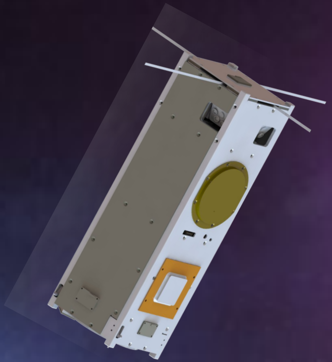


Phoenix

A 3U CubeSat to Study Urban Heat Islands

Sarah Rogers - Project Manager
NASA Space Grant Symposium
April 14, 2018

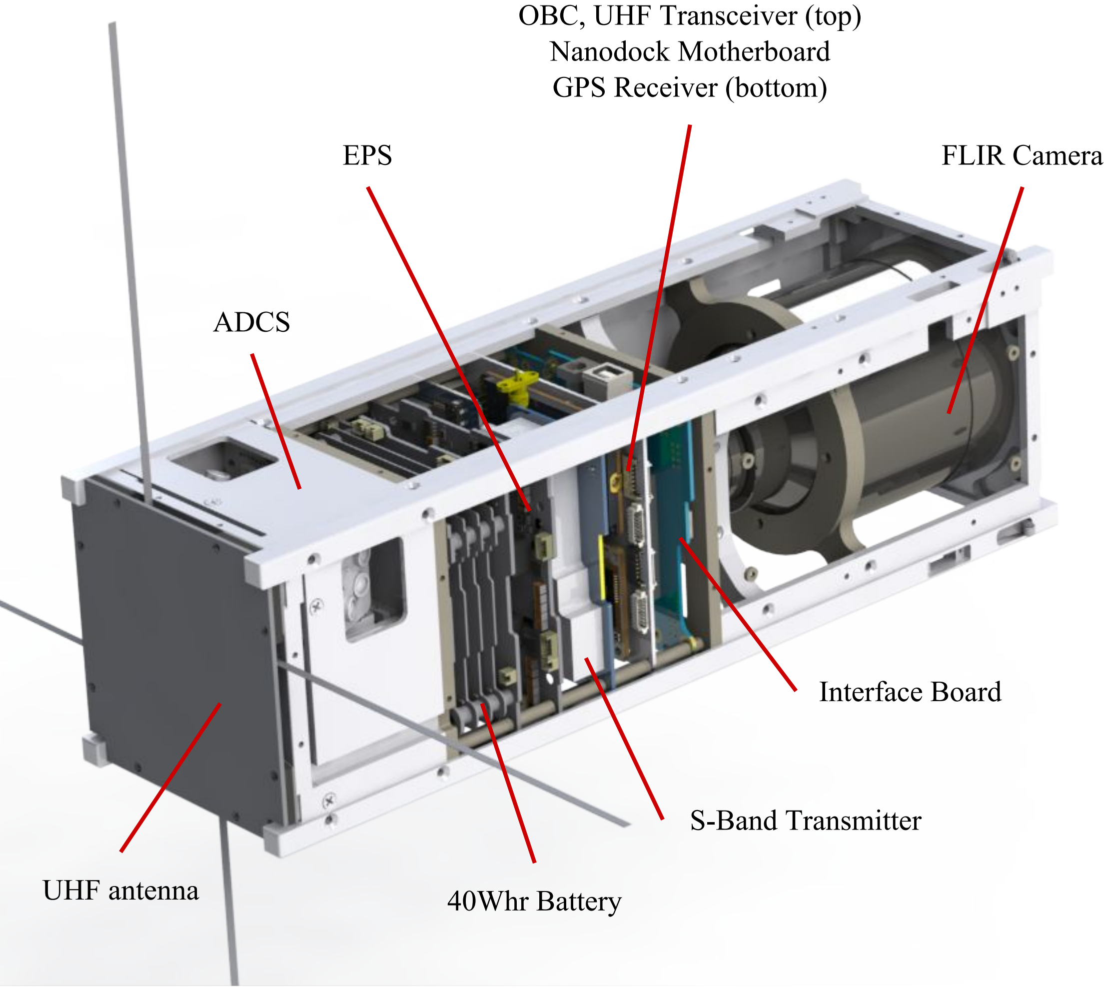
Phoenix Overview

- Undergraduate-led 3U CubeSat to study Urban Heat Islands through infrared imaging
  - Student Flight Research Opportunity funded through the NASA USIP program and NASA Space Grant
    - Program start: April 2016
  - First fully undergraduate student-led effort to build a CubeSat at ASU

- Mission Objectives
  - Phoenix is an educational mission, where our primary goal is to develop a functioning CubeSat, capable of imaging the Earth in the IR
  - Phoenix will study how city composition, using Local Climate Zones, affects the surface urban heat island signature in various U.S. cities

