IPEX
Intelligent Payload EXperiment

Eric Baumgarten

IPEX Mission Summary

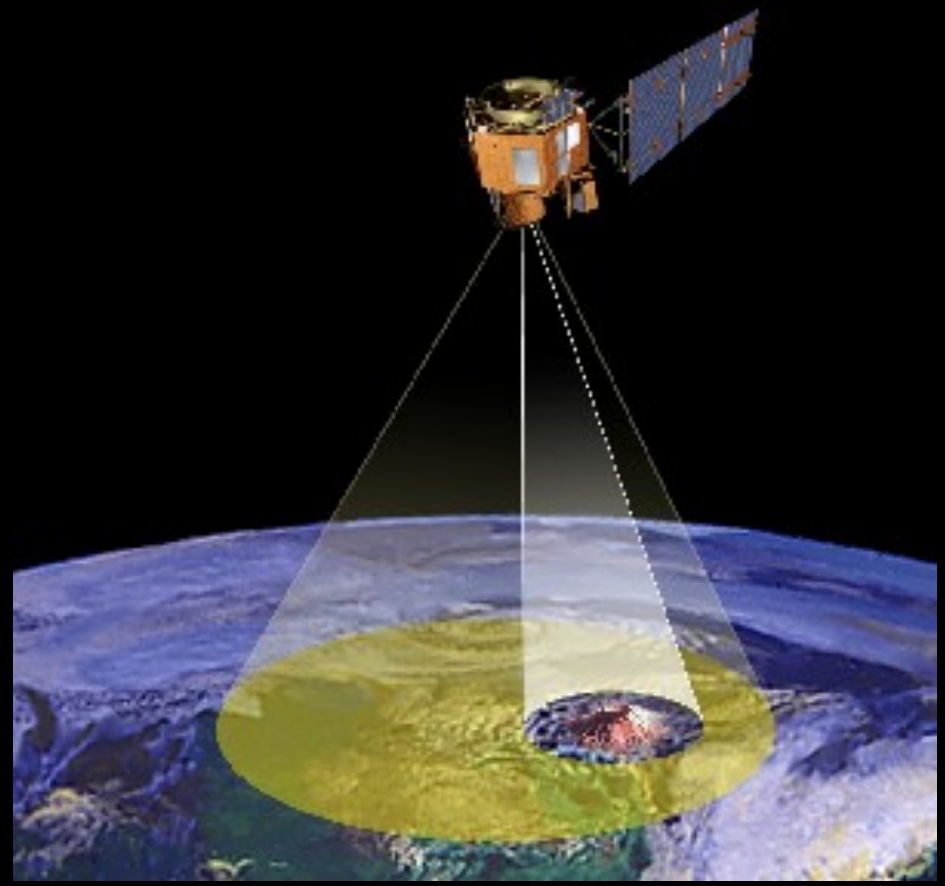
- 1U Cubesat in collaboration with JPL
- Cal Poly's PolySat constructed spacecraft bus
- 8th flight mission for PolySat
- JPL provide the payload software
- Launched December 6th 2013 as part of ELaNa 5 with GEMsat

Cal Poly's Mission Goals

- Educate Cal Poly Students on the design, manufacture, testing and operation of spacecraft
- Validate new generation bus hardware for future flight missions
- Validate new ground station operation for future missions

JPL's Mission Goals

- Validate CASPER (Continuous Activity Scheduling Planning Execution and Replanning)
  - Demonstrate autonomous operations of spacecraft engineering activities
  - Demonstrate autonomous onboard instrument product generation using HyspIRI-like image processing algorithms

