

# AeroCube 3

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Technology and Laboratory Operations  
The Aerospace Corporation

# Aerospace PICOSAT Program Value

## ***Perform Missions - two types:***

- High risk for maximum return
  - Use latest technology
  - Create capability roadmap
- Risk reduction for sponsor's main program
  - We have rapid response
  - We are payload centric
  - We allow fluid requirements
  - We resolve technical questions

## ***Develop Technology by:***

- Sustained internally funded effort
- Constant pursuit of limits
- Resident quality workforce
- Appropriate corporate structure

## ***Develop Workforce by Providing:***

- Engineering exercise
- Policy exercise
- Contractor-like experience
- Program leadership opportunities

## ***Support AF Acquisitions by Developing:***

- Cost models
- Concept Design Center models
- Mission assurance guidelines

# Aerospace's "PICOSAT" History\* from 1999 to 2012

OPAL PicoSats (2)  
Minotaur I  
250 grams



MEPSI (2)  
STS-113  
800 grams each



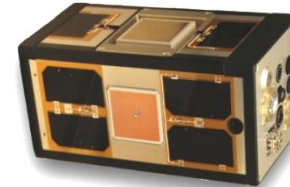
MEPSI (2)  
STS-116  
1.1 and 1.4 kilograms



AeroCube-3  
Minotaur I  
1.1 kilograms



PSSC Testbed-2  
STS-135  
3.6 kilograms



REBR2 (2)  
H-IIB  
4.5 kilograms  
with heat shield



1999

2001

2003

2005

2007

2009

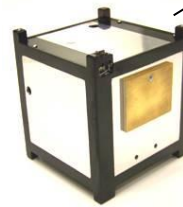
2011

2013



MightySat II.1 PicoSats (2)  
Minotaur I  
250 grams

First University  
CubeSat Launch

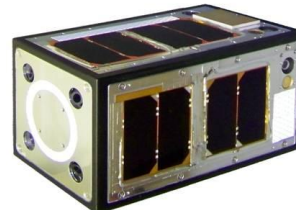


AeroCube-1  
Dnepr-1  
999 grams

**Failed to  
Reach orbit**



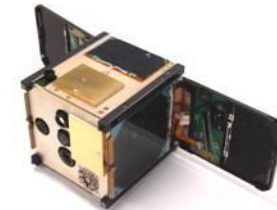
AeroCube-2  
Dnepr-1  
998 grams



PSSC Testbed  
STS-126  
6.4 kilograms



REBR (2)  
H-IIB  
4.5 kilograms  
with heat shield

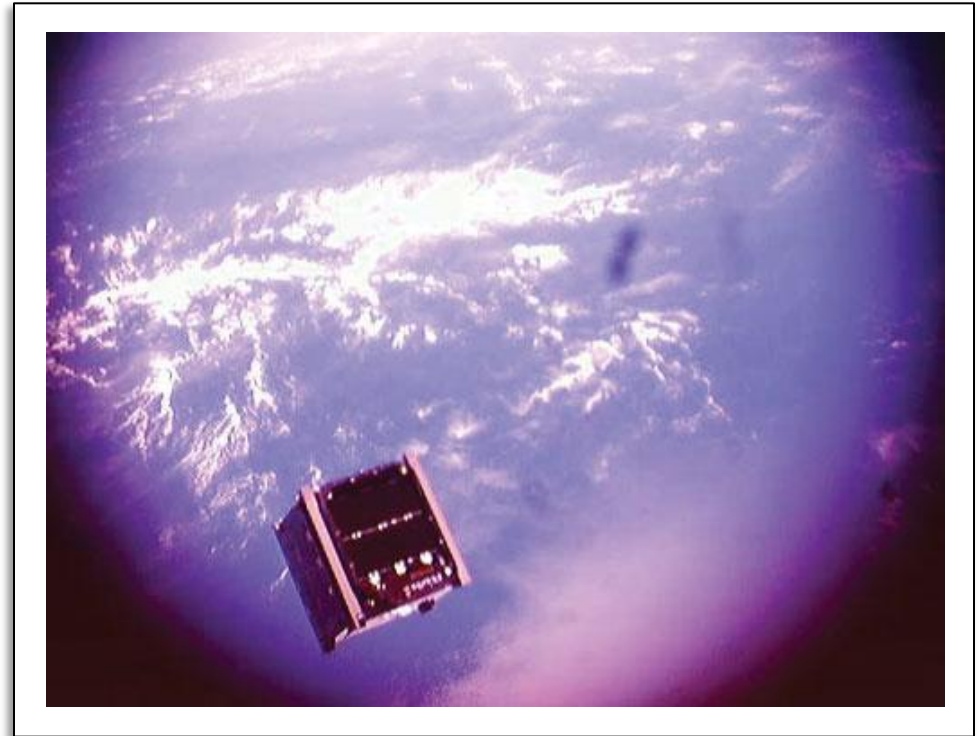


AeroCube-4.0 (1)  
AeroCube-4.5 (2)  
Atlas V, NROL-36  
1.3 kilograms

\* Timeline is for delivery date and not launch date

# AeroCube-2

- Launched May 2009
- 98° inclination
- 650 x 770 km altitude
- 1U CubeSat form factor
- 1 kg mass
- Norad ID 31133
- (Still in orbit)
- 4 solar cells total
- Tumbler – no attitude control



Cal Poly CubeSat CP-4 photographed by AeroCube-2. The first and, so far, only instance of one CubeSat photographing another.

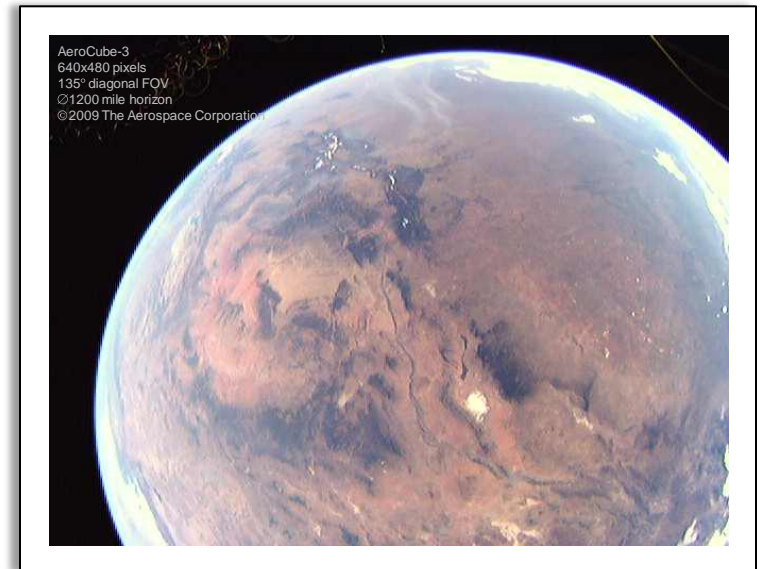
*Lasted 1 day only because of insufficient energy for recharging batteries*

# AeroCube-3

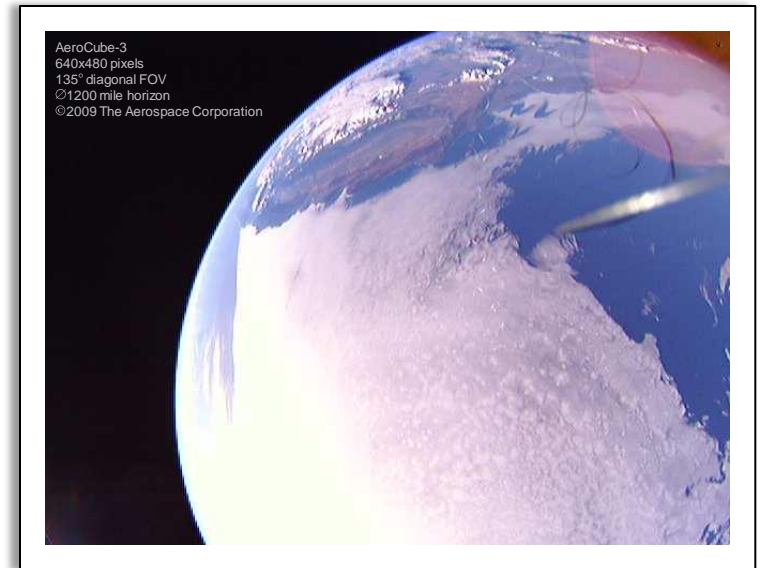
- Launched May 2009
- 40.5° inclination
- 460 km altitude
- 1U CubeSat form factor
- 1.1 kg mass
- Norad ID 35005
- Reentered
- 7 solar cells total
- Permanent magnet\*