- Projected launch date: Nov. 8 2018
  - **Target Delivery Date:** September 3, 2018
  - **Launch integrator:** Nanoracks
  - **Launch facility:** Wallops, VA
  - Launched from the ISS - orbit: 400 km altitude, 51.6° inclination
  - **Operational timeline:** 2 years

- Currently in CDR phase
  - Focus is centered on software development & component level testing



Satellite Overview

Payload, Tau 2 640 IR Camera:

- *Pixel Resolution:* 640 x 512 (Pixel size: 17µm)
- *Image Resolution:* 68 m/pixel (best), 110 m/pixel (worst)
- *Field of View:* 6.2° x 5° (43.5 x 35 km ground footprint)
- *Thermal Resolution:* < 50mK
- *Spectral Band:* 7.5µm-13.5µm (non filtered)

Attitude Control:

- *Attitude Control:* (3) Reaction Wheels, (3) Magnetorquers
- *Position Monitoring:* Sun Sensors, IR Earth Limb Sensors
- *Pointing Accuracy:* 0.5° (during imaging)

Communications:

- *Science Downlink:* S Amateur Bands (2402.5 MHz)
- *Command Uplink:* UHF Amateur Bands (437.35 MHz)
- *Clock & Position Monitoring:* OEM615 GPS Receiver

Power

- 40 Whr Battery
- EPS for power distribution

Cabling & Data Interfaces

- Interface board used for cable routing and data storage

Concept of Operations

Event A: Idle Mode

- Housekeeping data collection, health beacons, UHF command uplink
- **Duration:** Default mode
- **Orientation:** on-Nadir pointing, sun favoring

Event B: Science Mode

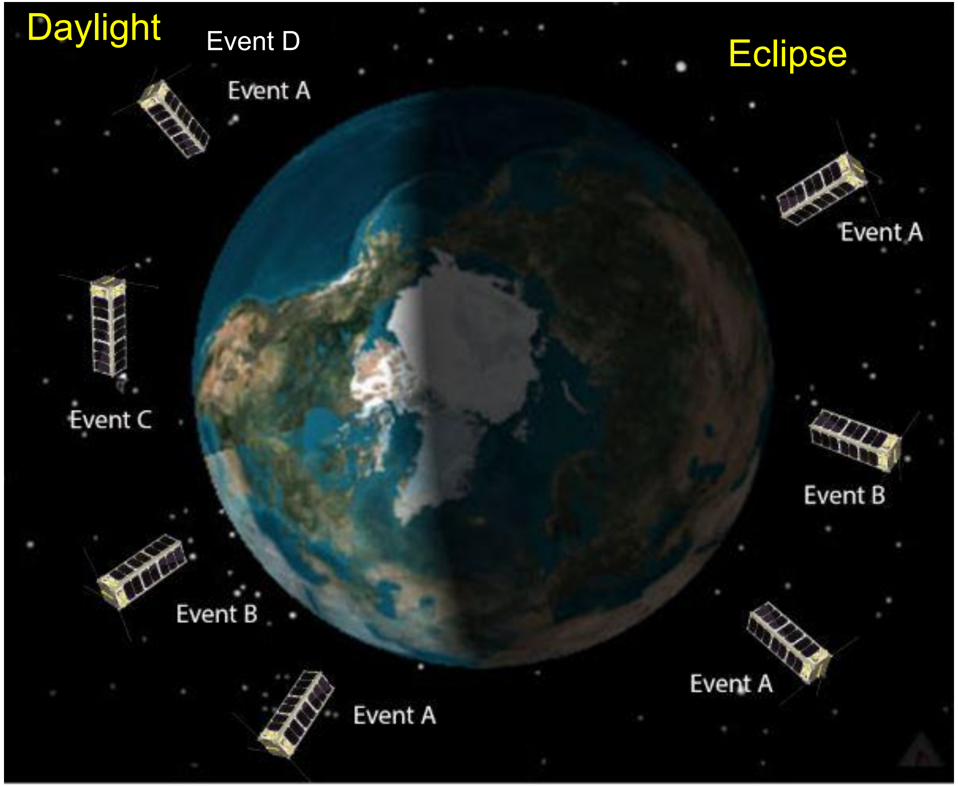
- Images are taken of target US cities
- **Duration**: 15 min (max)
- Nadir pointing, sun favoring

Event C: S-Band Transmission Mode

- Occurs 3x/week, only during the day (need sun sensors)
- **Duration:** 5 min (typ)
- Satellite is parallel to the earth, sun favoring with tracking to the ASU ground station

