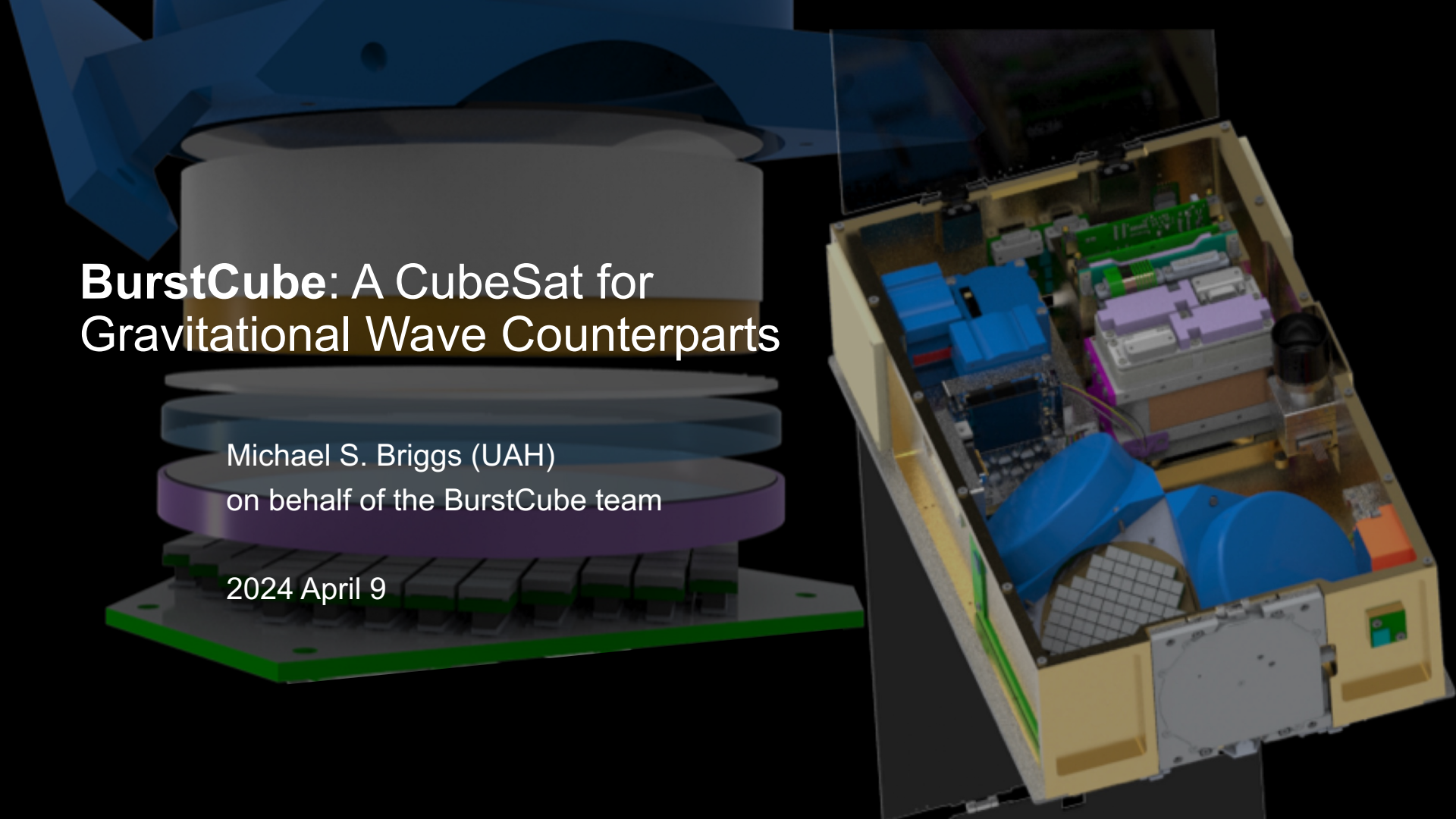
BurstCube: A CubeSat for Gravitational Wave Counterparts

Michael S. Briggs (UAH)
on behalf of the BurstCube team

2024 April 9



BurstCube Team

PI: Jeremy Perkins (NASA/GSFC)

Website: https://asd.gsfc.nasa.gov/burstcube/

Clemson
Dieter Hartmann

CRESST/GSFC
John Krizmanic
Israel Martinez

CUA/GSFC
Alessandro Bruno
Teresa Tatoli

Delaware
Isabella Brewer

GWU
Sylvain Guiriec
Alyson Joens
Grant Mitchell
Pi Nuessle

NASA/MSFC
Michelle Hui
Daniel Kocevski
Colleen Wilson-Hodge

LSU
Eric Burns

NASA/GSFC
Regina Caputo
Brad Cenko
Georgia de Nolfo
Carolyn Kierans
Julie McEnery
Judith Racusin

