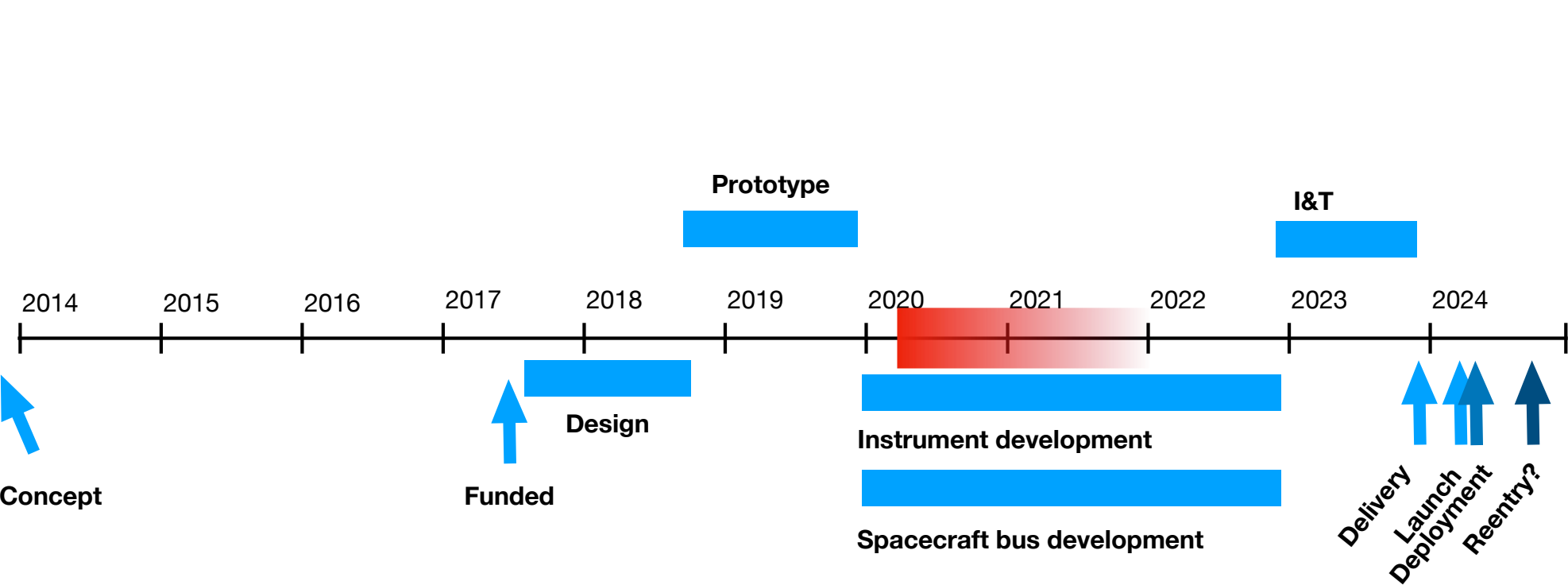
The background of the slide is a photograph of space. On the left, a large, complex array of solar panels is visible, with many small rectangular cells and a network of thin wires. In the center-right, a small satellite is floating, showing its solar panels and various instruments. In the top right corner, a white rectangular object with the word "Nanoracks" printed on it is visible. The bottom of the image shows the curved horizon of the Earth with a thin blue atmosphere and white clouds.

# BurstCube: Development and Status

Jeremy S. Perkins (NASA/GSFC)  
For the BurstCube Team  
September 13, 2024  
11th Fermi Symposium

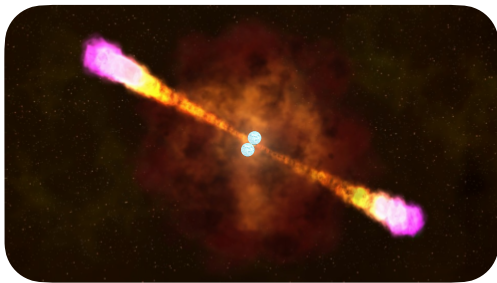
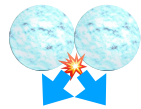