Central Mexico

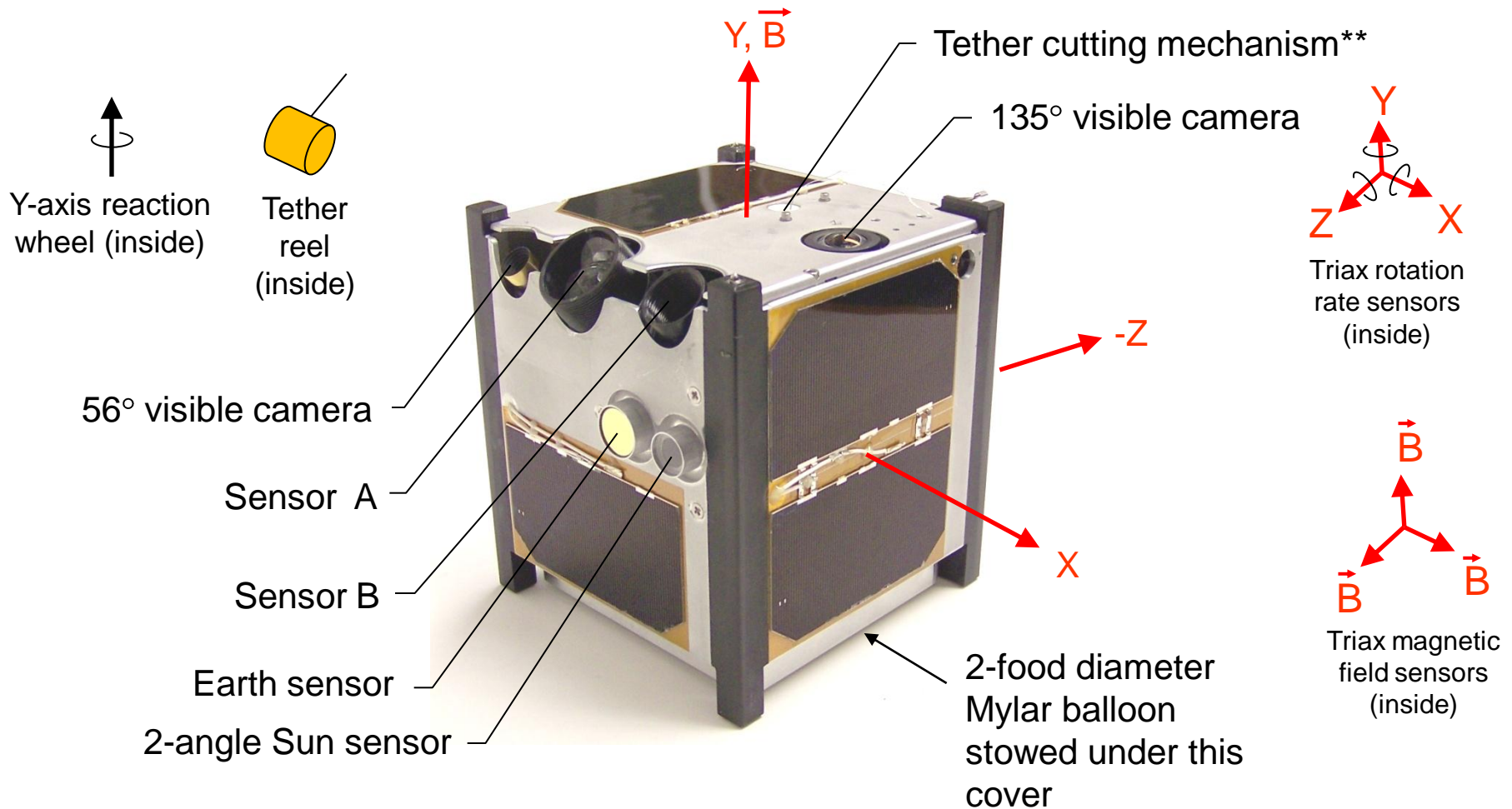


Pacific Ocean



*Corrected and improved AeroCube-2*

# AeroCube-3 Features

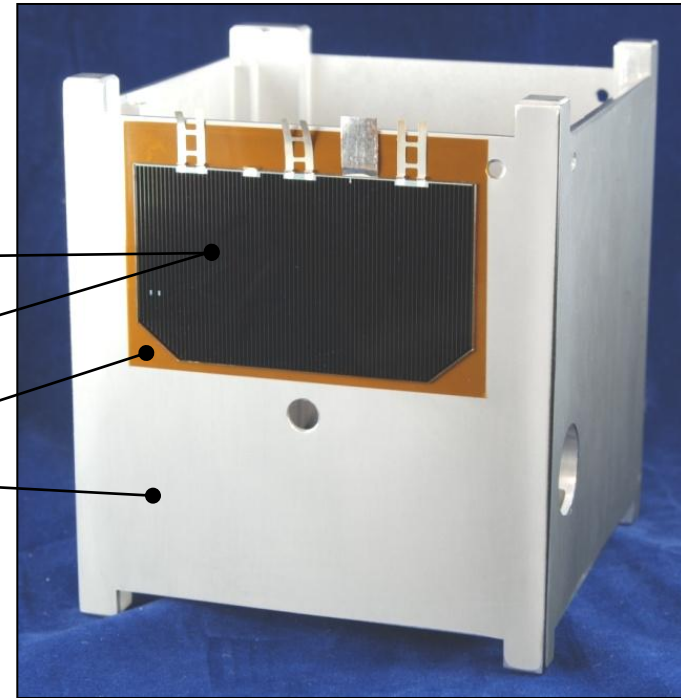
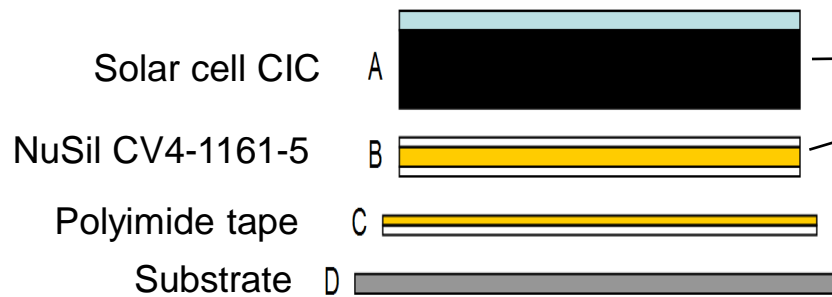