NRL
Lee Mitchell
Jacob R. Smith

UAH
Michael Briggs
Boyan Hristov

UCD
Lorraine Hanlon
Sheila McBreen
David Murphy
Alexey Uliyanov
Sarah Walsh

UMD
Peter Shawhan

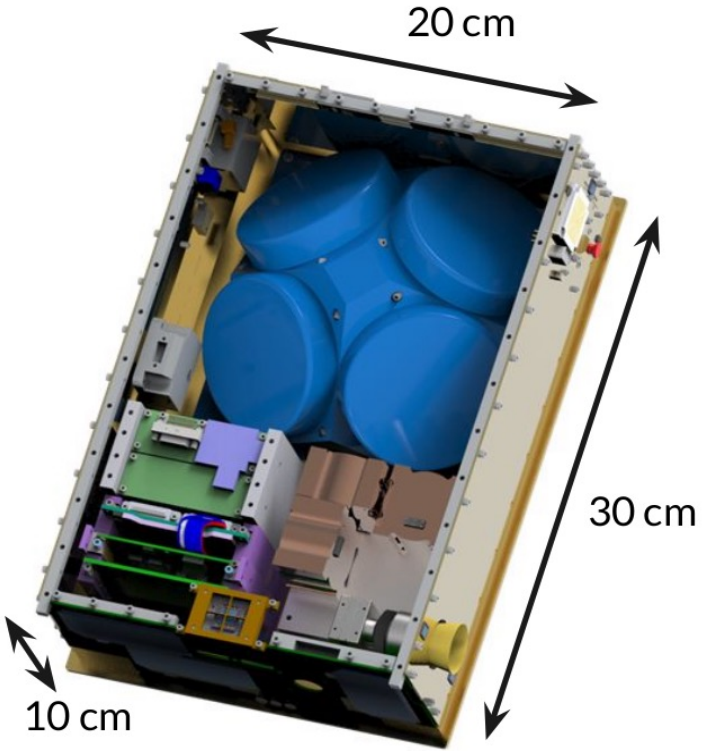
USRA
Adam Goldstein
Oliver Roberts

UVI
Antonino Cucchiara
David Morris

Wisconsin
Sean Griffin

Overview

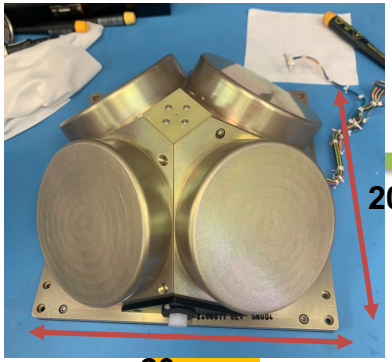
- 6U CubeSat with the **primary science goal to detect, localize, and characterize short gamma-ray bursts** (SGRBs)

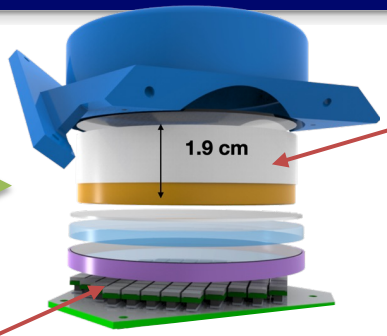


BurstCube Science

- Low earth orbit
- BurstCube will **detect** GRBs from the **entire unocculted sky**
  - Broadband spectra
  - Rough localizations for follow-up
  - Accurately timed light curves
- BurstCube will also **detect solar flares, magnetar flares,** and other **transients.**
- Combined with Fermi and Swift, BurstCube will provide all-sky coverage for a **small fraction of the cost** of an Explorer mission

BurstCube Instrument

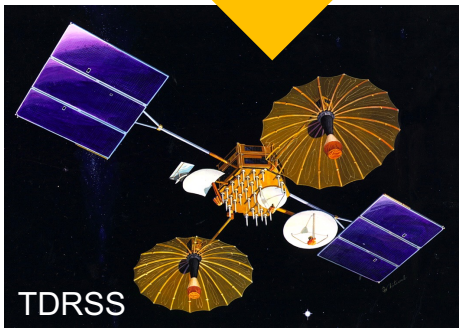




CsI(Tl) Scintillator Crystal

Silicon Photomultipliers (SiPMs)