# Timeline

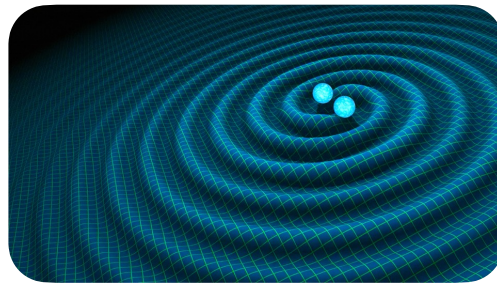


# The Multi-Messenger Connection

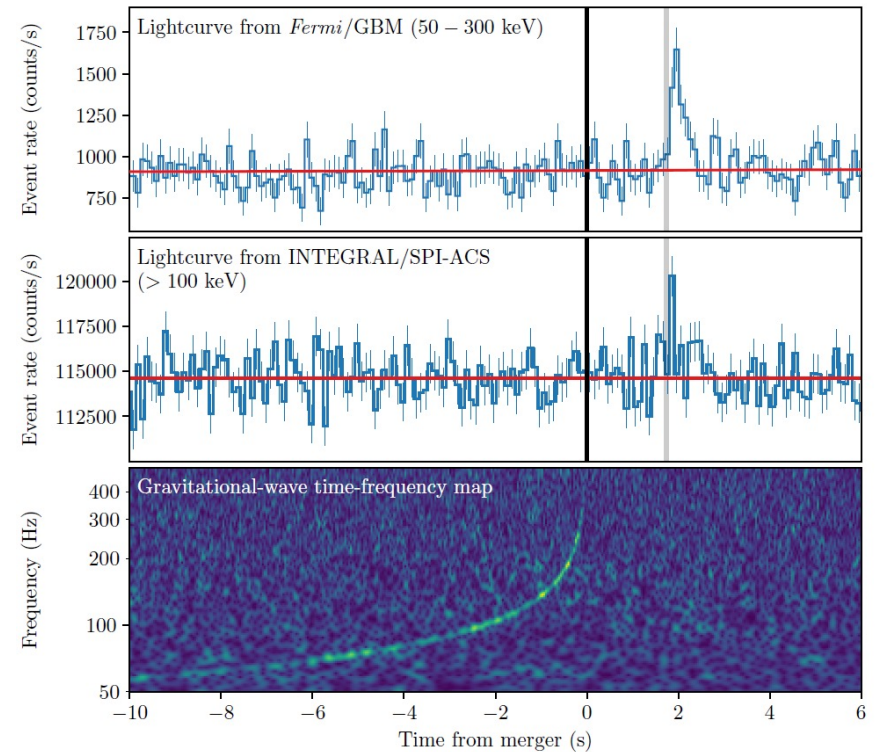
- Gamma-Ray Bursts (GRBs) are **short and intense** gamma-ray flashes
  - We are particularly interested in short GRBs ( $\sim 1$ s)
- The collision of two neutron stars result in two completely different types of messenger!
- GRB/GW 170817 remains the single joint observation to date.
- The gravitational wave network (LIGO-Virgo-KAGRA) is currently on its fourth observation run