\*\* 200' of Dyneema is spooled inside

*Substantial number of new subsystems*

# AeroCube-3 New Solar Cell Laydown Method

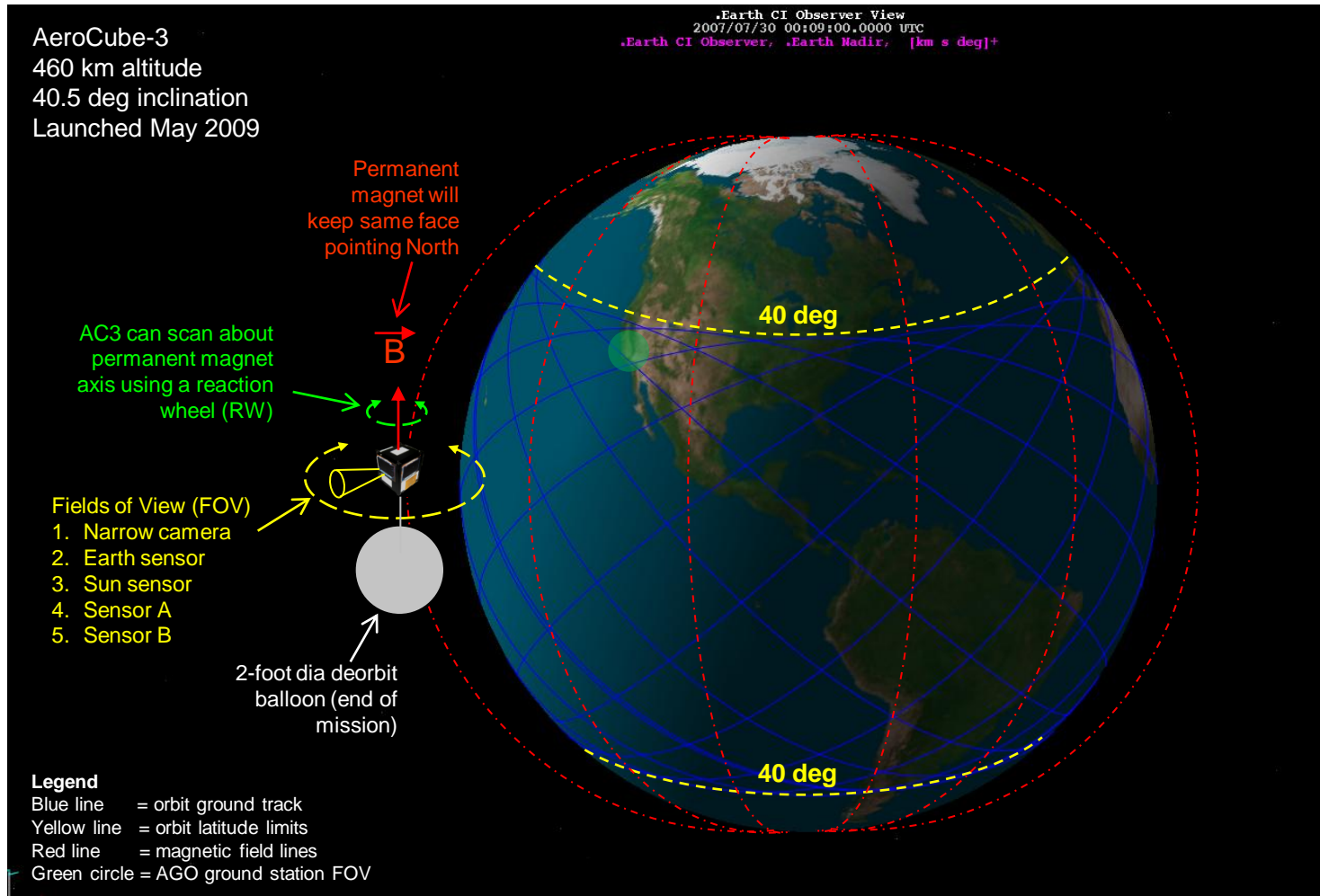
- Testing a new method for solar cell installation
- Nusil CV4 is a double sided tape with space rated outgassing properties
- 1U CubeSat solar cells laid down in 1 day



Reference: Karuza, et al, "Solar Cell Installation Using Double Sided Polysiloxane Pressure Sensitive Adhesive (PSA) Polyimide Film," 2009

