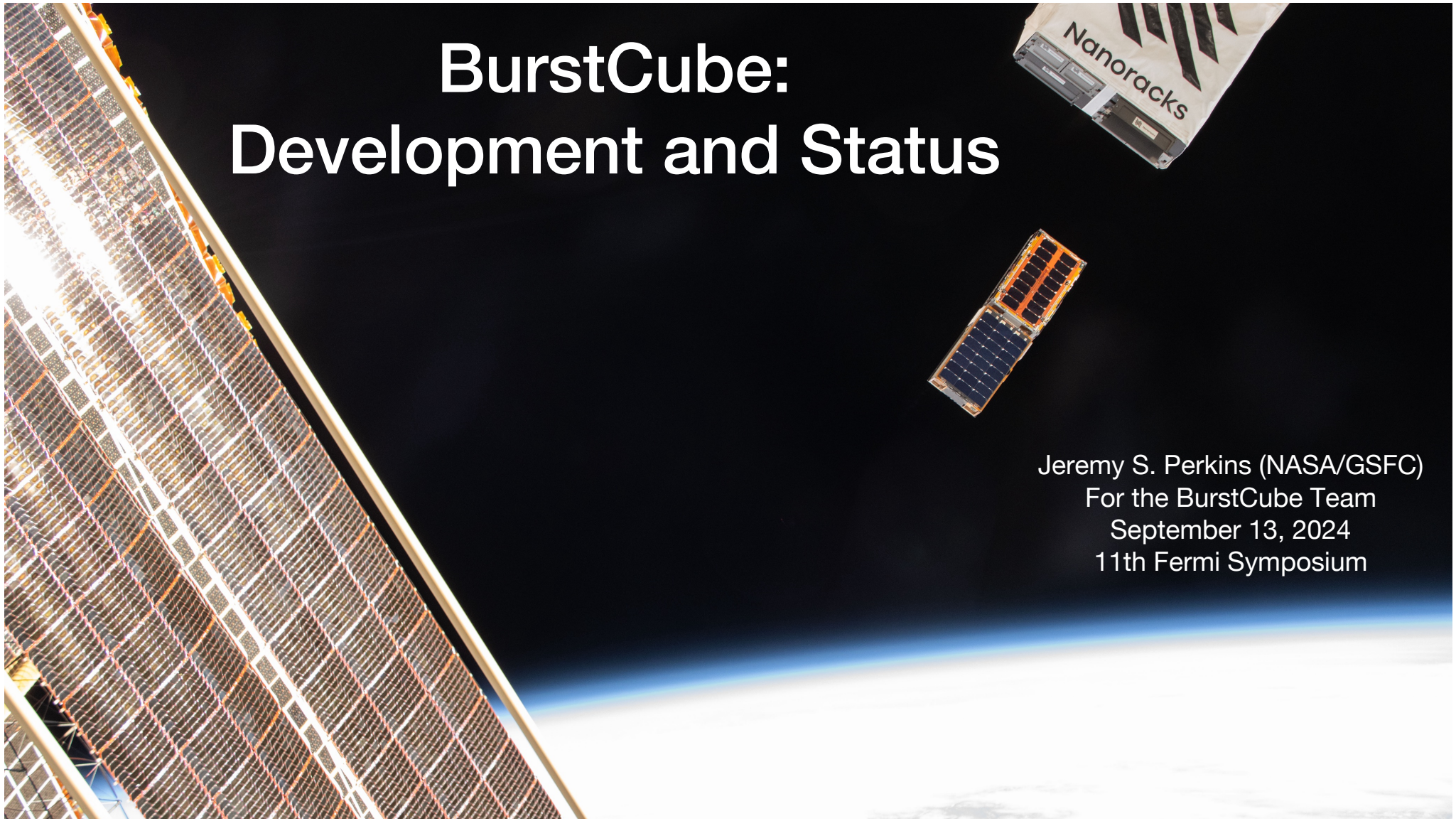
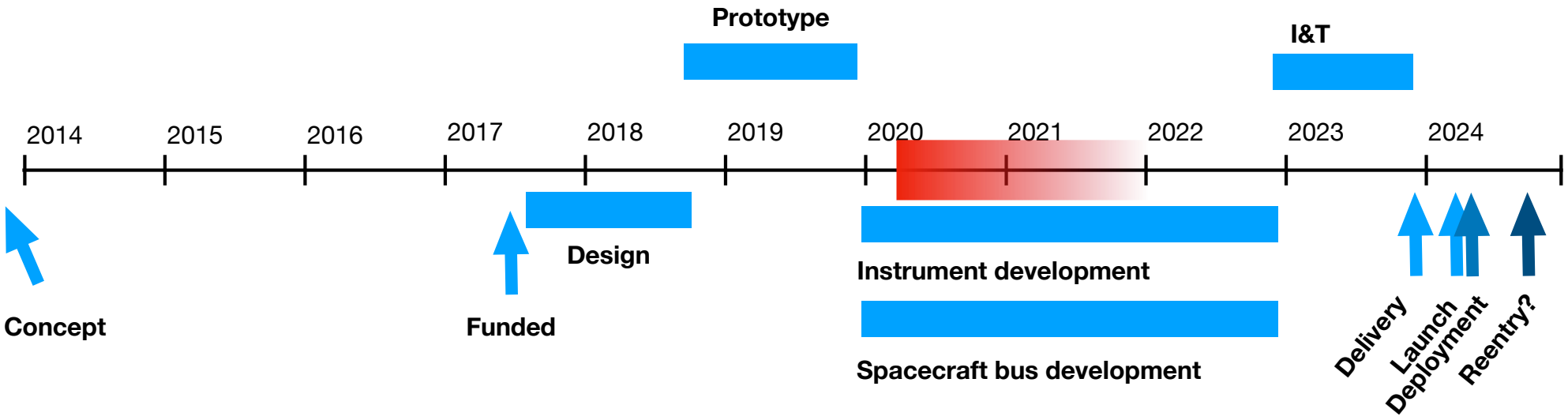
BurstCube: Development and Status