Electromagnetic radiation

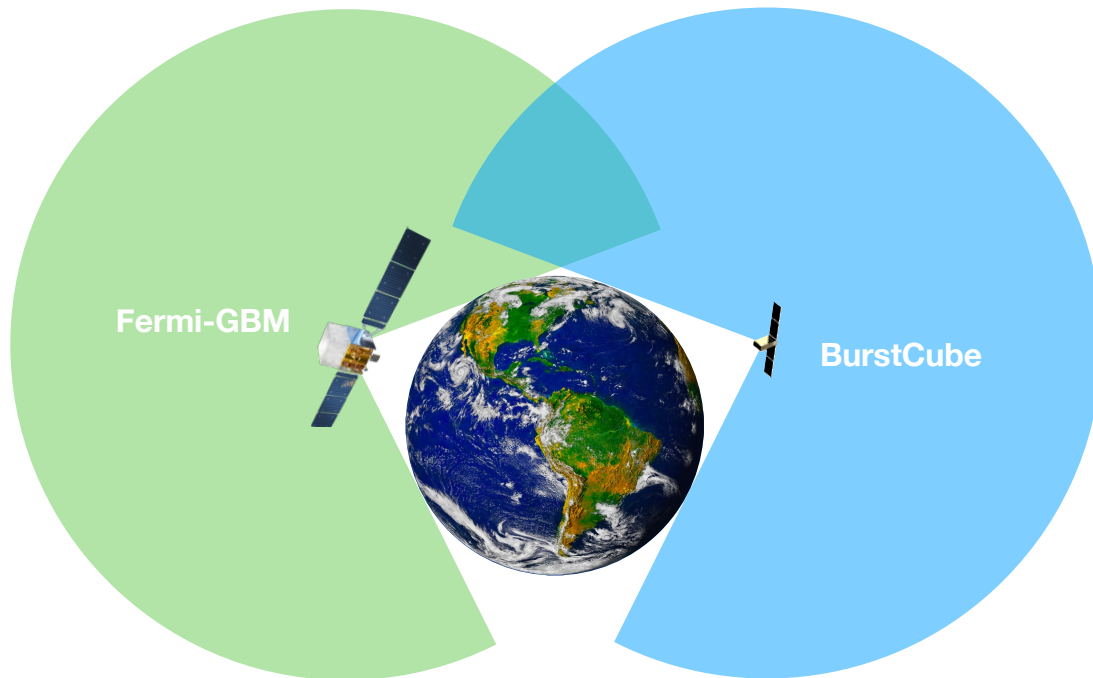


Gravitational waves

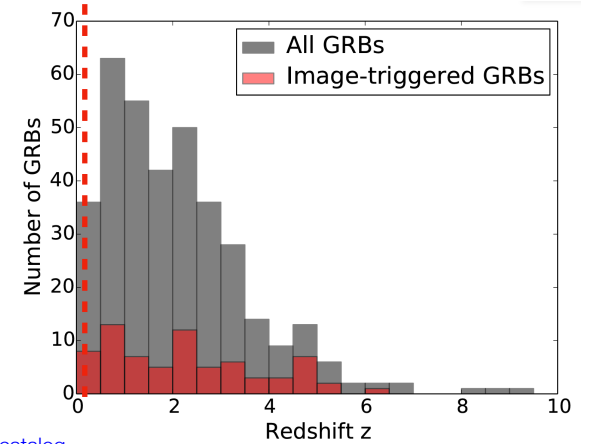


## The Need for BurstCube

- There are other GRB detectors, but large areas of the sky are not within the **field of view** of any mission.
- Using CubeSats, we can significantly increase the sky coverage by a small fraction of the cost, with high returns!
- Only nearby sources are detectable with gravitational waves, and therefore they are *likely* to be bright: a small missions is sensitive enough



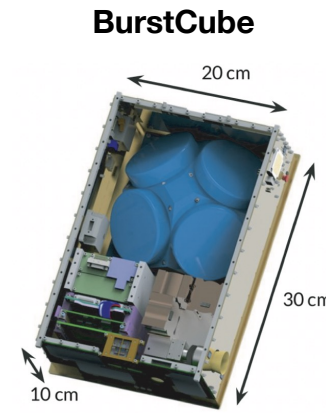
Gravitational waves  
detection horizon



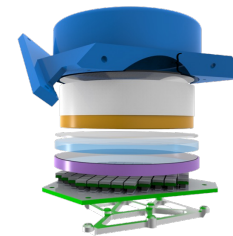
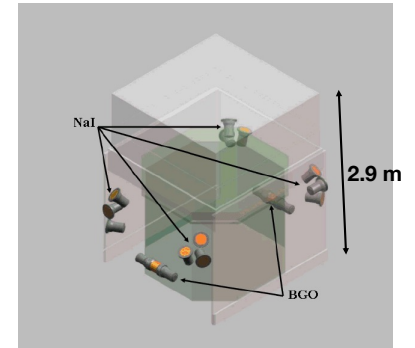
[Swift GRB catalog](#)

## The Cube in BurstCube

- CubeSats are small satellites that use **commercial off-the-shelf components**
  - Cheaper and faster to build
  - Unique opportunity for early-career professionals: a small team handles a full-fledged mission
  - With limited resources, there's less margin of error
- BurstCube is possible thanks to Silicon Photo-Multipliers (**SiPMs**)
  - Semiconductor technology (solid state)
  - Light, compact and power efficient
  - Comparable efficiency to traditional PMTs
- BurstCube is the first CubeSat using the Tracking and Data Relay Satellite System (**TDRSS**)