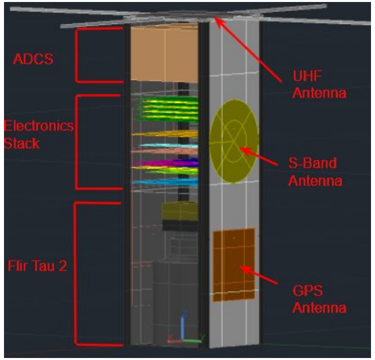
Event D: Safe Mode

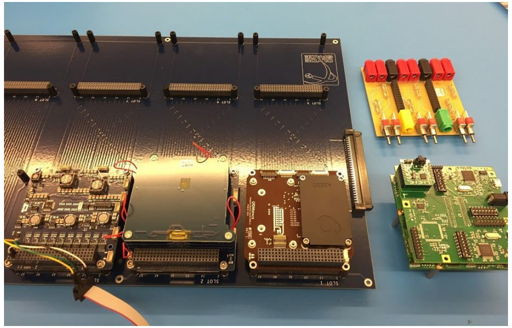
- Lowest amount of power is consumed - only components required for survival are on until otherwise commanded by mission operators
- **Orientation:** Nadir



How we Break Down

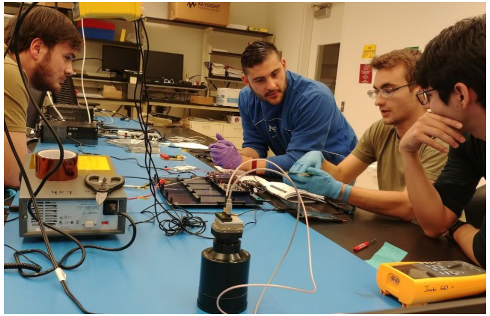
- ADCS
  - Gain tuning & verification
  - Pointing accuracy & stability analyses
- Comms
  - Integrates ground station/satellite hardware - verifies link budget
- EPS
  - Power budget & EPS management
  - Interface board
- Mission Ops
  - Schedule planning (NAIF & JMars)
  - Telemetry management (COSMOS)
- Payload
  - Determines how the payload operates and how it affects the science objective
- Software
  - software/hardware integration
  -
- Structures
  - Develops satellite chassis & mounting brackets
- Systems/Management
  - Schedule, project management, environmental testing
  - Fills in the gaps
- Thermal
  - Thermal modeling in thermal desktop
  - Model verification

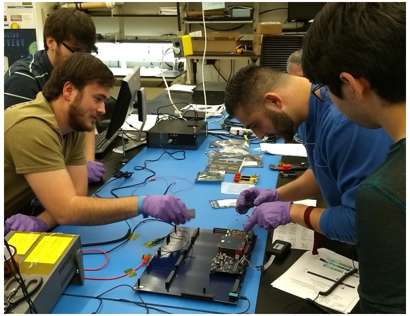




How Do You Get to Launch Readiness?

- **Define:** *What are your minimum functionality requirements, and how do you complete those?*
  - For Phoenix: We will have a CubeSat which can point, take a picture of the earth, and downlink it
- Organize minimum, ideal, and "nice to haves"
  - Then, build up from the base requirements
- Flow your tests from your requirements
- Prioritize, prioritize, prioritize





Lessons Learned from Development

- Setting a Schedule
  - Outline your larger milestones first & work backward, flow these from your requirements
  - Define weekly deliverables which add to the milestone
- Working Toward a Goal
  - Task tracking & progress must be transparent to everyone
  - Define hard, clear deliverables
- Integrating Everything Together
  - Start prototyping as early as possible, stay on top of your resources
  - Consider: is it more efficient to **learn by doing?**
  - Focus on piecewise software/hardware integration
- Know and organize your resources

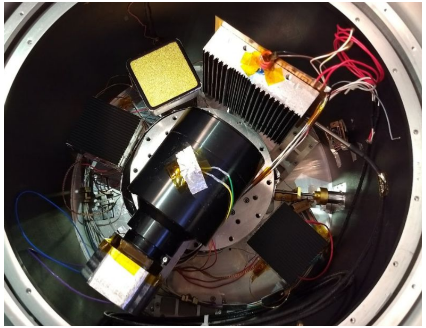
Acknowledgements

Industry Partners

- NASA Wallops/Goddard (USIP)
- Jack Lightholder (JPL)
- Belinda Shreckengost (JPL)
- Travis Imken (JPL)
- Conor Brown, Henry Martin, Tristan Prejean, Nathan Daniels (Nanoracks Integration Team)
- Brackett Aircraft Company
- EagleSat II Team (ERAU)

ASU Affiliate

- ASU NASA Space Grant - special thanks to Dr. Tom Sharp & Desiree Crawl!
- Dr. Judd Bowman
- Dr. Daniel Jacobs
- Dr. Paul Scowen
- Ernest Cisneros
- Dr. Mark Miner
- Andrew Ryan



Those above have helped the team with what has been an amazing journey, and we could not be more grateful