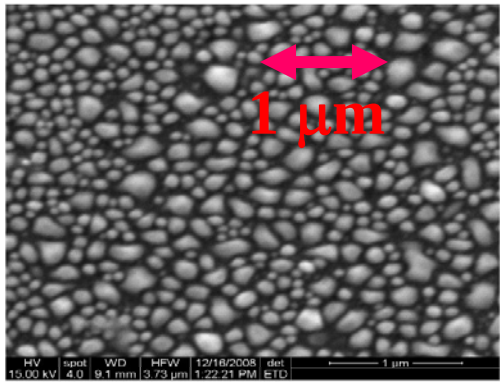
North Dakota / North Florida Prototype ITO Ozone sensors

- Collaboration between two universities in two states
  - University of North Florida (sensor development)
  - University of North Dakota (payload development)
- Flight test of prototype solid state gas-sensitive resistor sensor
  - CMOS indium tin oxide (ITO) sensor
  - Material doped in order to be sensitive to different gases
- Payload has successfully flown twice
  - Array of 24 Ozone sensors of three different types in 2008
  - Array of Ozone and NO_X sensors in 2009

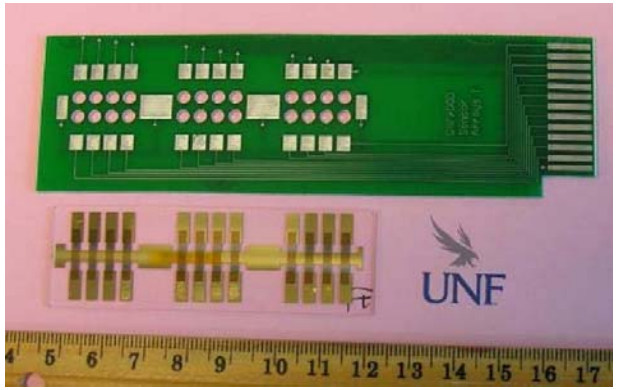
Single ITO Sensor



ITO Sensor Surface



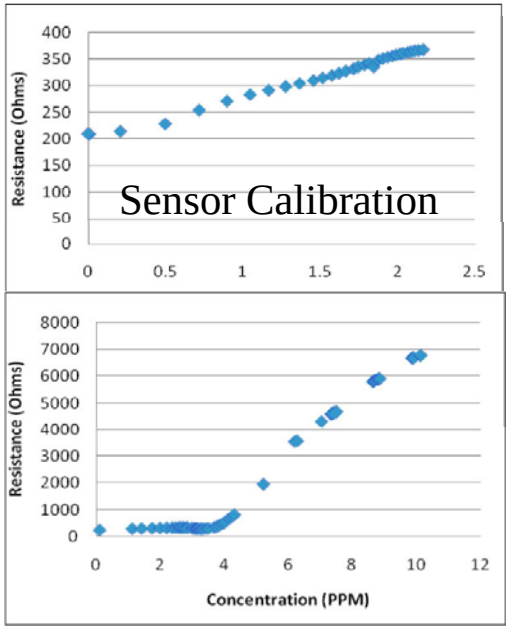
24 Sensor Flight Array