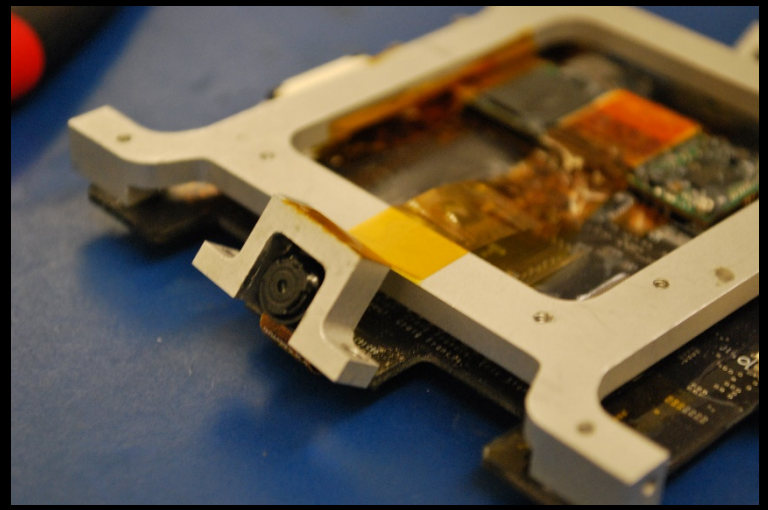


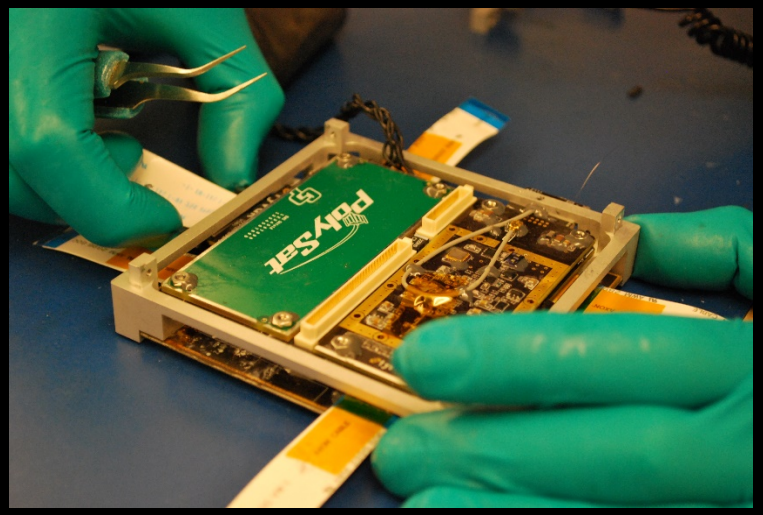
IPEX BUS

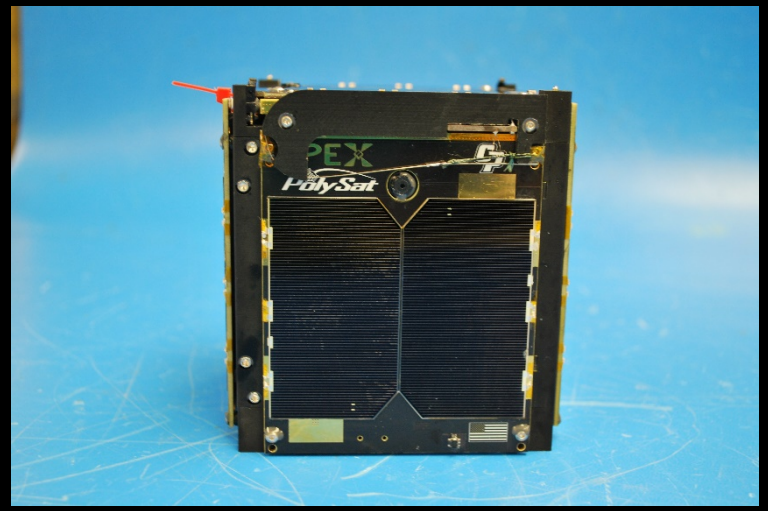
- HyperCube Structure
- Tyvak Intrepid Systemboard
- UHF Comm system
- 5x 3Mp cell phone cameras

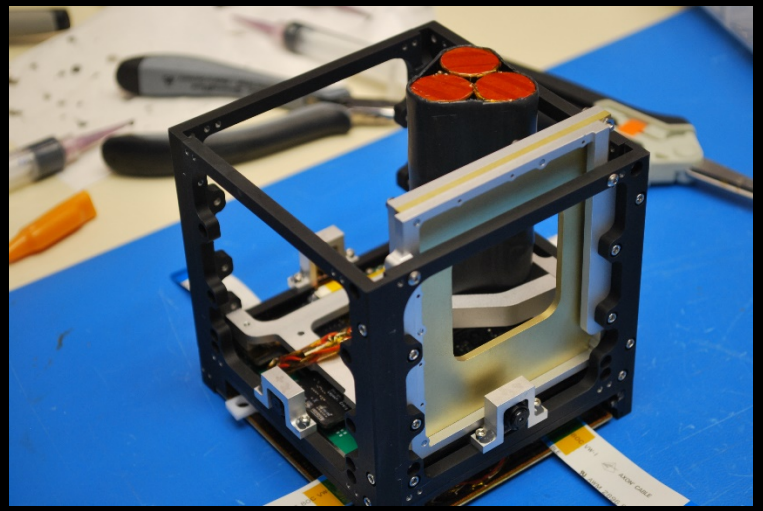
Problems encountered:

- Replace Spacecube Mini with Gumstix
- Add brass ballasts to offset Space Cube mini weight









Gumstix EarthSTORM

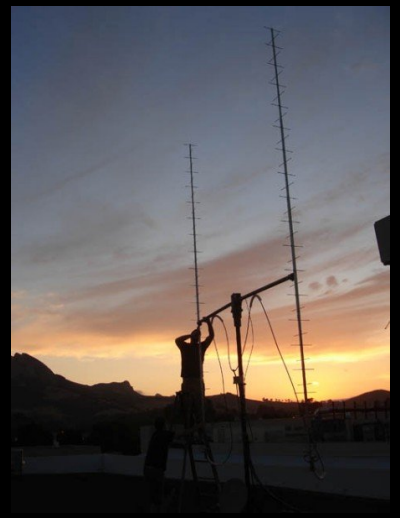
- Secondary Processor for payload processing
- Replaced Space Cube Mini at late stage in development
- COTS solution
  - Inexpensive
- Smaller form factor than SC mini
- Lower power but less powerful than SC Mini

IPEX Software

- Linux-based
  - Custom code to add expected satellite functionality
- Standards compliant
  - Smaller learning curve for Poly students, others
- Standard communication protocols
- On-orbit software updates