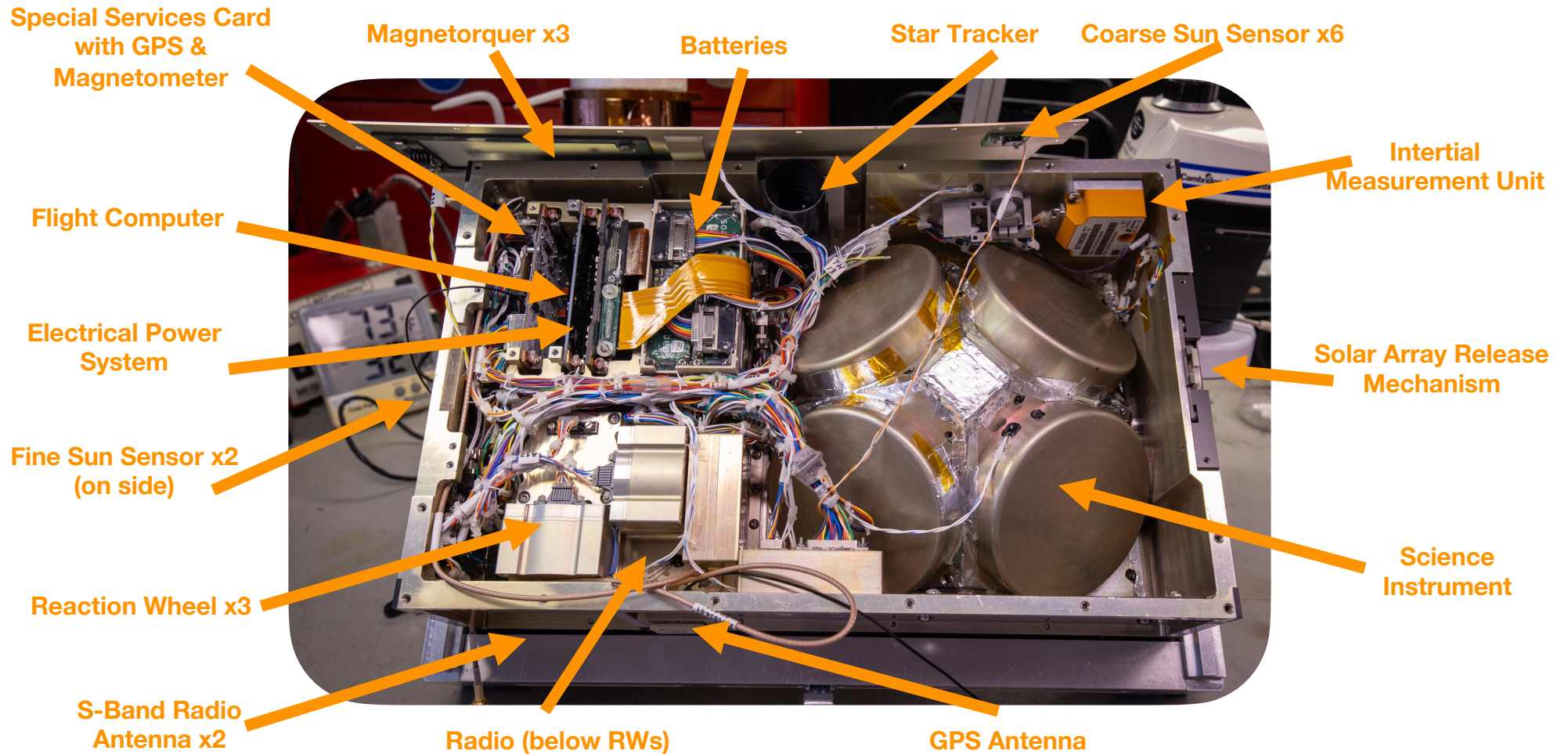


**Fermi-GBM (since 2008)**



# Integrated Spacecraft

SmallSats require all the components and I&T processes essential to larger missions.



# BurstCube Delivery



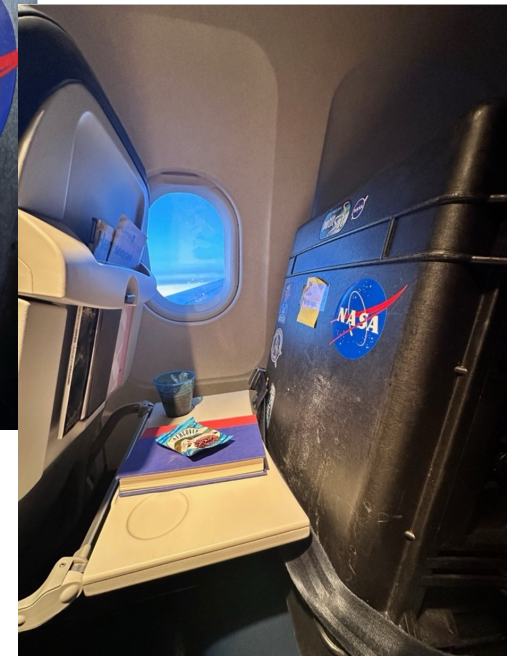
Departing Integration and Test Lab



Posing at the Airport



Reading the Safety Pamphlet



Having a Snack!