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

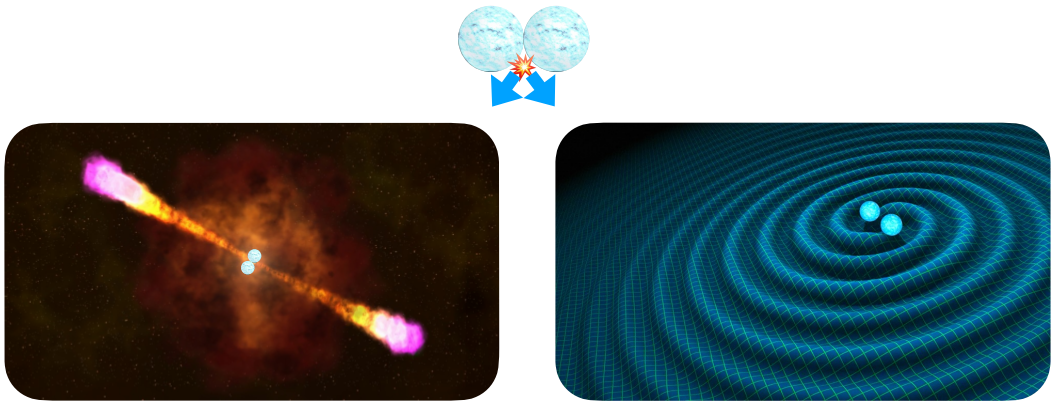

Nanoracks

Timeline


Prototype
I&T
2014
2015
2016
2017
2018
2019
2020
2021
2022
2023
2024
Design
Concept
Funded
Instrument development
Spacecraft bus development
Delivery
Launch Deployment
Reentry?