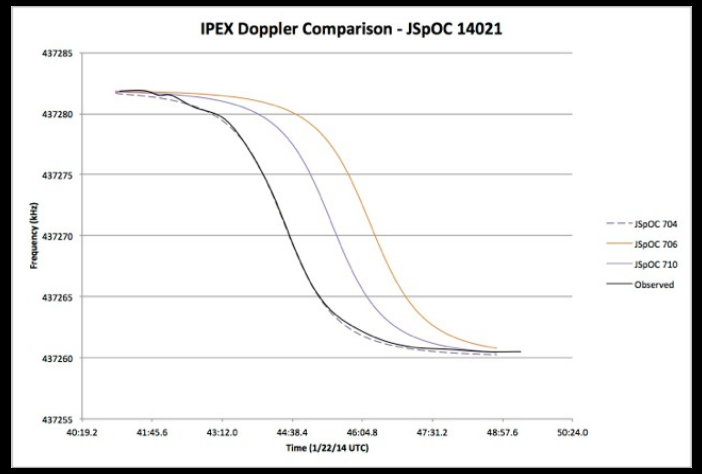
New Ground Station

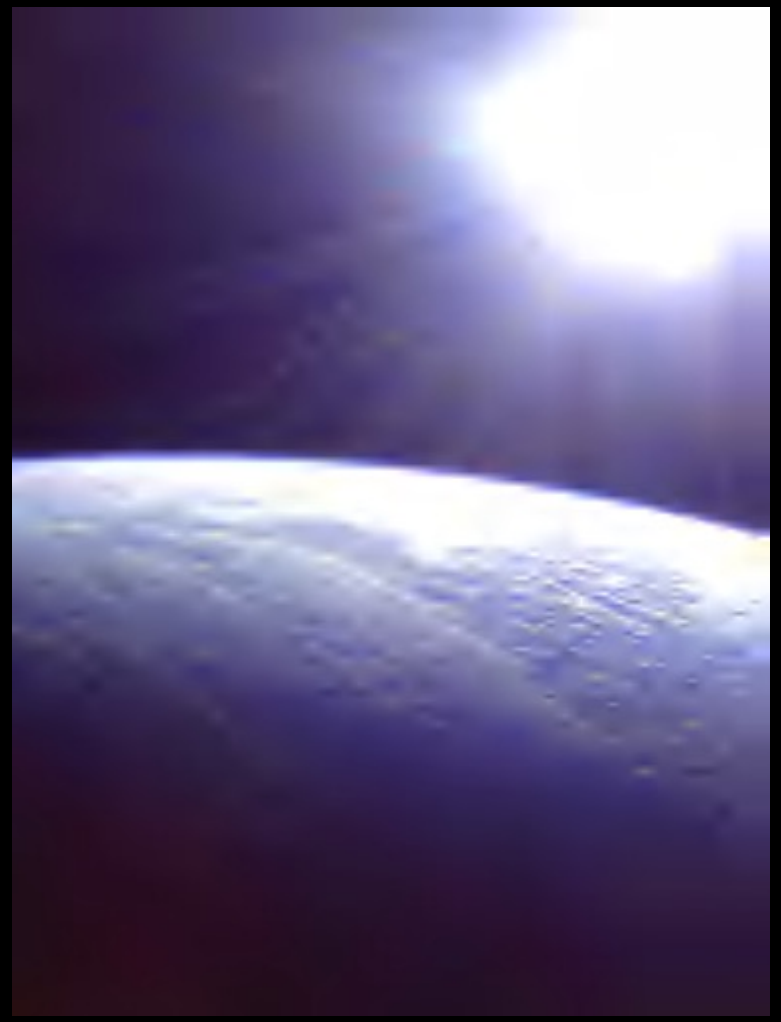
- Using systemboard as ground station radio
- Receive diversity over 3 ground stations
- All in one package



Beginning of Life Ops

- Funcube
- Doppler plots
- Cubesat community help
- First pictures downlinked day after launch





Low Resolution Thumbnail

High Resolution Image

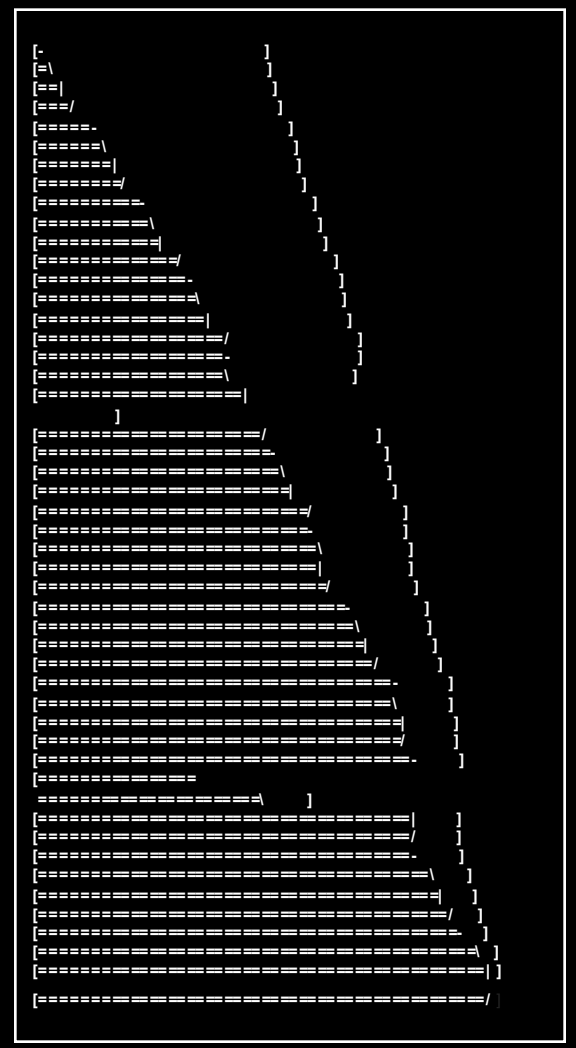
Automated Ops

- Remote pass operation possibility
- Scheduling passes in advance
- Email pass reports
- Increased data volume
- Full nights sleep

The following ground station(s) participated in the IPEX pass that began at 05:08:42 04/11/2014 UTC.

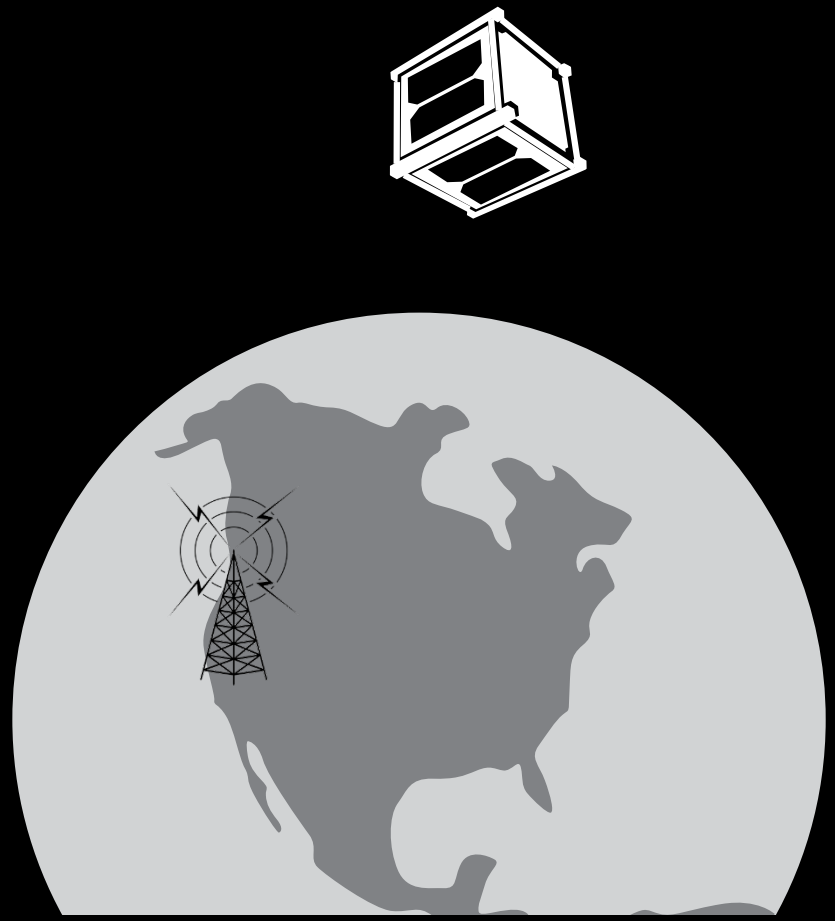
Hertz-RasPi:
- Start: 05:08:22 04/11/2014 UTC
- End: 05:20:31 04/11/2014 UTC
- Length: 12 min 09 sec
- Max El: 66.202595
- RX Pkts: 332
- RX Bytes: 47188
- TX Pkts: 0
- TX Bytes: 0