# BurstCube Launch and Status

- Launched to the ISS on 3/21 and Deployed on 4/18.
  - Contact 90 minutes after deployment (**first try**)!
  - TDRSS beacons report on health of mission every few hours (a first for a CubeSat)
- The instrument works **beautifully**
  - Needed to adjust the noise threshold resulting in a higher low energy threshold
  - Using ACROSS (<https://pcos.gsfc.nasa.gov/multimessenger/>) to selectively look for triggers from other missions.
- Released our **first GCN** on 8/29! (See next slide on why this was 'late')



An official website of the United States government [Here's how you know](#)

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### GCN Circular 37340

**Subject** GRB 240629A: First GRB Detected by BurstCube  
**Date** 2024-08-29T17:00:16Z (11 days ago)  
**From** Judith Racusin at NASA/GSFC <judith.racusin@nasa.gov>  
**Via** Web form

I. Martinez-Castellanos (GSFC/UMD/CRESST), A. Myers (GSFC/ORAU), D. Violette (GSFC/ORAU), L. Angellini (GSFC), J. Asercion (GSFC/ADNET), M. S. Briggs (UAH), R. Caputo (GSFC), J. Cox (GSFC), G. de Nolfo (GSFC), K. Gasaway (GSFC), S. Griffin (UWM), D. Hartmann (Clemson), B. A. Hristov (UAH), A. Joens (Berkeley), P. Nuessle (GSFC/GWU), J. S. Perkins (GSFC), J. Racusin (GSFC), S. Semper (GSFC), P. Shawhan (UMD), J. Smith (UAH), L. Tian (GSFC) on behalf of the BurstCube Team:

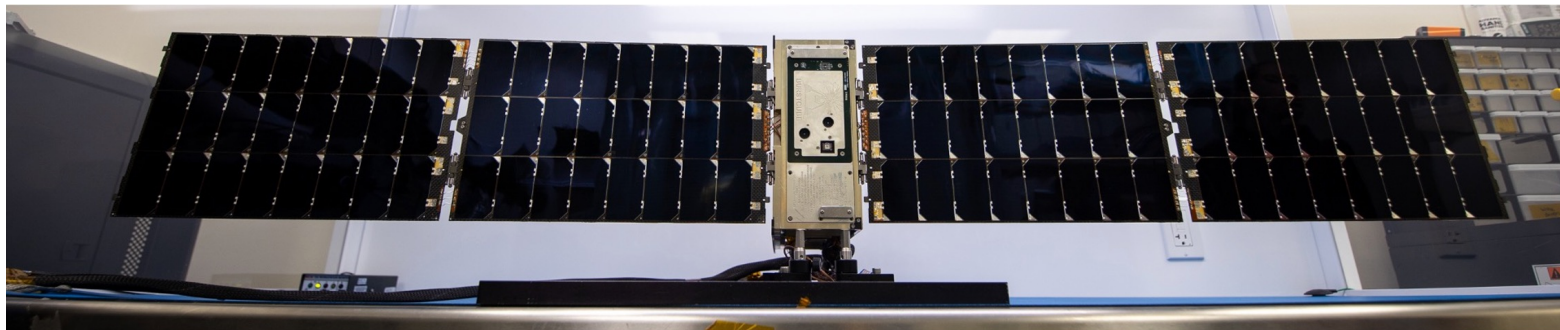
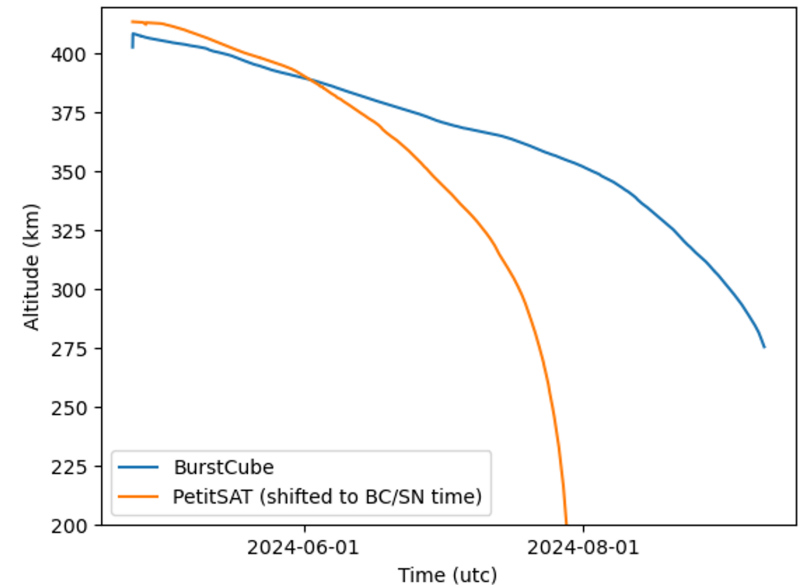
At approximately 16:53 UTC on 29 June 2024, BurstCube detected GRB 240629A, also seen by Fermi-GBM (GCN 36786) and SVOM (GCN 36805). The spacecraft reported time was 16:53:28 UTC, with an approximate offset of -25 s from the GBM trigger time, which we attribute to BurstCube's onboard clock uncertainty at the time of this data collection.