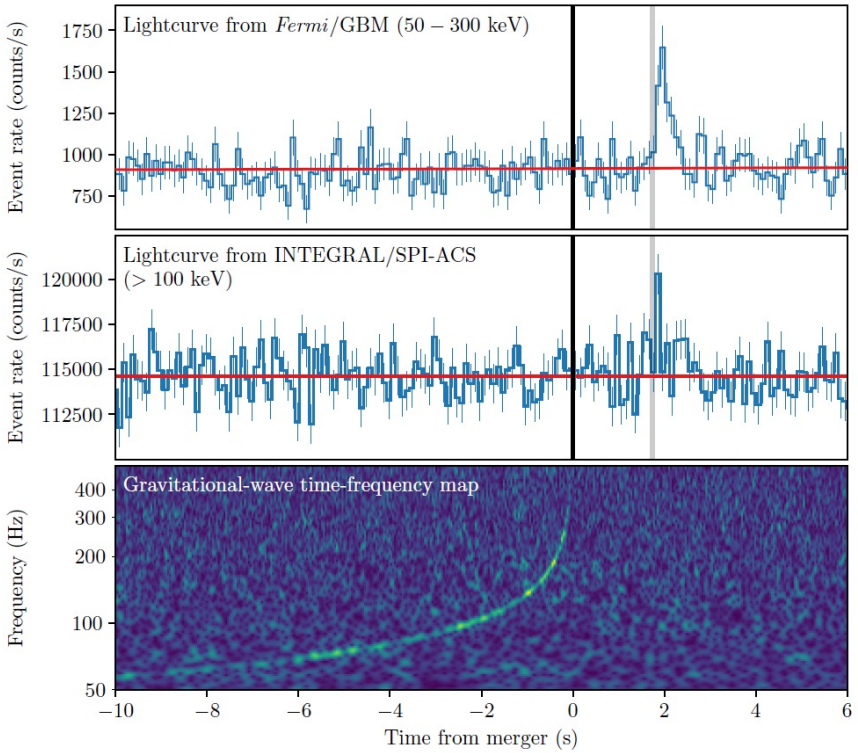
The Multi-Messenger Connection

- Gamma-Ray Bursts (GRBs) are **short and intense** gamma-ray flashes
  - We are particularly interested in short GRBs (~1s)
- 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