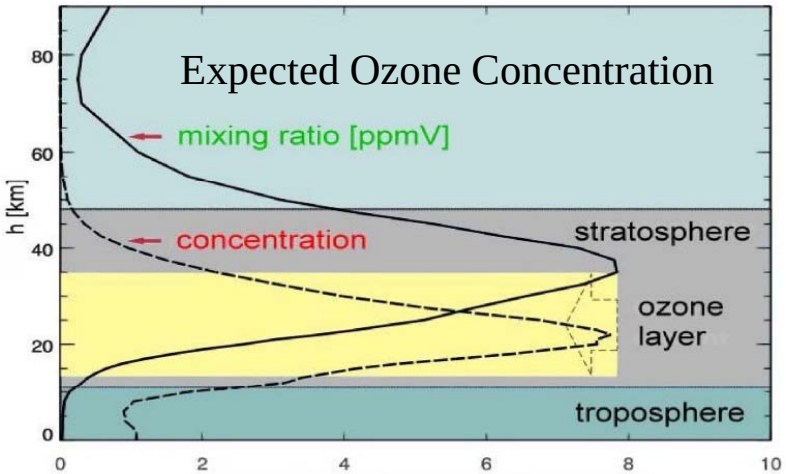


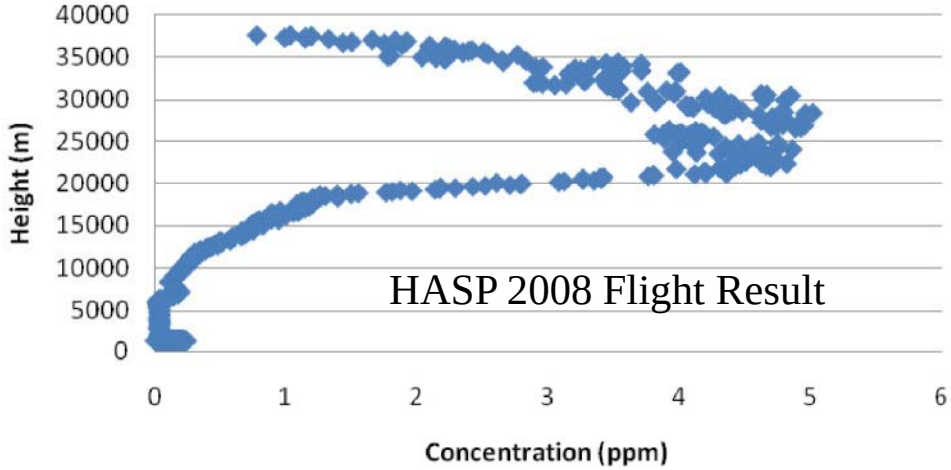
Images courtesy UND/UNF teams

ITO Sensors Flight Results

- The electrical resistance of ITO increases in the presence of oxidizing gases
  - Vacancy site is filled by a charge accepting molecule
  - Electrons are depleted from conduction band, leading to an increase in resistance
- Sensors were calibrated with known O_3 concentrations
- HASP 2008 flight results yield a measured ozone profile very similar to what was expected.
- Project has already resulted in one publication and one Master's Degree thesis.

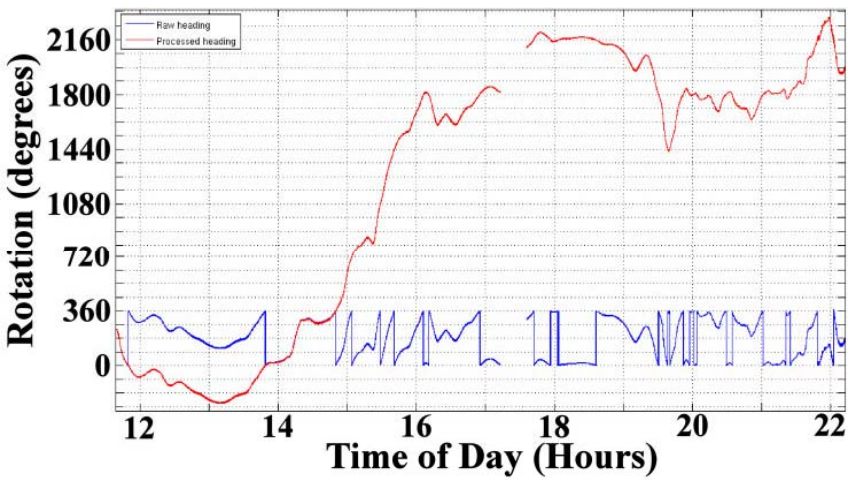


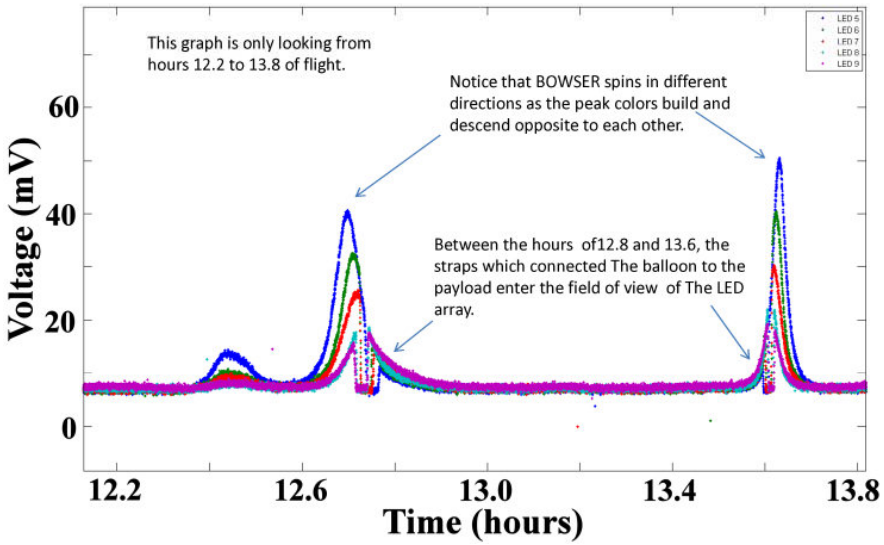




Balloon Observatory for Wavelength and Spectral Emission Readings (BOWSER)