*Much quicker and cleaner than liquid adhesive*

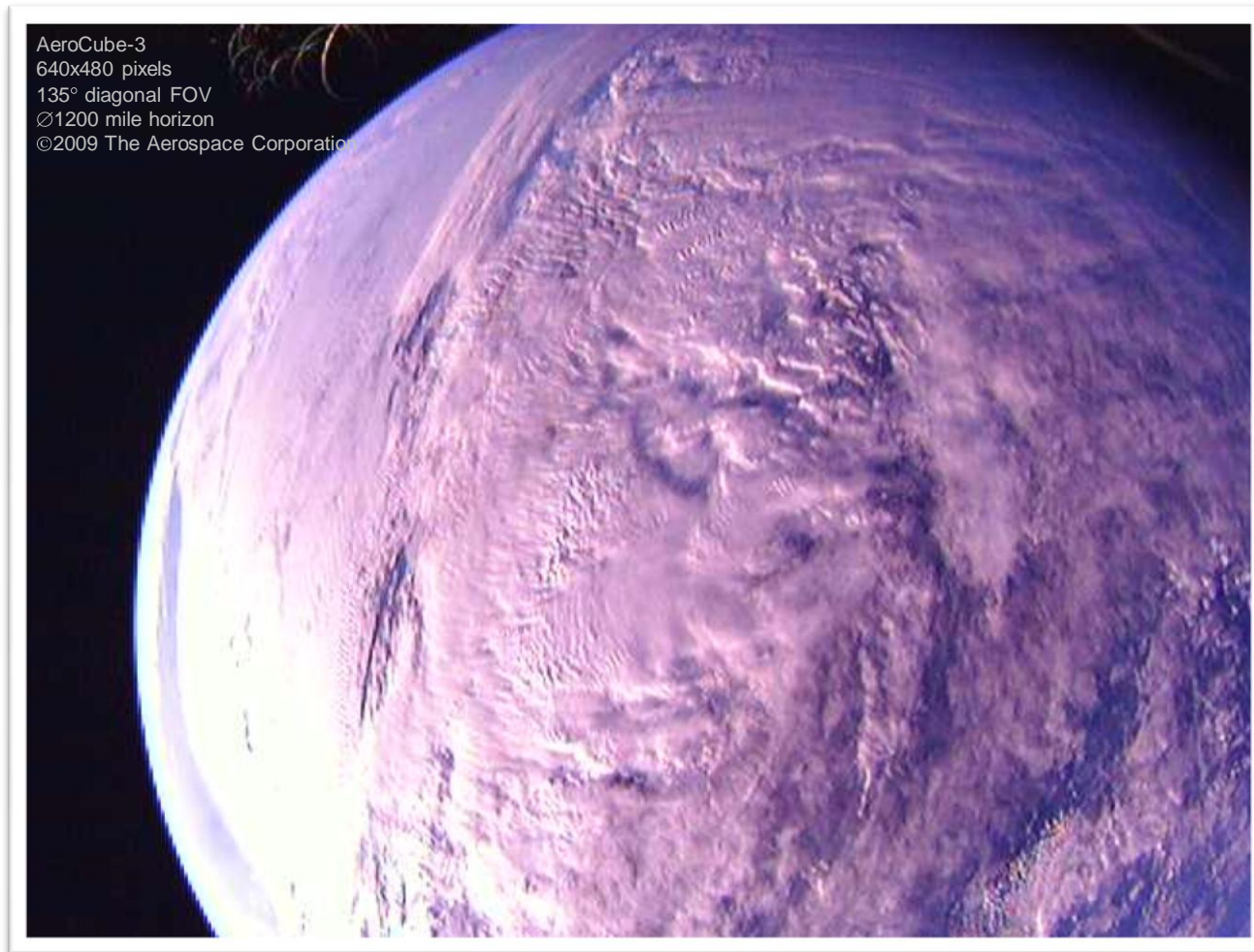
# AeroCube-3 Concept of Operations



*Mission = test new sensors, comm link, power system, deorbit device*

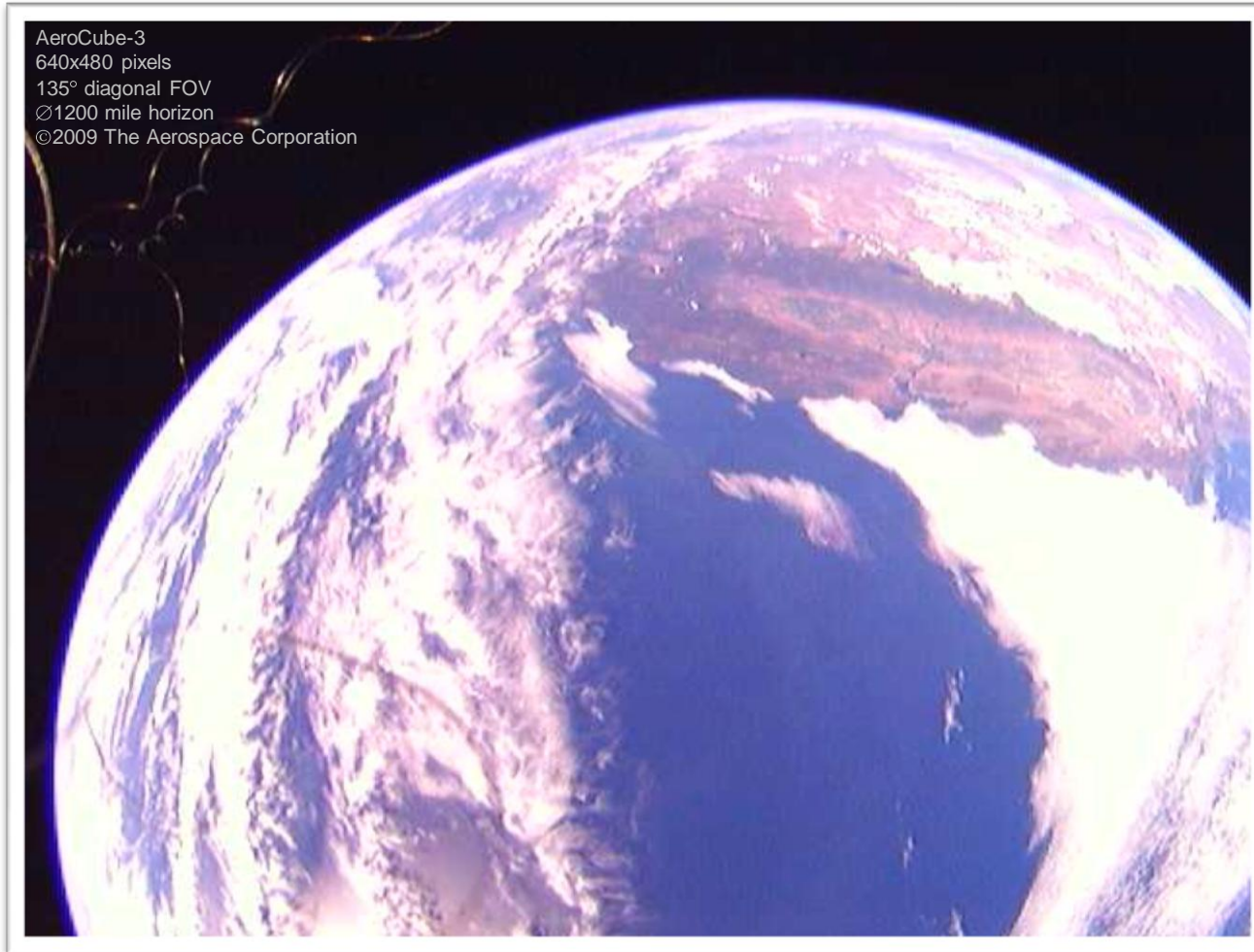


# AeroCube-3 Earth Photo



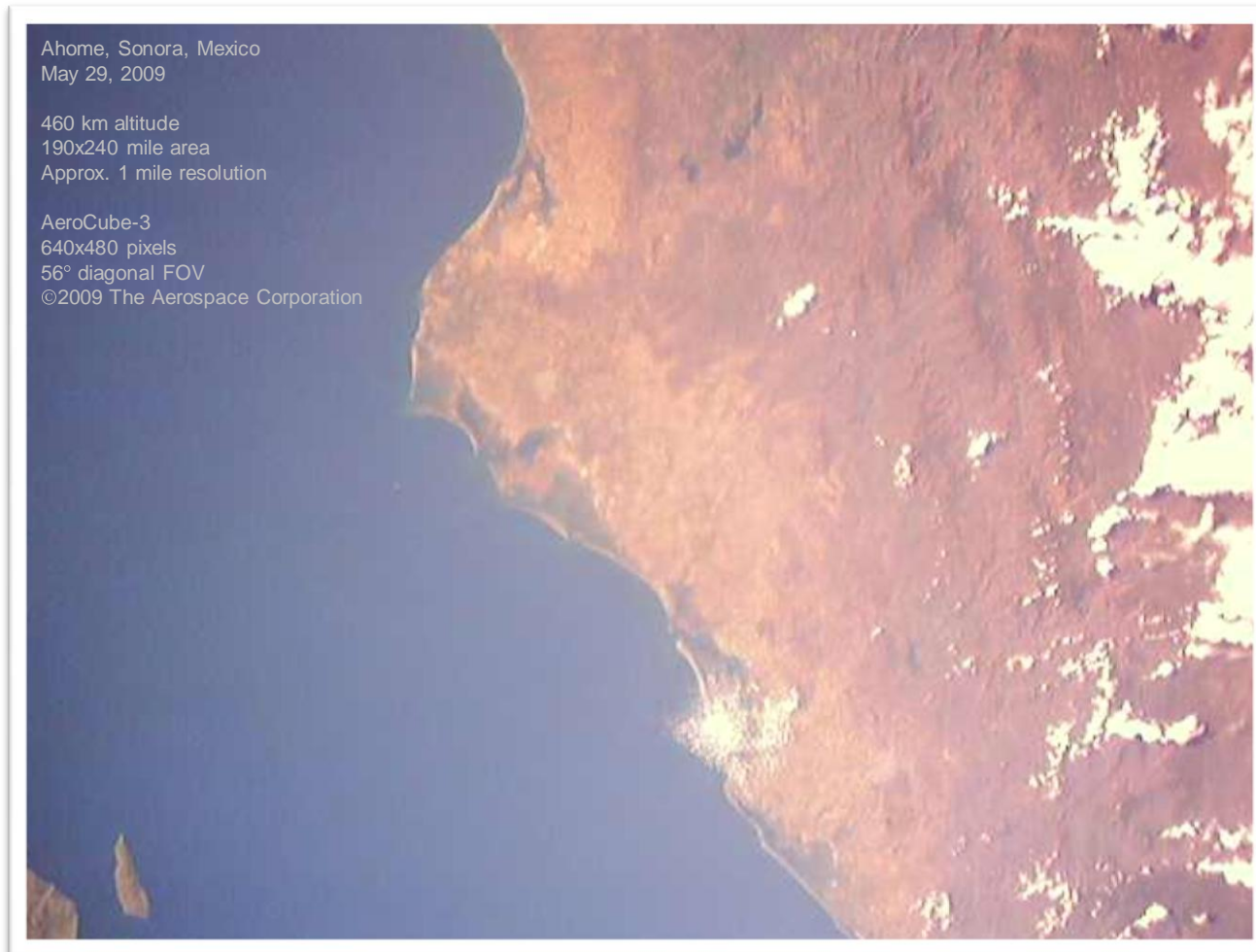
*2700 mile diameter of cloud cover (same size as the United States!)*