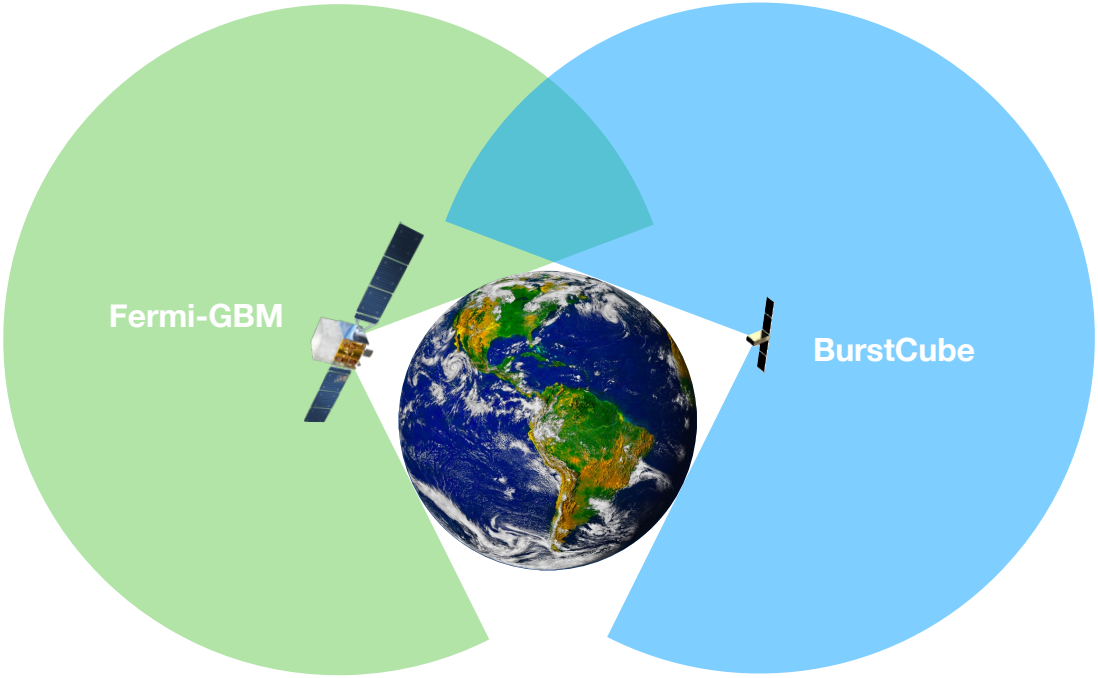
Electromagnetic radiation

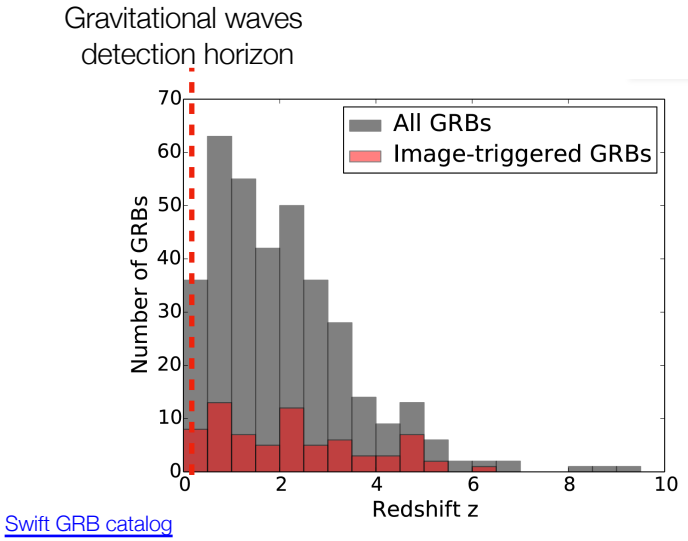
Gravitational waves



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



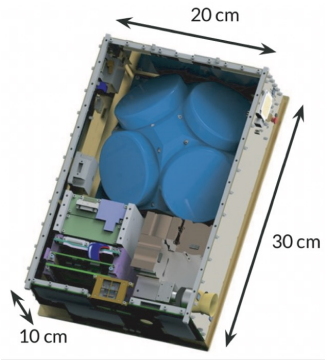


Swift GRB catalog

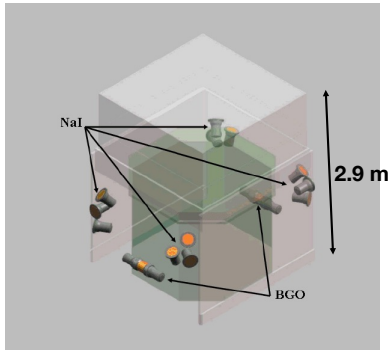
The Cube in BurstCube

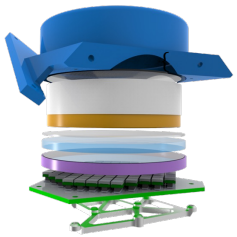
- CubeSats are small satellites that use **commercial off-the-shelf components**
  - Cheaper and faster to build
  - Unique opportunity for early-career professionals: a small team handles a full-fledged mission
  - With limited resources, there's less margin of error
- BurstCube is possible thanks to 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**)