- University of Colorado (Boulder) team experiment is design to test the feasibility of balloon-borne observatories
  - Use an array of LED sensors to measure sky brightness in the visible, ultraviolet and infrared
  - Use wide and narrow field cameras to image star fields and celestial objects
  - Include a magnetometer compass, accelerometers and gyroscopes to determine the platform attitude and stability during the flight
- Flown in 2008 (DIEHARD) and 2009 (BOWSER)

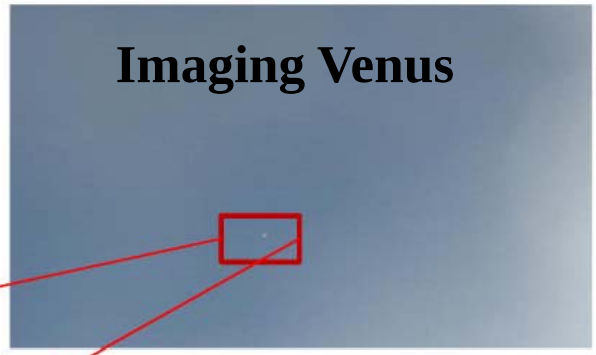




Images courtesy UC team

BOWSER Imaging of Venus

Images courtesy
UC team

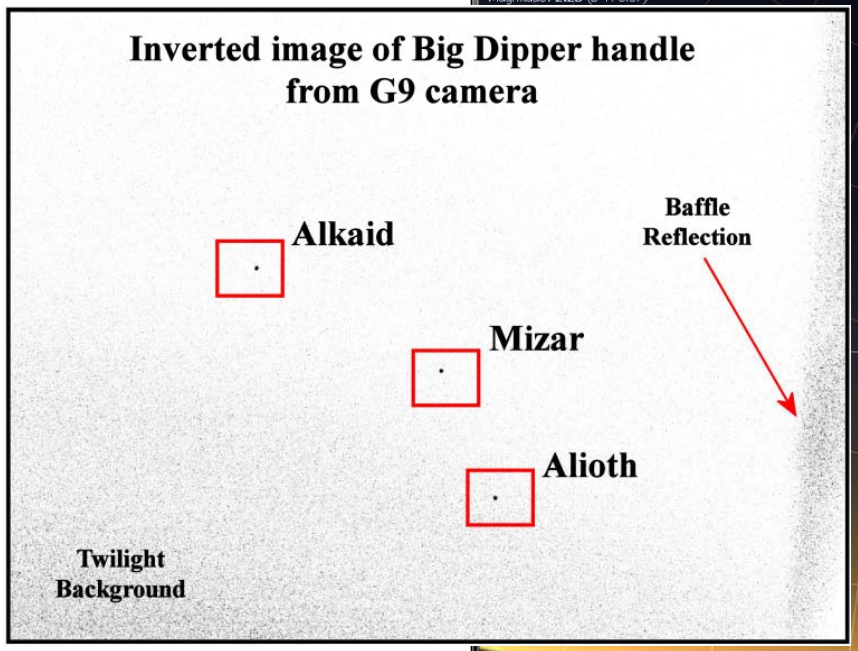


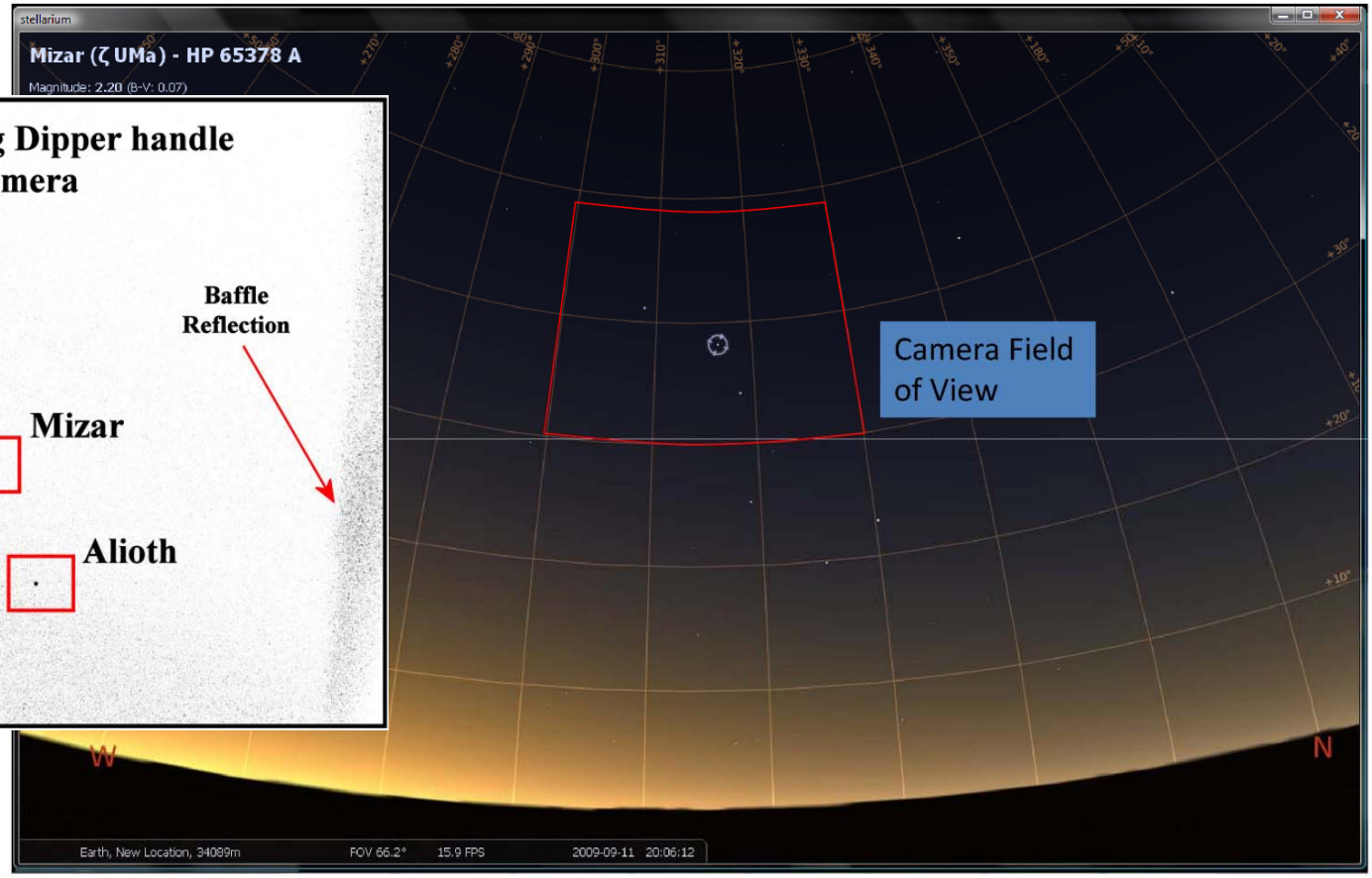
Exposure time:
1/13 second

Zoomed in from top picture

Computer generated image of Venus at 3 pm on launch day by Stellarium.

BOWSER Imaging of Big Dipper Stars





Exposure time:
1 second

Time: 20:06

Latitude: 33.9114 degrees N
Longitude: 111.5310 degrees W
Altitude: 34089 m

Compass reading: 311 degrees (NW)
Sun's azimuth: 279 degrees

Call for Payloads 2010

CFP document and application materials is available on the "Participant Info" tab of the HASP website

http://laspace.lsu.edu/hasp/Participantinfo.html

Q&A Teleconference **November 13, 2009** at 10 am (central time)

Dial 1-866-717-2684, ID 6879021

Completed applications are due on **December 18, 2009**

Submission Instructions

- E-mail PDF version of application by 11:59 pm (central time) to guzik@phunds.phys.lsu.edu
- Mail hardcopy of application to

T. Gregory Guzik
202 Nicholson Hall / Tower Drive
Department of Physics & Astronomy
Louisiana State University
Baton Rouge, LA 70803-4001

- Applications will be reviewed by HASP Management at LSU and the NASA Balloon Program Office
  - Applications will be reviewed for completeness, consistency, scientific or technical justification, and ability to fit within the HASP constraints
  - Priority will be given to payloads that are clearly designed, built, managed and operated by students
- Decisions will be announced by January 15, 2010