# AeroCube-3 Earth Photo



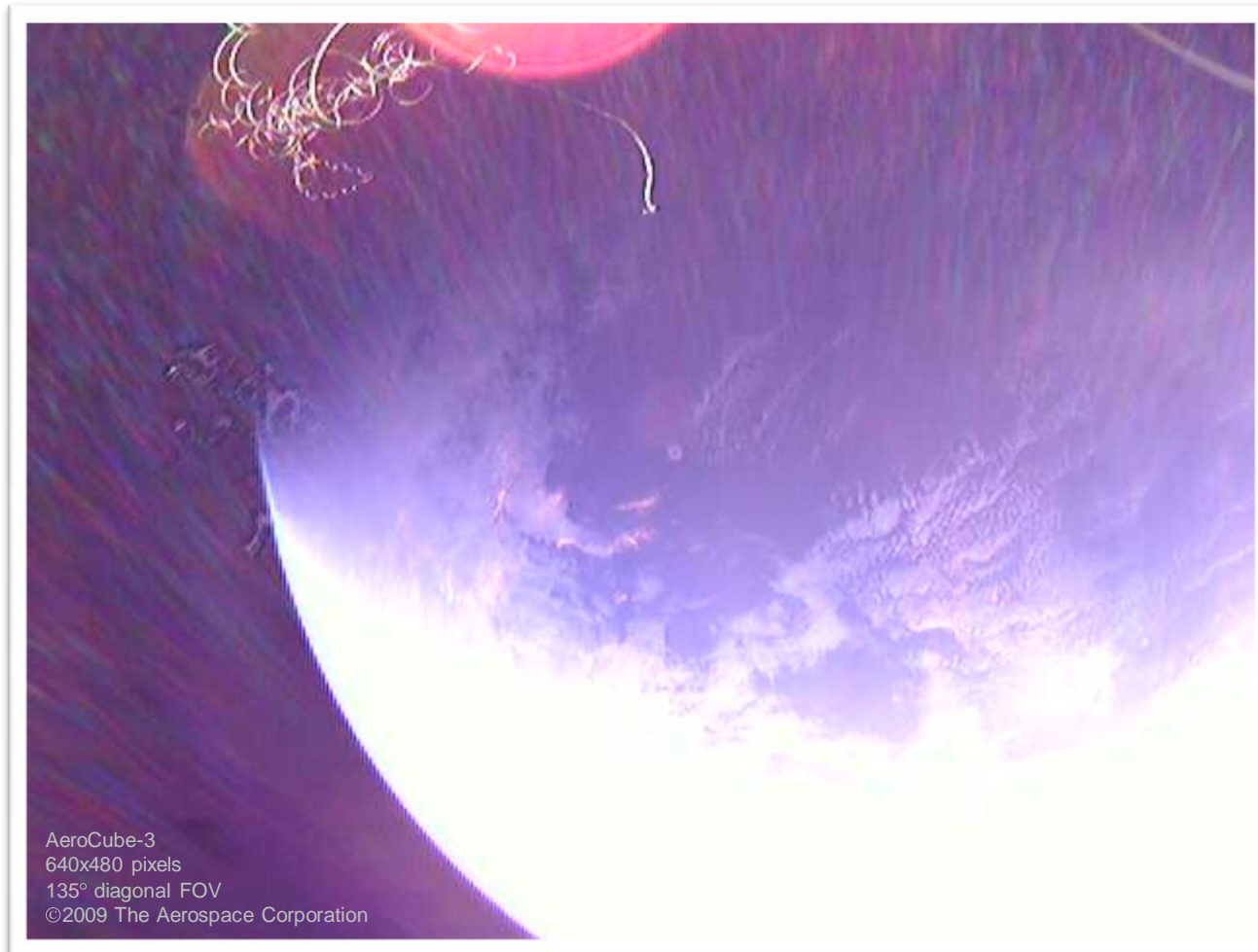
*Approaching the California Coast*

# AeroCube-3 Earth Photo



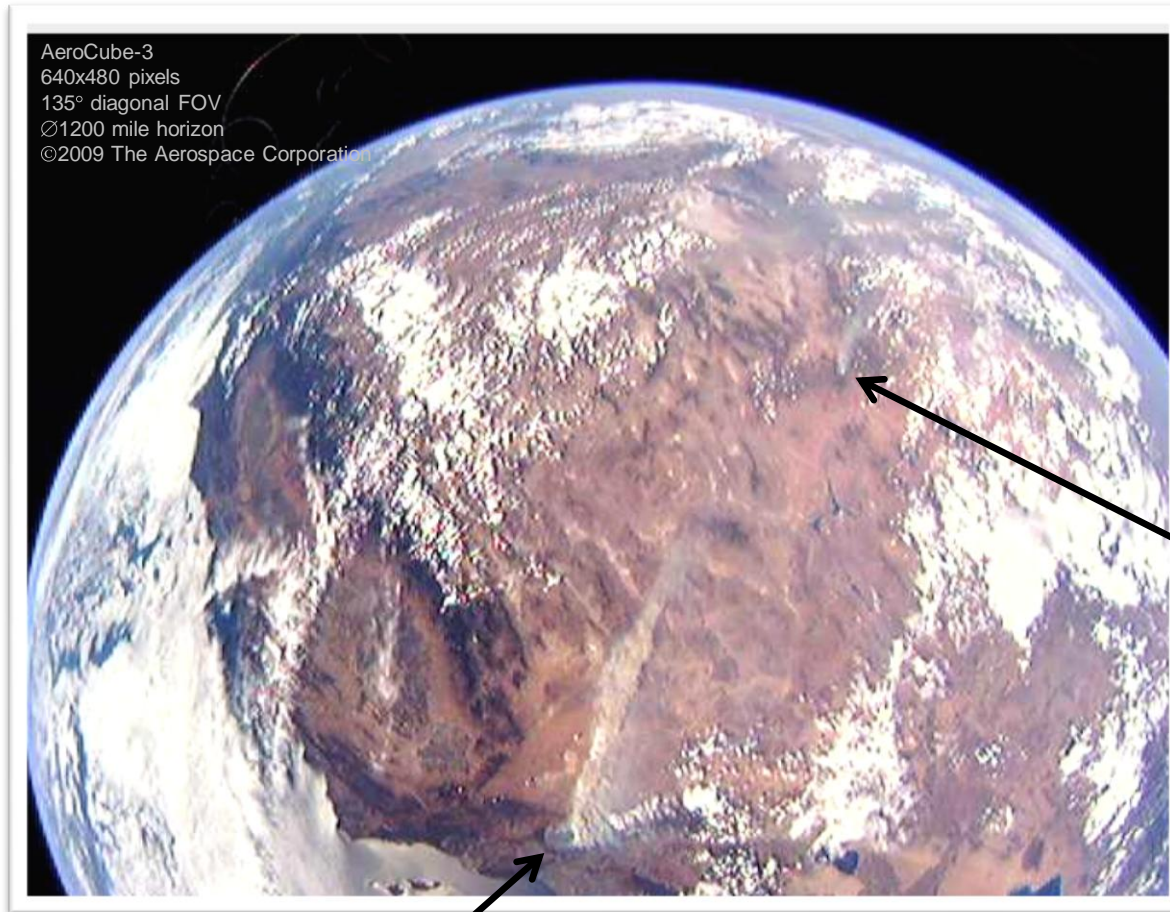
*Intelligence, Surveillance, and Reconnaissance*

# AeroCube-3 Earth Photo



*Day / night terminator*

# AeroCube-3 Earth Photo



New Harmony  
fire (Utah)

Station fire (Los Angeles)

*Locating gigantic fires! (September 1, 2009)*

# AeroCube-3 Deorbit Balloon



Uninflated 2-foot diameter AC3 balloon. Kapton fill tube has kinks that prevented inflation.



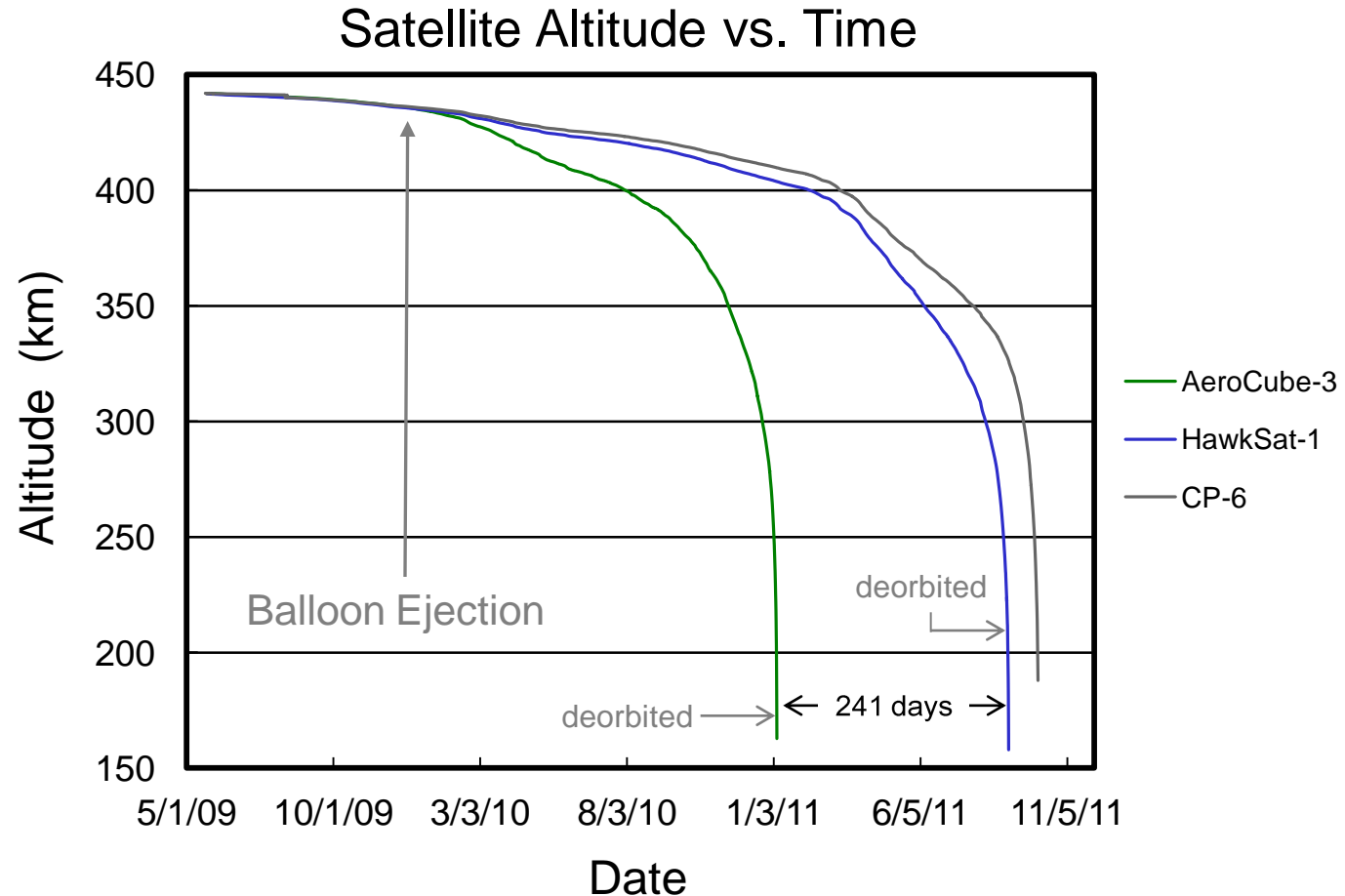
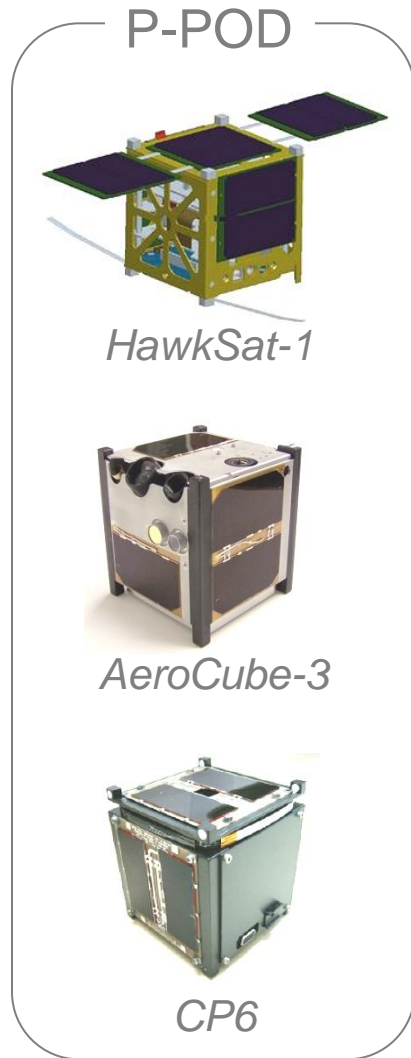
6 panel x 2-foot diameter AC3 balloon inflated in vacuum chamber