Marconi iCom:
- Start: 05:08:22 04/11/2014 UTC
- End: 05:20:31 04/11/2014 UTC
- Length: 12 min 09 sec
- Max El: 66.202595
- RX Pkts: 300
- RX Bytes: 46956
- TX Pkts: 549
- TX Bytes: 36341



Flight software update in orbit

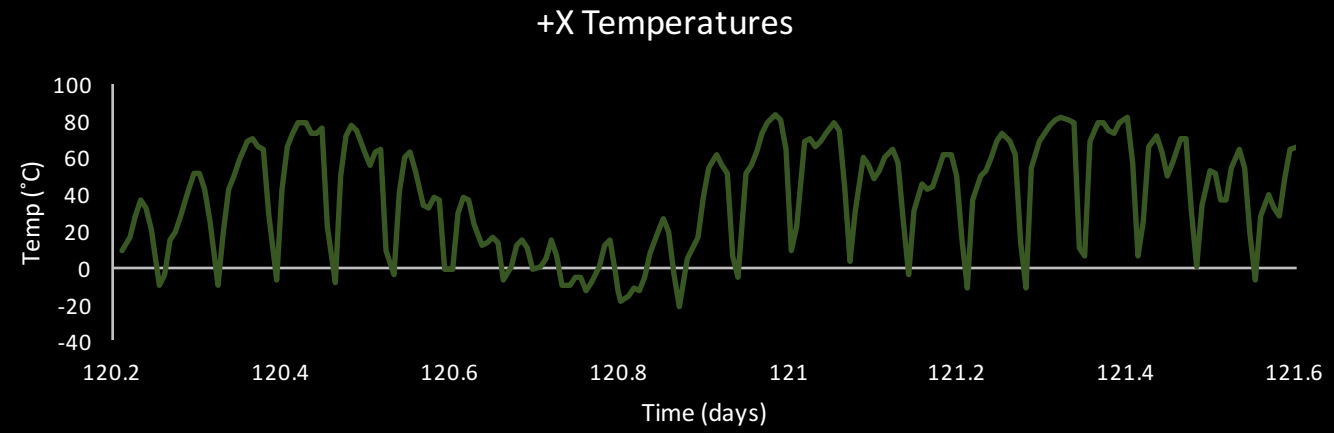
- First time for PolySat
- Test on ETU before upload
- Update software to enable downlink of more payload data
- Produce thumbnails of CASPER images to enable higher volume of download

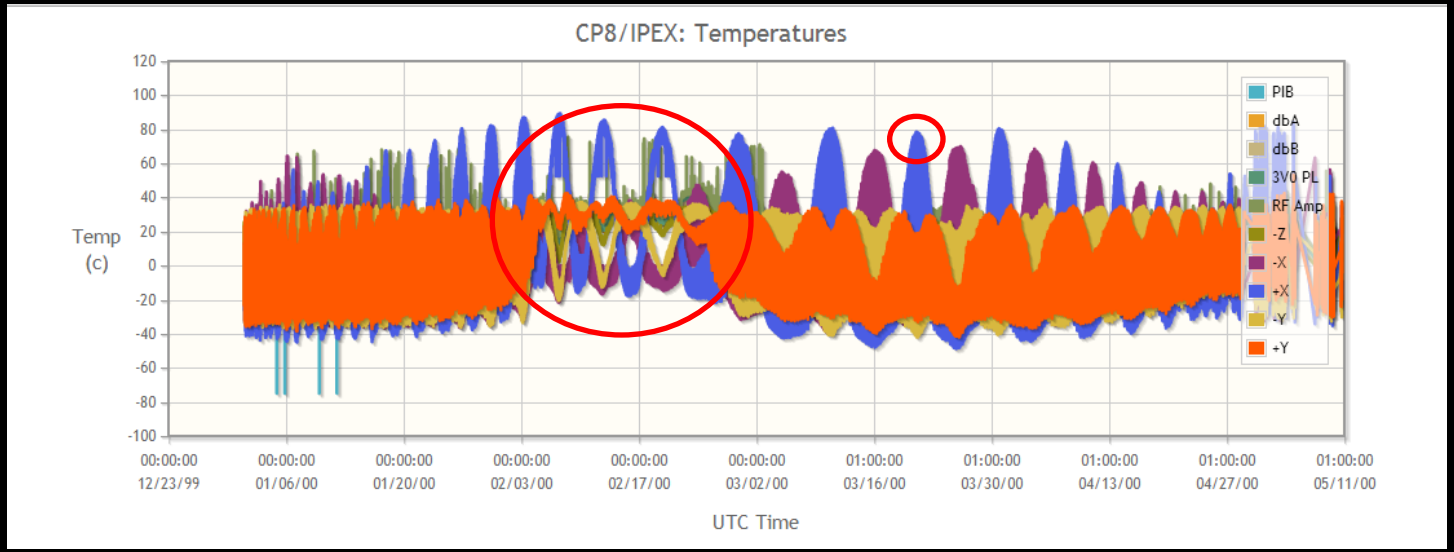


Spacecraft Telemetry: Temperatures

- Temperatures measured from -50˚C to +80 ˚C on +X side panel (external of cubesat)
- Possible large temperature range due to no brass ballast behind +X panel
- No eclipse orbit
- Data for every 10 min for 4 months