Energy range: ~50 keV- 1 MeV



NEN

Science Data: Once Daily (NEN)
Alert Data: Instantaneous (TDRSS)

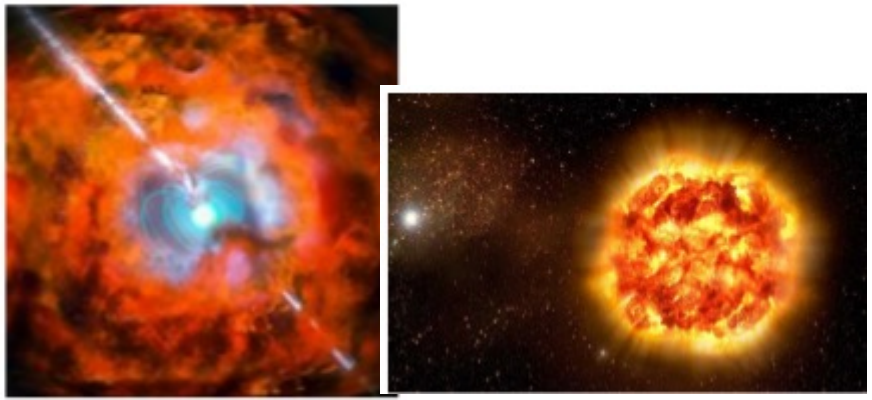
Mission Performance

Energy range: ~50 keV - 1 MeV

Energy resolution: 10% at 662 keV

Field of View: ~50% of the sky (instantaneous)

BurstCube:
SGRBs: ~20 per year
LGRBs: >100 per year
GBM:
SGRBs: ~40 per year
LGRBs: ~200 long per year