AC3 balloon inflation module

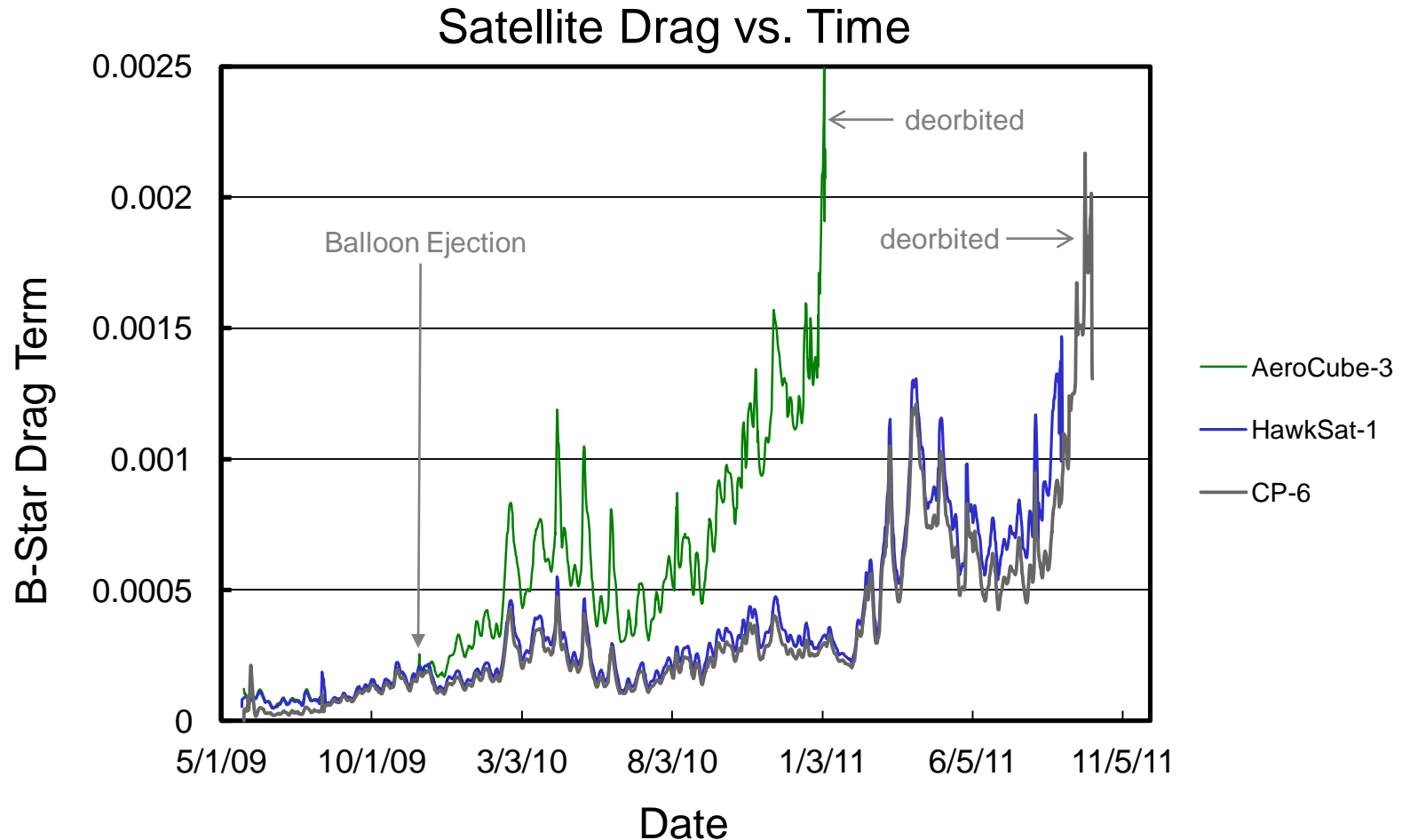
*Spherical balloon would be easy to spot from earth with binoculars*

# AeroCube-3 Deorbit Balloon Performance



*All three CubeSats were launched from the same P-POD launch tube*

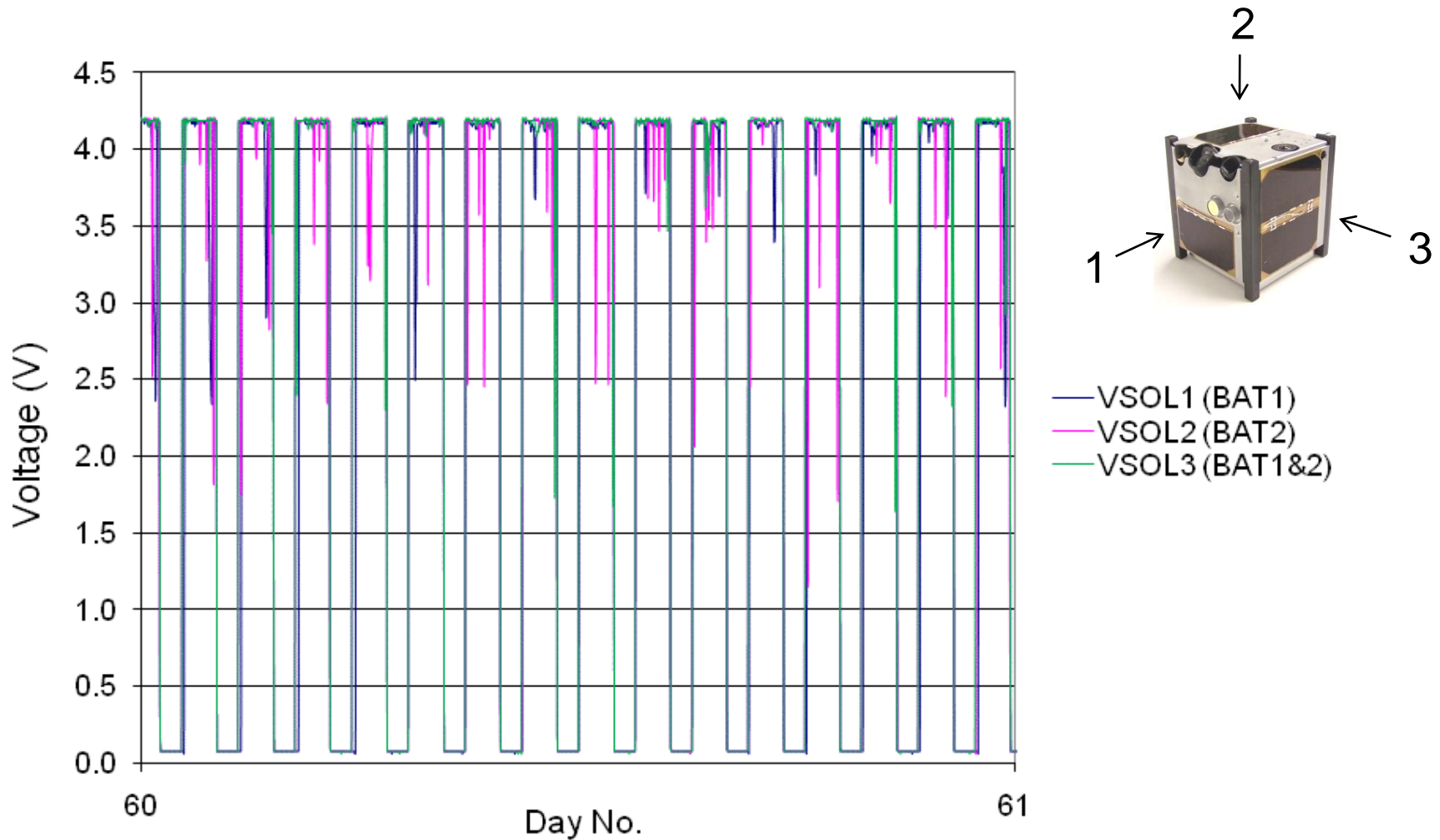
# AeroCube-3 Deorbit Balloon Performance