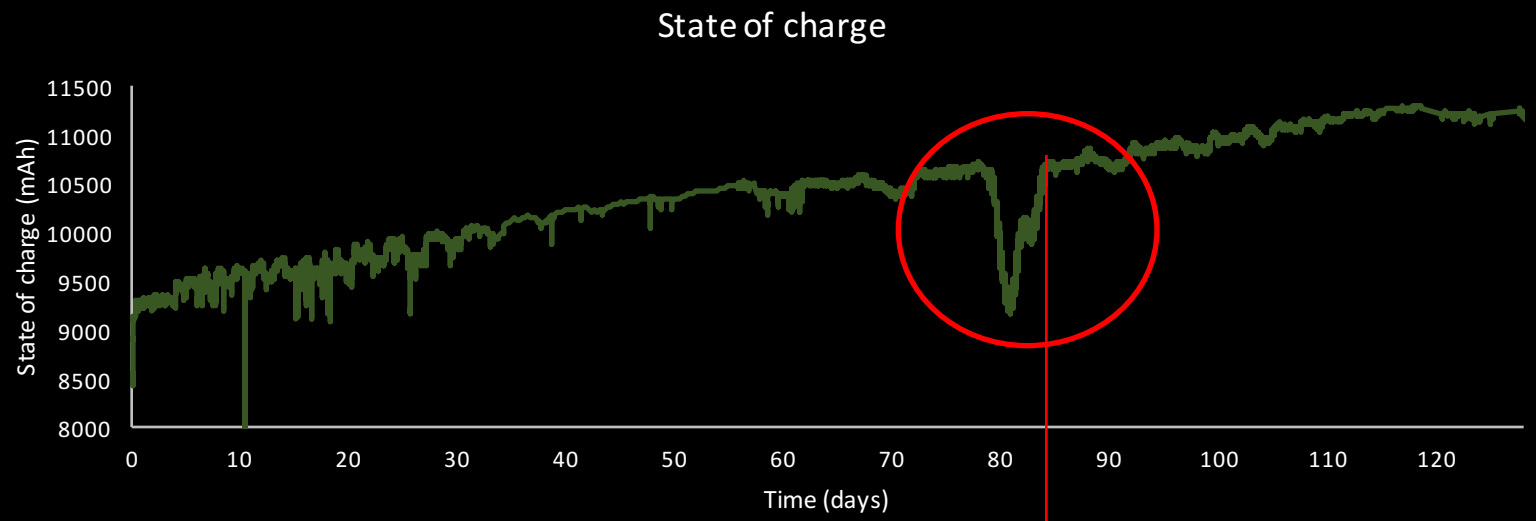
Total volume downlinked: **20-30 MB**

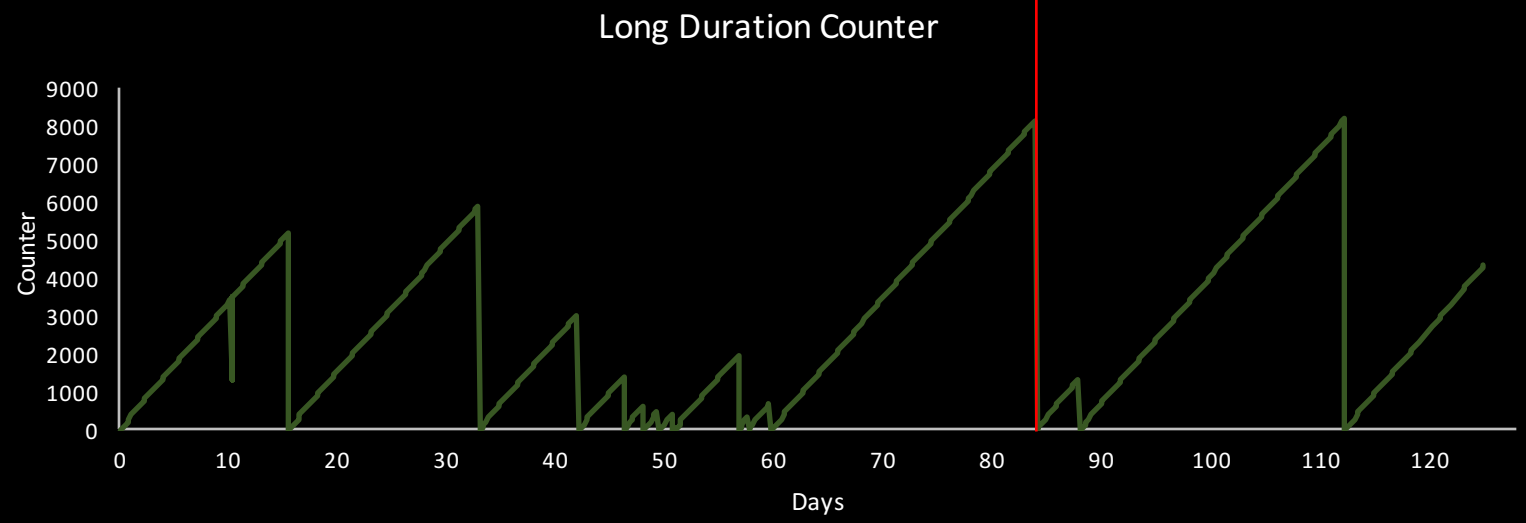




Spacecraft Telemetry: State of charge

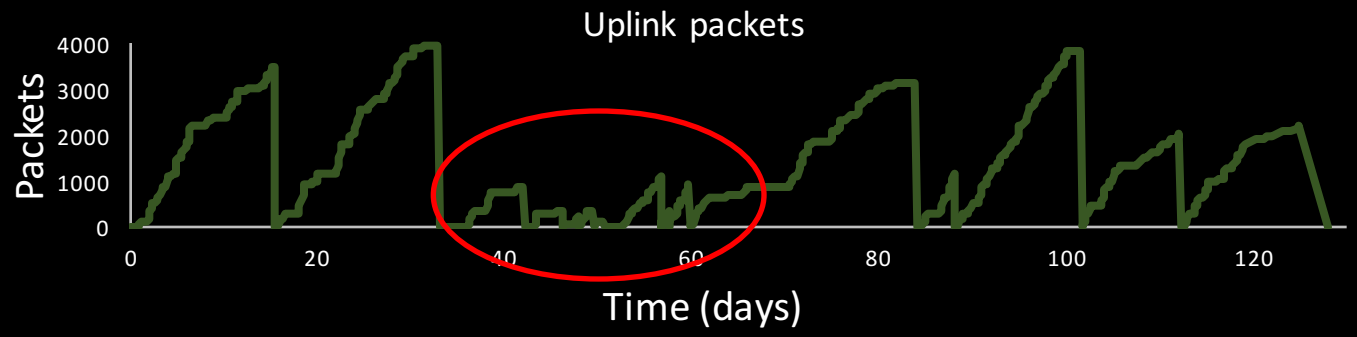
- State of charge latchup
  - Constant power draw until satellite was reset
- More resets during time of sun sync orbit
- Resets can solve common problems