This is the first GRB detected by BurstCube in a ground analysis of downlinked commissioning data.

# BurstCube Challenges

- One solar panel failed to deploy
  - Covering the Star Tracker and a Course Sun Sensor
- Additional anomalies in Attitude Control System (ACS)
  - Only viable ACS mode is Sun-point (no 2-axis control)
  - Sun point → more drag → shorter mission lifetime
- Data throughput lower than expected

**All of these challenges have prevented us from consistently operating the instrument and distributing the data.**



## BurstCube Next Steps

- Operating the instrument **as much as possible**
- Downlinking as much of our **science data** as possible
  - Enable offline searches, instrument performance metrics, and other scientific/technical results
- Working to archive and **publicly release** all of the data
  - Will release the data prior to publishing scientific results.
- Developing a **full publication plan** - there is a lot to talk about.
  - Lessons learned, Mission Details, Instrument Performance, GRB results...



## The Team (Everyone That Has Ever Contributed)

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### **NASA GSFC (Greenbelt)**

Seth Abramczyk  
Naeem Ahmed  
John Anders  
Lorella Angelini  
Joe Asercion / **ADNET**  
Behnam Azimi  
Isabella Brewer / **ADNET**  
Alessandro Bruno / **CUA**  
Regina Caputo  
Nickalas Cason  
Brad Cenko  
Justin Clavette / **SSAI**  
Julie Cox  
Tom Dixon  
Georgia de Nolfo  
Jeff DuMonthier  
Kate Fowee Gasaway  
Benjamin Gauvain  
Leslie Hartz  
Miguel Hernandez / **Emergent**  
Jeanette Kazmierczak / **CRESST**  
Iker Liceaga Indart / **CUA**  
Hasnaa Khalifi  
Carolyn Kierans  
John Krizmanic

Paul Lestingi / **SSAI**  
Israel Martinez / **CRESST**  
Grant Mitchell  
Ava Myers / **NPP**  
Julie McEnery  
Robert Moss  
Benjamin Nold  
Jeremy Perkins (PI)  
Omar Quiñones  
Judy Racusin (DPI)  
Sophia Roberts / **AIMM**  
Dakotah Rusley  
Luis Santos  
Sean Semper  
Scott Starin  
George Suarez  
Teresa Tatoli / **CUA**  
Lucia Tian  
John Valliant  
Carlos Vazquez  
Dan Violette / **NPP**  
Dave Ward  
Dennis Wicks / **ASRC**

**BurstCube is funded by NASA/APRA**

### **NASA GSFC (IV&V)**

D. Cody Cutright / **TMC**  
Matthew Grubb / **TMC**  
John Lucas

### **NASA GSFC (WFF)**

Ted Daisey  
Pavel Galchenko  
Ian Hammer  
John Hudeck  
Chris Lewis

### **NASA MSFC**

Michael Briggs / **UAH**  
Boyan Hristov / **UAH**  
Michelle Hui  
Daniel Kocevski  
Jacob Smith / **UAH**  
Colleen Wilson-Hodge

### **Clemson U**

Dieter Hartmann

### **GWU**

Sylvain Guiriec  
Pi Nuessle

### **LSU**

Eric Burns

### **NRL**

Lee Mitchell

### **UC Berkeley**

Alyson Joens

### **UC Dublin**

Lorraine Hanlon  
Sheila McBreen  
David Murphy  
Alexey Uliyanov  
Sarah Walsh

### **UMD**

Peter Shawhan

### **USRA**

Adam Goldstein  
Oliver Roberts

### **U Virgin Islands**

Antonino Cucchiara  
David Morris

### **UW Madison**

Sean Griffin

