

#### **On-Orbit Performance**

#### AINXSS CUBESAT First Flight of the BCT XACT 3-axis ADCS

#### James Paul Mason CU Boulder LASP

photo credit: NASA/ESA Tim Peake Matthew D. Baumgart, Thomas N. Woods, Chloe Downs, (BCT) Daniel Hegel, Bryan Rogler, George Stafford, (HAO) Stanley C. Solomon, (NASA Goddard) Phillip Chamberlin, (SWRI) Amir Caspi, (CU) Scott E. Palo, (CU/LASP) Andrew Jones, Rick Kohnert, Xinlin Li, Christopher S. Moore, Colden Rouleau

## <u>Miniature X-ray Solar</u> <u>Spectrometer CubeSat</u>





#### First launched NASA SMD science CubeSat

## 2015 December 6



#### Lesson: Don't go home after multiple scrubs

youtu.be/wZYa9ZKZeDk

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## ISS capture of Cygnus

Credit: NAS

## LASP UHF ground station

### Reverse assembly



#### Lesson: Pick 1 or 2 hard things to do, outsource the rest

## Power performance: almost too good

XACT consumes 1.9 W

Mode	Average power consumed [W]	Min eclipse margin [%]	Max eclipse margin [%]
Science	8.0	59	35
Safe	5.3	73	57
Phoenix	2.6	87	79

#### Lesson: No critical monitors on shared I2C bus

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### Thermal performance: on target



Figure courtesy of Chloe Downs

# Pointing performance — safe mode

- MinXSS deployment → XACT booted to safe
- XACT autonomously placed spacecraft in safe attitude with arrays on sun and low total momentum
  - Per first pass telemetry
- Safe mode algorithms reliably find and track the sun
  - Uses XACT coarse sun sensors (CSS)
  - In Fine Pointing data (right), albedo induces 2-3° error on CSS sun measurements



## Typical MinXSS attitude control scenario

- Spacecraft +X axis is sun-pointed (nearly constant in inertial space)
- One rotation about +X axis per orbit (star tracker to zenith)



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## Pointing performance — momentum accurately controlled

- Nonzero commanded momentum bias
  - [0, 1.5, 1.5] Nms don't want wheel to stick at 0
  - Still have 0-crossings 4x / orbit unavoidable with 3 wheels
    - . XACT can support 4 wheels
- Momentum is accurately provided
  - Sawtooth in plot is artifact of reconstructing inertial frame momentum from telemetry points with different quantizations
  - Some telemetry frame errors
  - Actual control error: ~0.2 mNms



Figure courtesy of Matt Baumgart

# Pointing performance highlyaccurate overallPer XACTPer SPSSpe

- Two independent measures of attitude control error
  - XACT's based on star tracker, high-fidelity sun model
  - MinXSS's fine Sun Position Sensor (SPS) with 2 arcsec dark noise
- Z-axis in spec but more sensitive to disturbance torques due to low inertia
- Significant unmeasured high-frequency motion is unlikely
  - (right) 2/3 wheel speeds often within tracker bandwidth
  - Same accuracy measured when 3rd wheel is also within tracker bandwidth





\*cross-boresight, caveat, caveat, caveat

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Figure courtesy of Matt Baumgart

# Science objectives achieved

- 7 M-class, > 40 C-class flares observed
- Met minimum success criteria
- Comprehensive success in mid-September (3 months observation)
- First science paper in prep
- Dedicated session at AGU





Figure courtesy of Tom Woods, lasp.colorado.edu/home/minxss/science/minxss-science-nugget-1

### THANK YOU

For more BCT booth: 70 LASP booth: 95 Talk: Dan Hegel (BCT) Wednesday 5:45





LASP

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