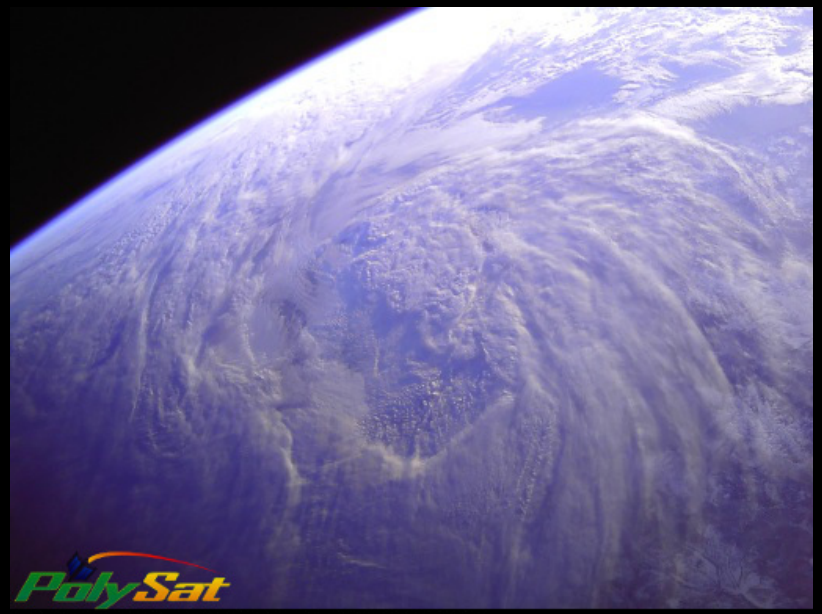


Spacecraft Telemetry: Uplink Packets

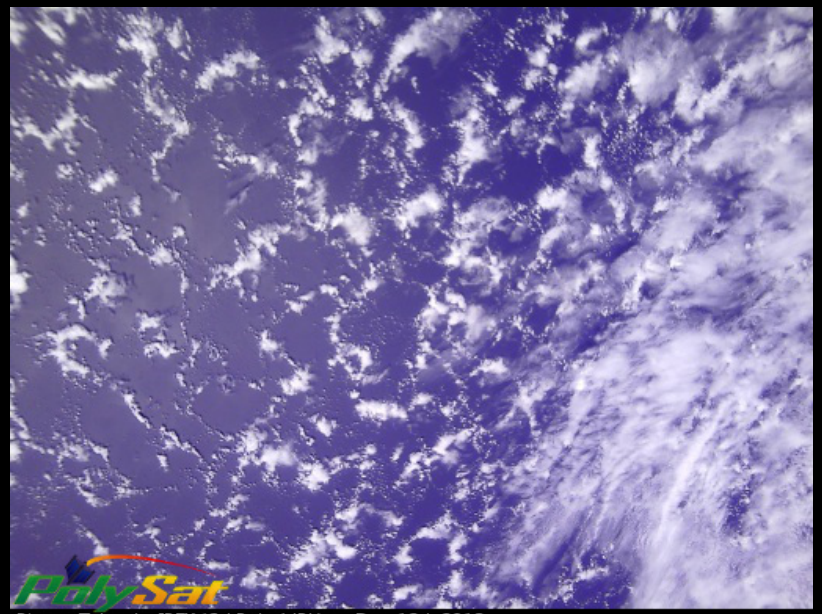
- Slope of line is good indicator to the quality of communication with spacecraft
- Downtime of ground station clearly shown
- Able to determine groundstation performance