*Balloon deployed (uninflated due to fault in inflation system) on 11-18-09*

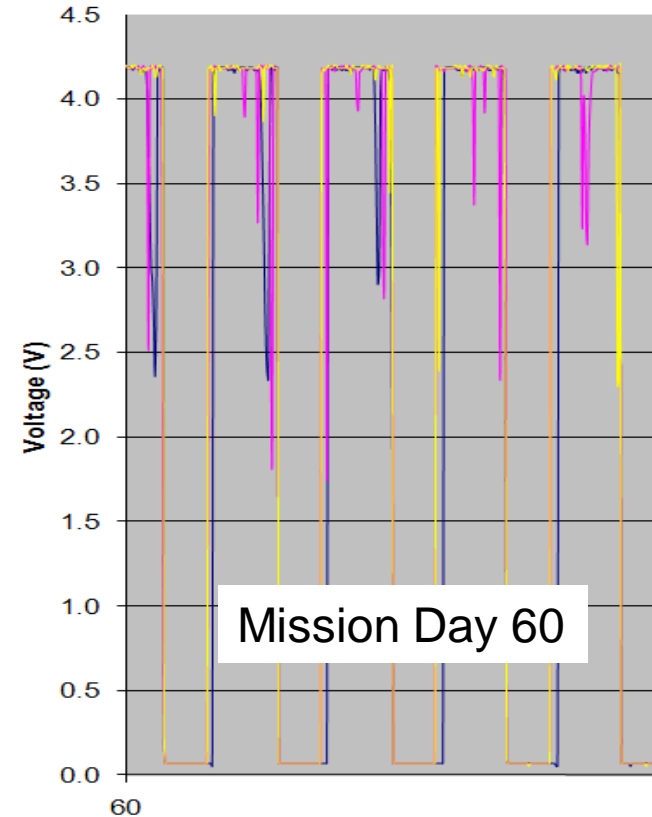
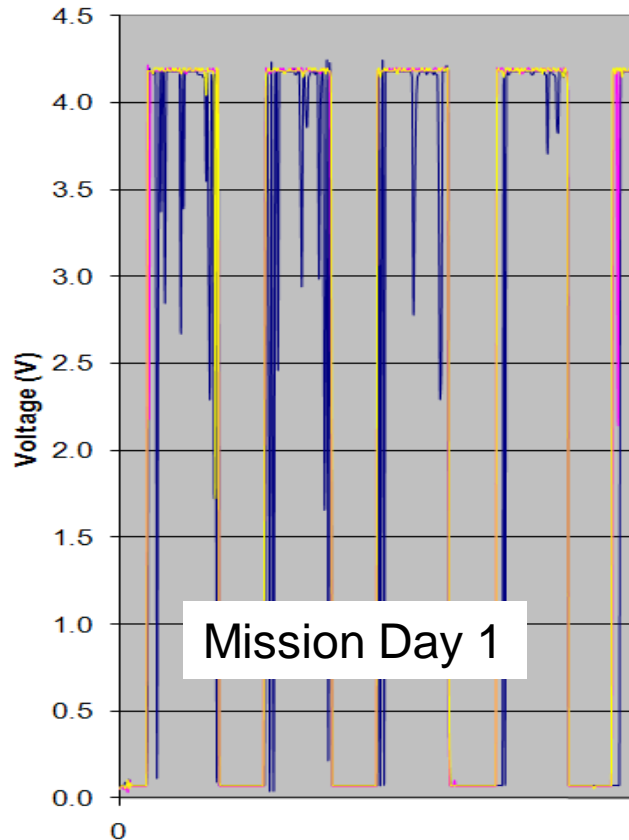


# AeroCube-3 Solar Up-converter Voltages - Baseline



*Lithium ion batteries charge at 4.2V*

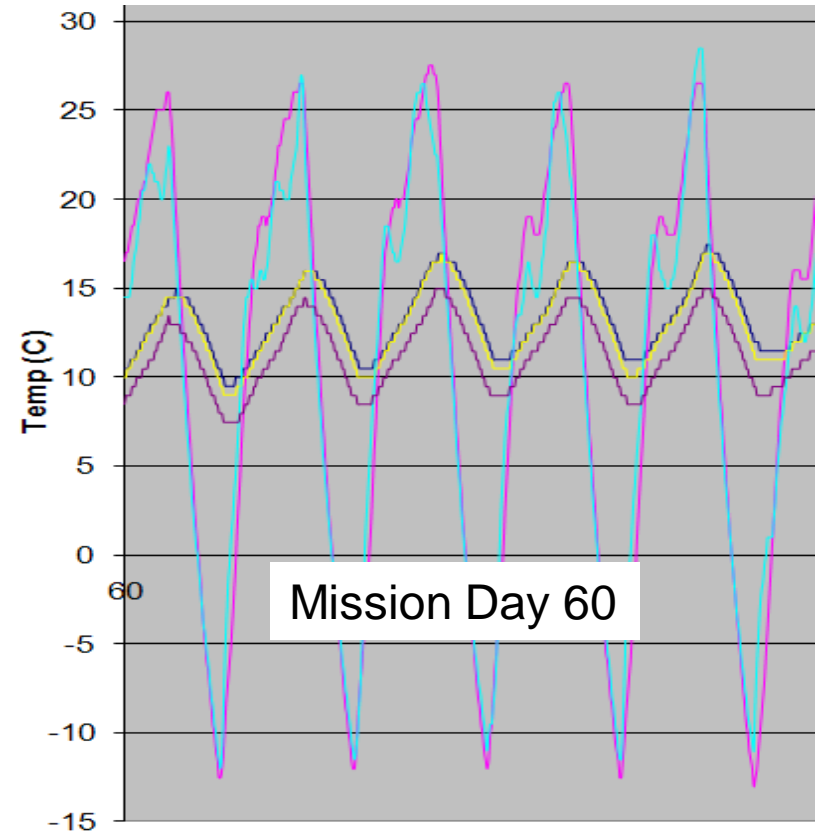
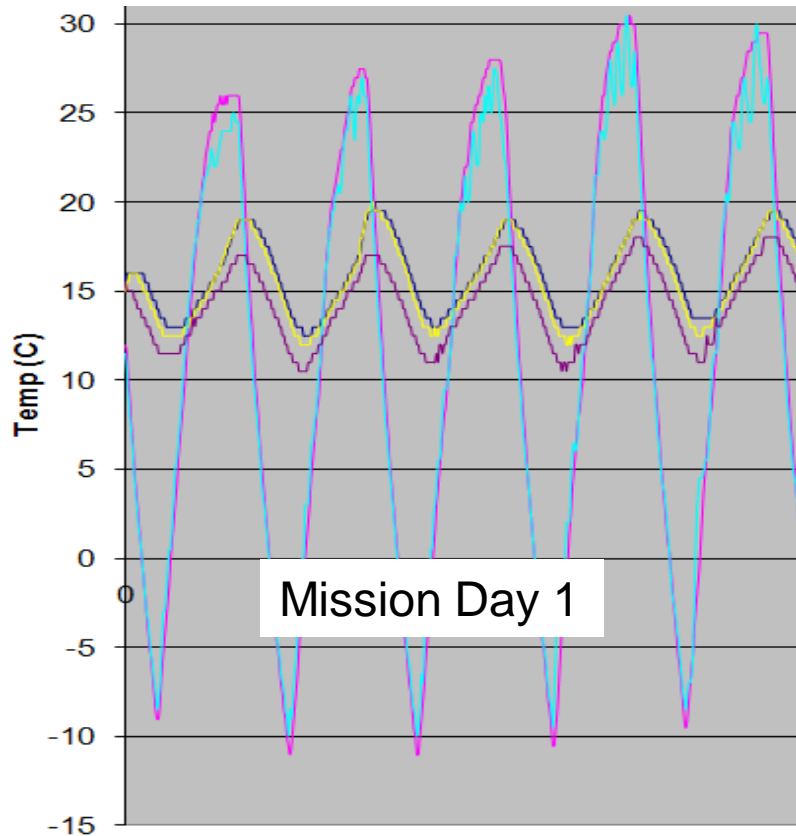
# AeroCube-3 Solar Up-converter at 0 and 60 days