BurstCube



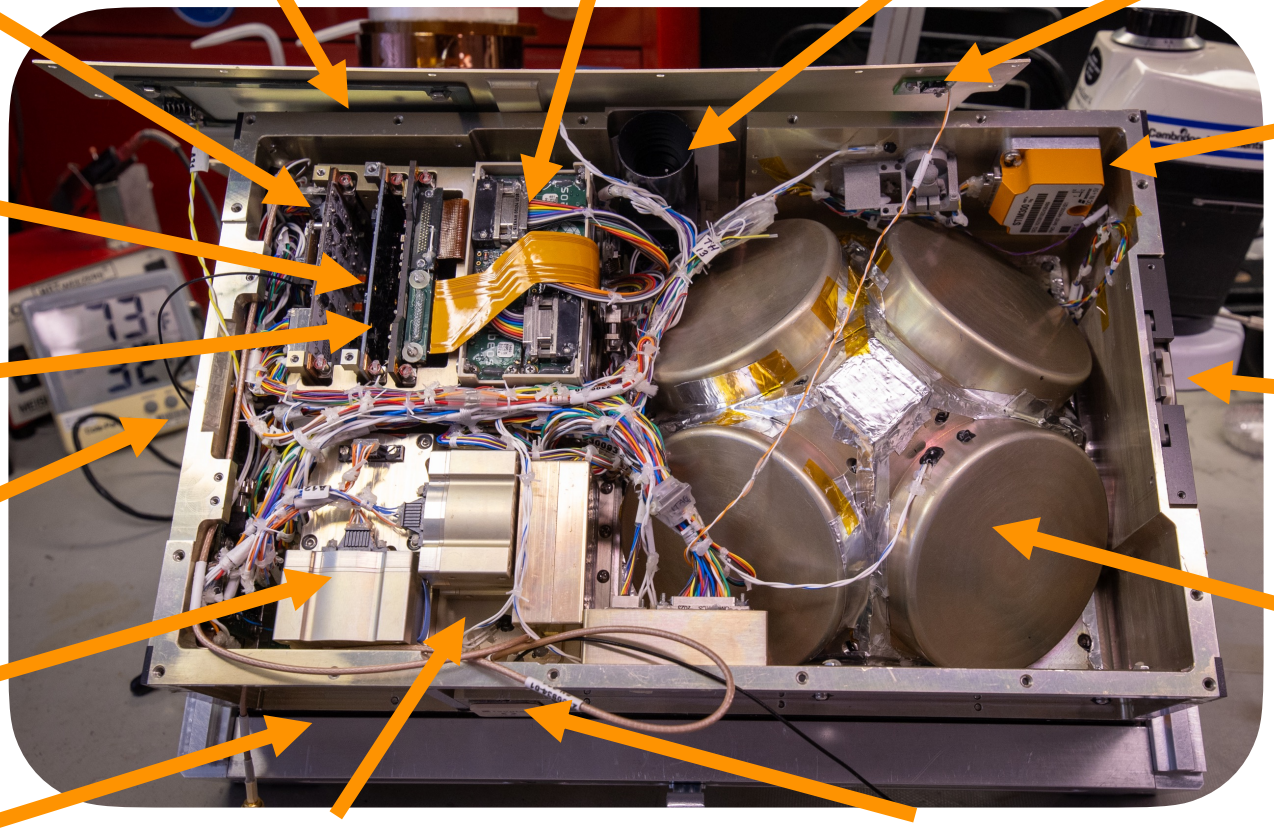
Fermi-GBM (since 2008)





Integrated Spacecraft

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



BurstCube Delivery

Departing Integration and Test Lab

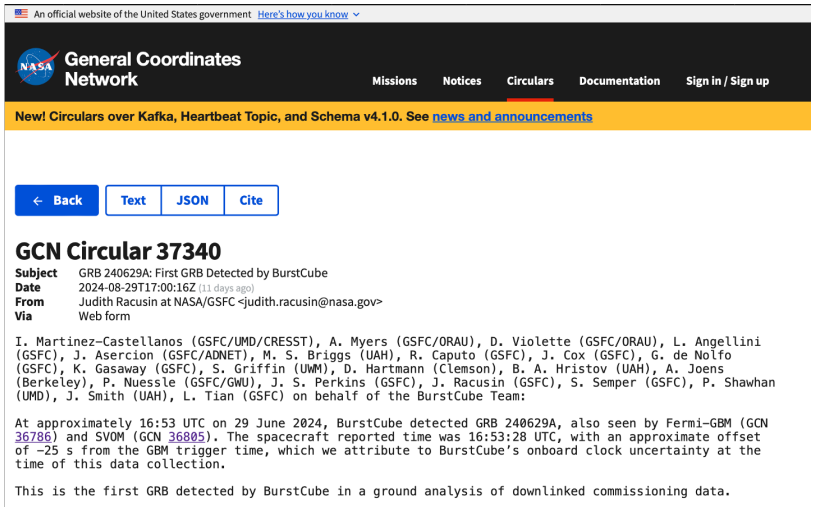
Posing at the Airport

Reading the Safety Pamphlet

Having a Snack!