Pictures



Picture taken by IPEX (Cal Poly) / JPL) on Dec. 12th 2013



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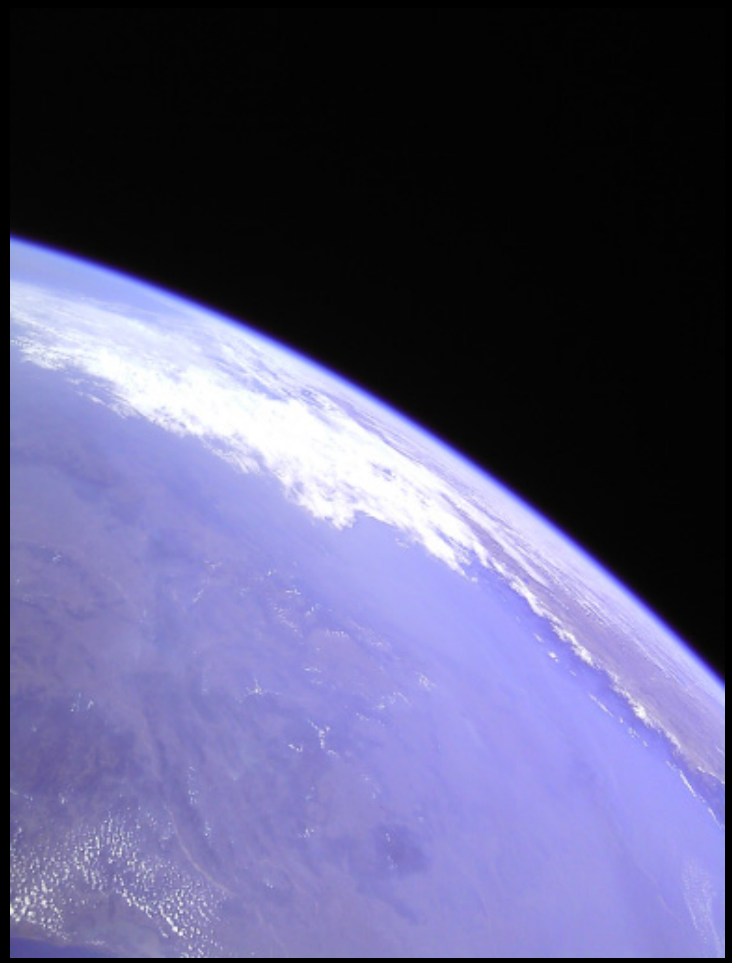
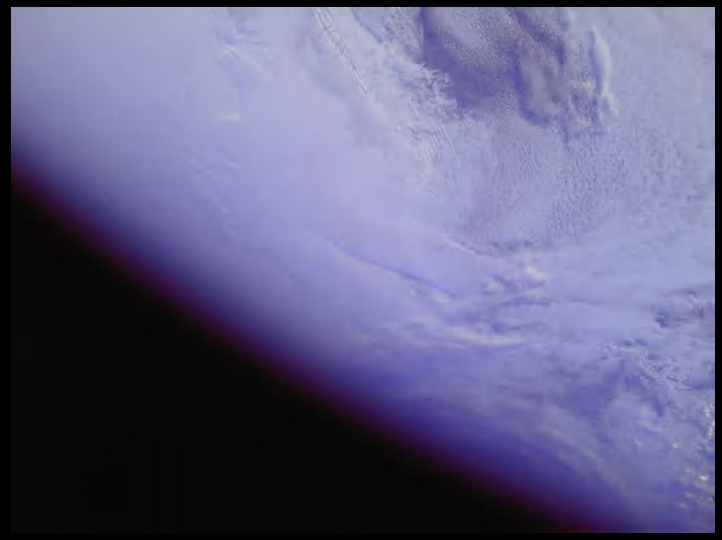
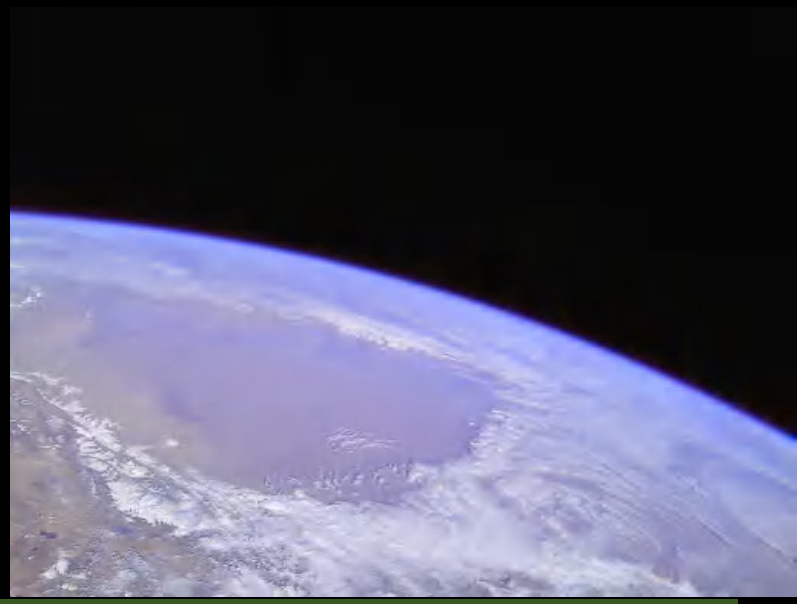
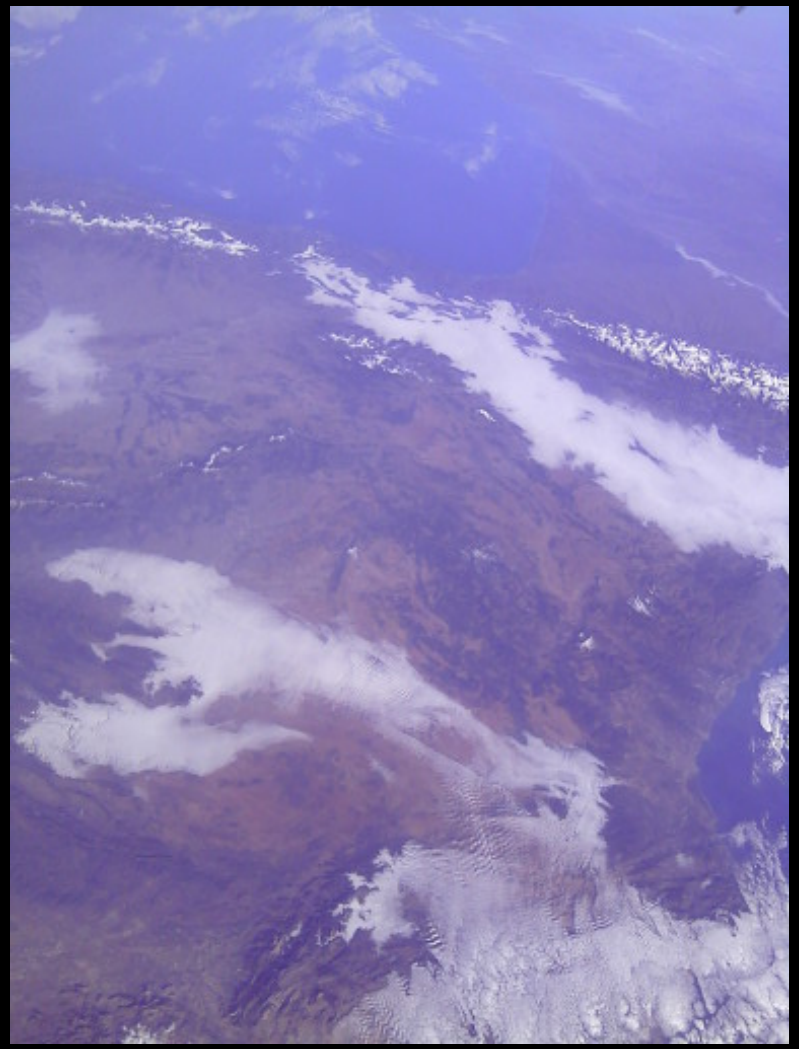
More Pictures