–Yellow / Blue / Pink lines are solar array upconverted voltages

*No change in solar array performance in 60 days*

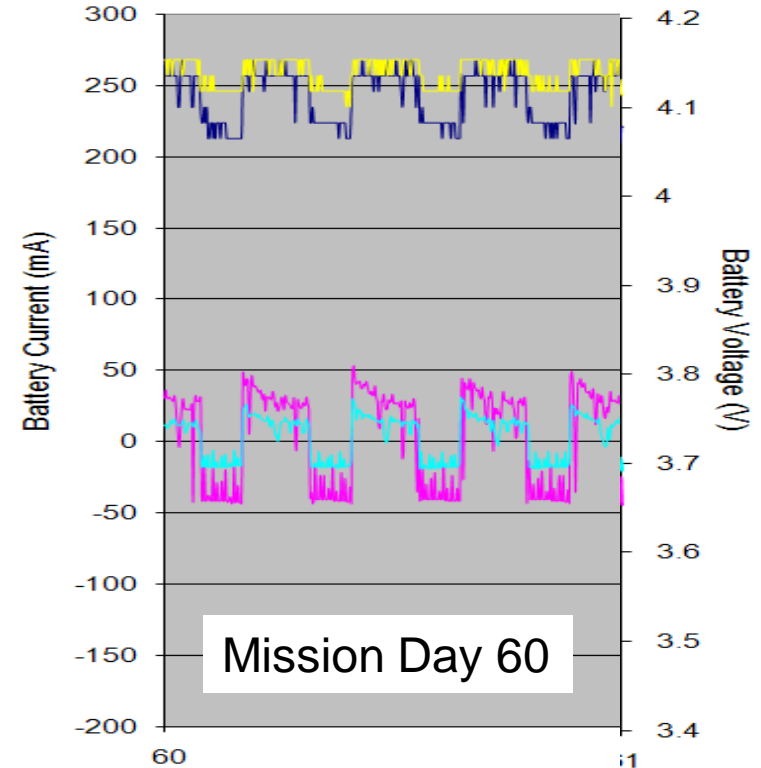
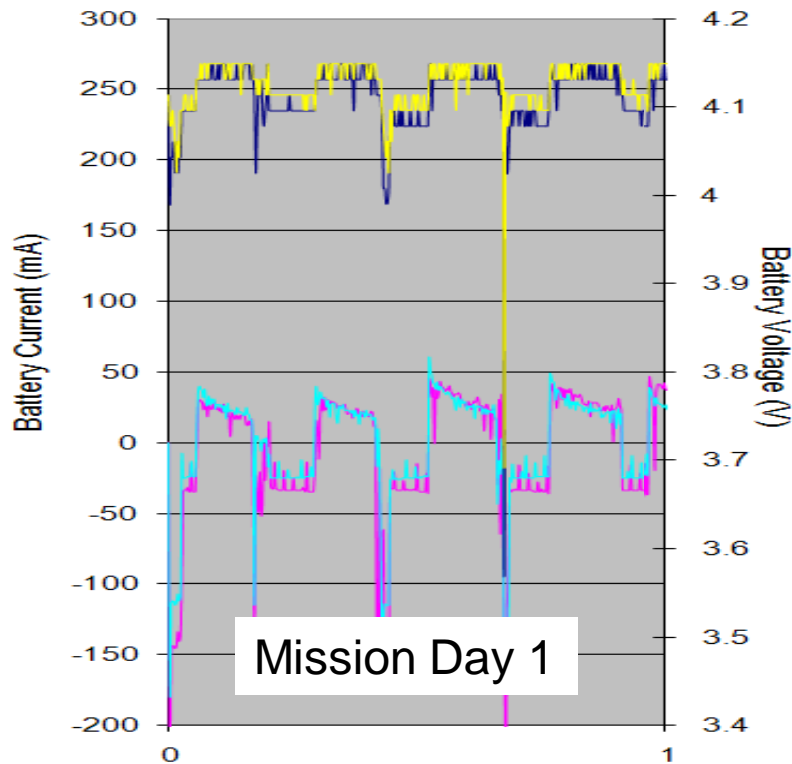
# AeroCube-3 Temperatures at 0 and 60 days



- Blue / Pink lines are temperature sensors located on 2 different exterior walls of AeroCube-3
- Yellow / Black / Purple lines are temperature sensors located on the electronics module

*Note that interior temperatures do not fluctuate as much by design*

# AeroCube-3 Battery Data at 0 and 60 days

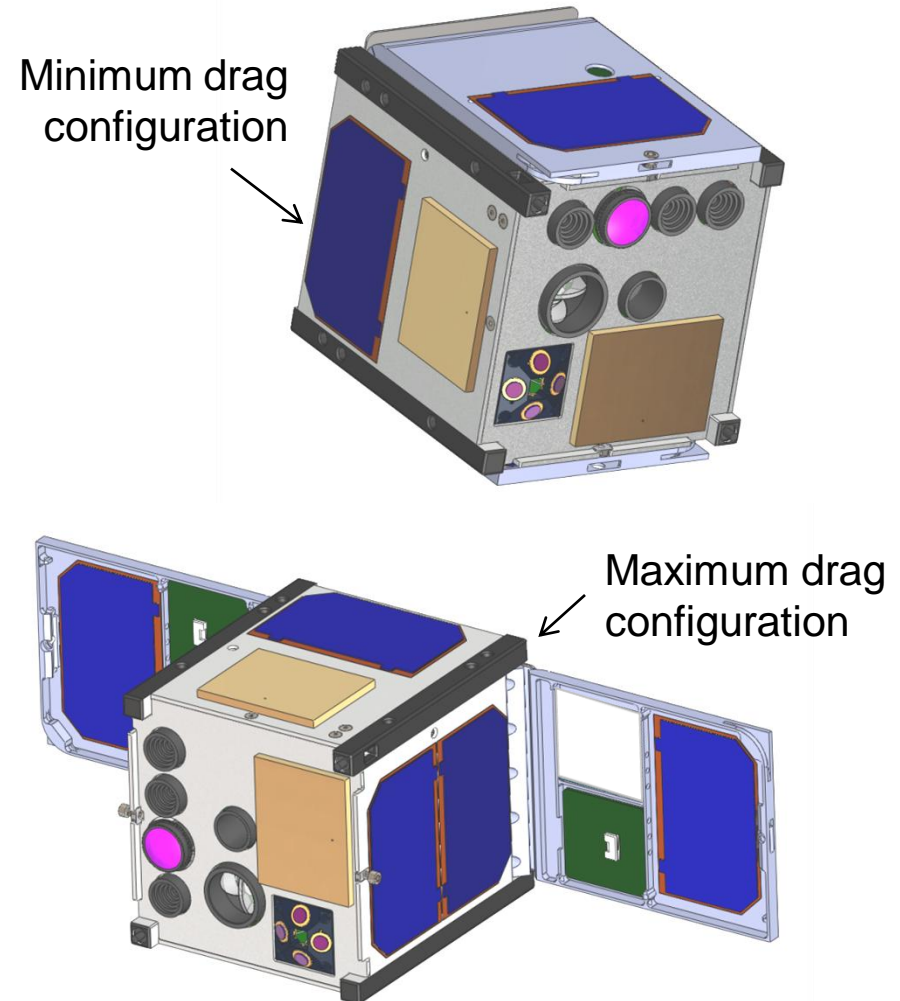


- Blue / Yellow lines are Battery 1 and Battery 2 voltages (V)
- Cyan / Pink lines are Battery 1 and Battery 2 currents (mA)

*No change in battery performance in 60 days*

# AeroCube-4 Preview

- Launch August 2012
- 60° inclination
- 470 x 780 km altitude
- 1U CubeSat form factor
- 1.3 kg mass
- 10 solar cells total
- Full attitude control
- Sun sensors
- Earth nadir sensor
- 1600x1200 cameras
- Adjustable wings for variable drag
- 2 ft dia x 1.5ft tall conical deorbit chute
- GPS
- Redundant radios
- Redundant software
- Reprogrammable on orbit
- Triax reaction wheels
- Triax torque coils



*Vast improvement in capability over AeroCube-3*

# Acknowledgements

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