BurstCube Launch and Status

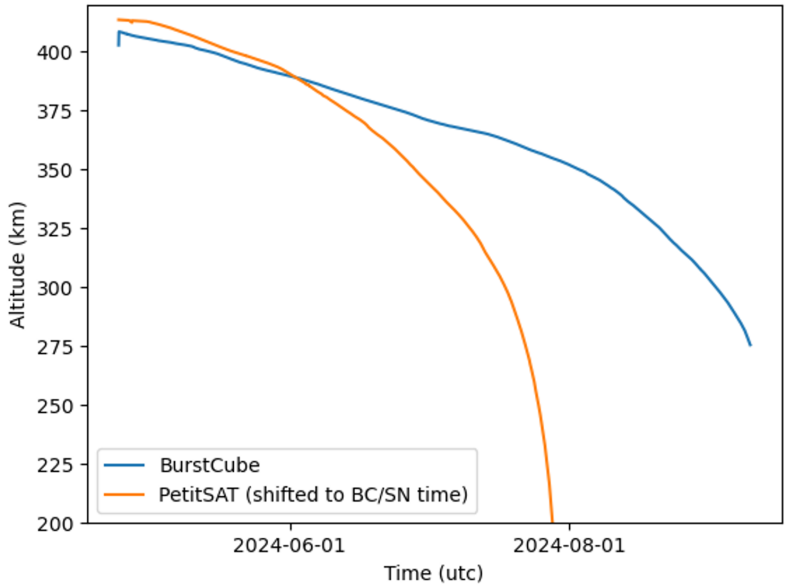
- Launched to the ISS on 3/21 and Deployed on 4/18.
  - Contact 90 minutes after deployment (**first try**)!
  - TDRSS beacons report on health of mission every few hours (a first for a CubeSat)
- The instrument works **beautifully**
  - Needed to adjust the noise threshold resulting in a higher low 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')

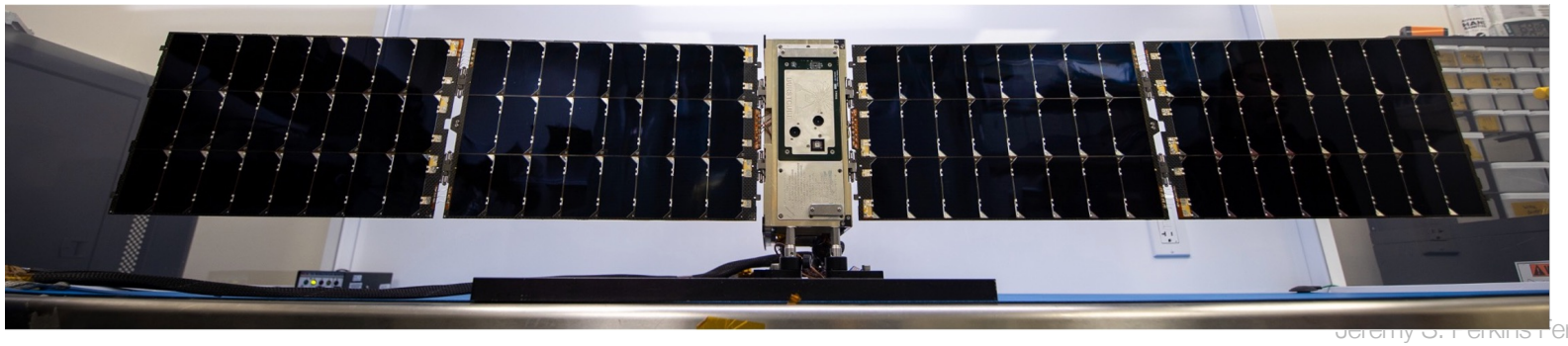


BurstCube Challenges

- One solar panel failed to delploy
  - 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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