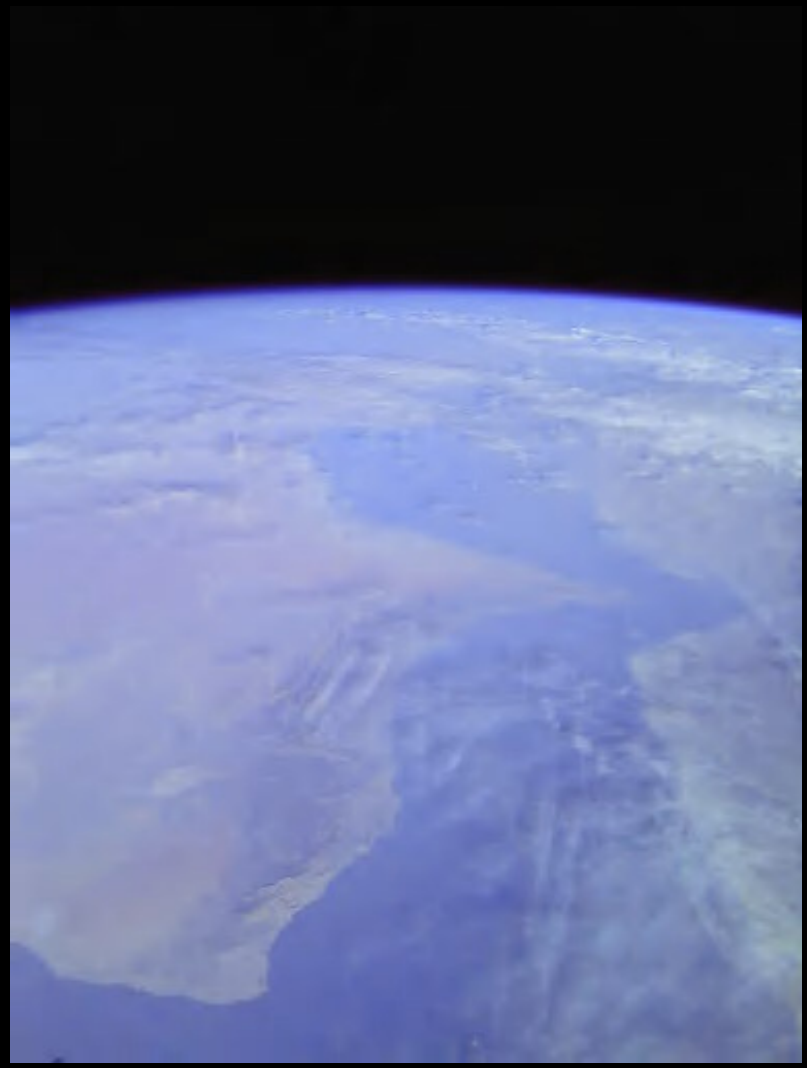






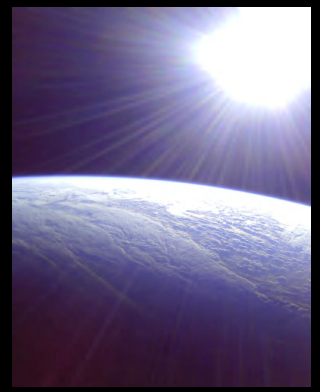
More Pictures

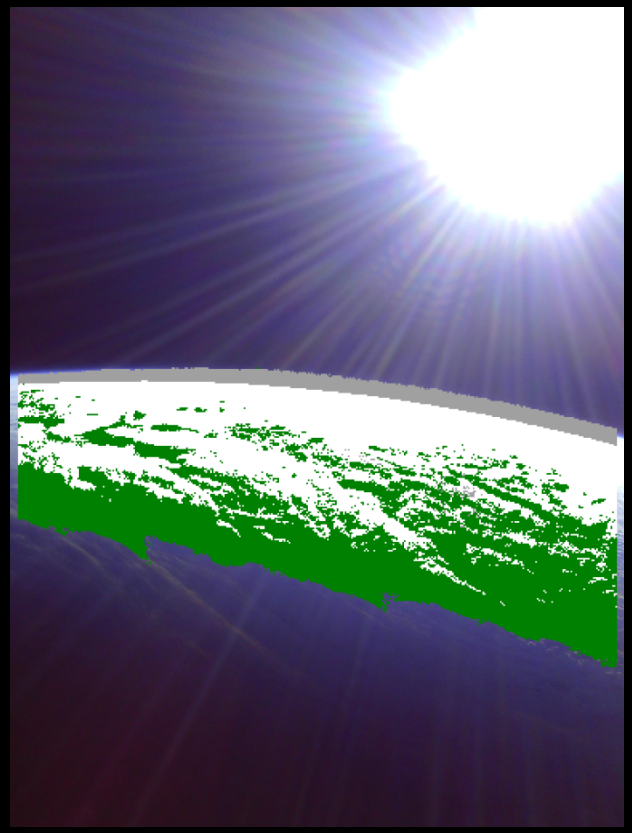


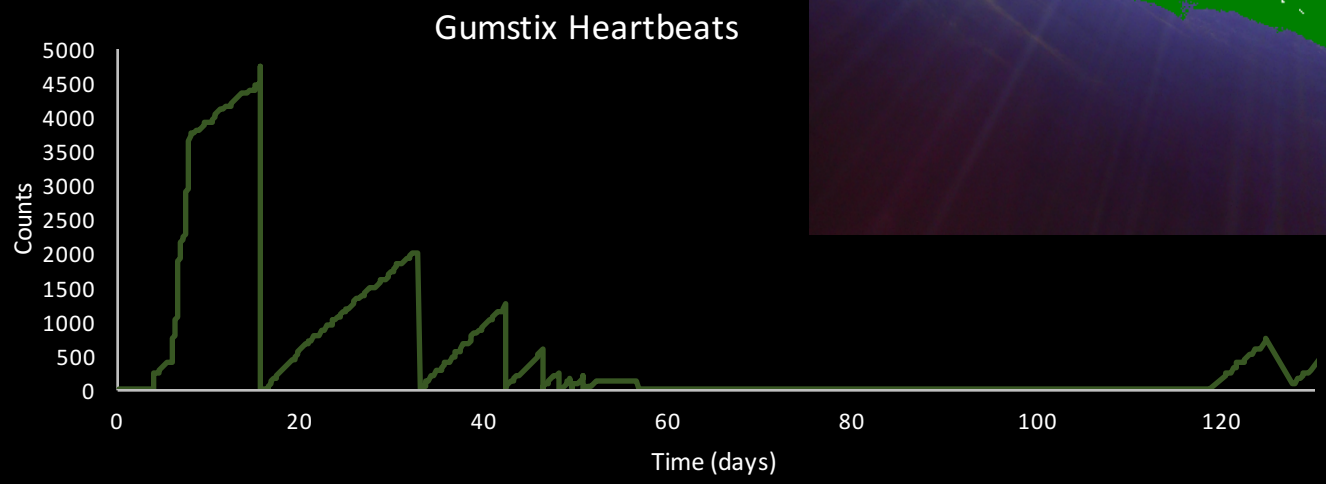


CASPER/JPL mission status

- ~72 hours of payload data processing on Gumstix
- 2 months of CASPER processing pause to improve throughput
- 17000 hyspiri-like data products
- Verified against redundant CDH and Gumstix processing
- 12k verifications against ground processing







Questions?