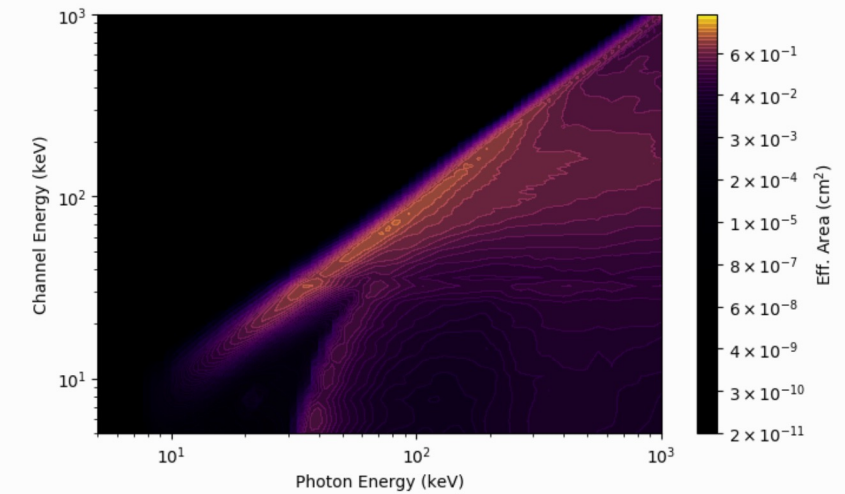
Data products

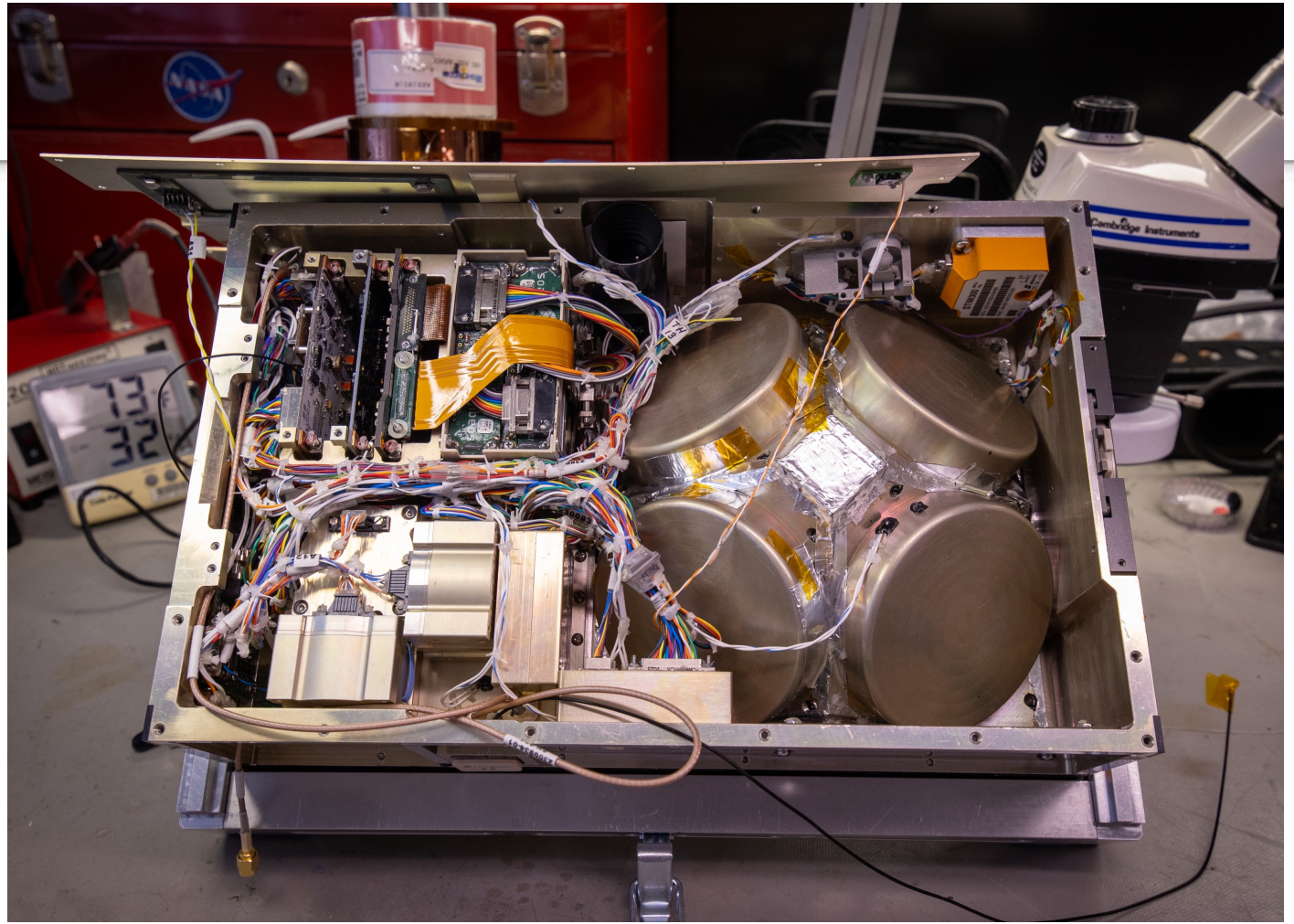
- Various data products
  - Binned and event data
  - Public immediately upon processing
- Requested time-tagged event data, including by community request

Datatype	Latency	Type	Energy Channels	Time Resolution	Time Coverage
ATD	~15 min	Trigger	16	50 ms to 2 s	-60 to +60 s
T^3E	~1 day	Trigger	1024	10 μs	-30 to 100 s
RTTE	~1 day	Requested	1024	10 μs	requested
CBD	~1 day	Continuous	16	256 ms	continuous

Analysis software: bc-tools

- Detector-agnostic API for counting gamma-ray instruments
- Will allow for
  - Data processing
  - Localization
  - Detector response generation
  - Data binning and light curve generation
  - Spectral fitting
- Built on top of GBM Data Tools
  - Python library developed to analyze GBM data
- Open source: https://gitlab.com/burstcube/bc-tools





https://svs.gsfc.nasa.gov/gallery/cube-sats/

Credit: NASA/Jeanette Kazmierczak

Current Status

- Launched March 21st to the ISS.
- Deployment expected ~April 18th.
- Short checkout period, then science operations.
- BurstCube data will be public at the HEASARC, along with the bc-tools
- Event data can be requested (RTTE)


SEPTEMBER 9-13, 2024
COLLEGE PARK, MARYLAND, USA
11TH INTERNATONAL
FERMI SYMPOSIUM
Topics include Gamma-ray Studies of:
• Supernova Remnants and Pulsar Wind Nebulae
• Gamma-ray Bursts and Other Transients
• Blazars and Other Galaxies
• Future Missions and Instruments
• Multimessenger Sources
• Other Galactic Sources
• Diffuse Emission
• Solar System
• Dark Matter
• Pulsars
Important Dates
• Abstracts Due – May 1, 2024
• Registration Deadline – August 1, 2024
fermi.gsfc.nasa.gov/science/mtgs/symposia/eleventh/

Backup slides...

BurstCube Detector Overview

Thin Aluminum housing that is transparent to gamma-rays

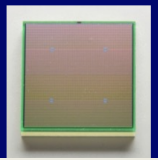
CsI Crystal that converts gamma-rays into scintillation light (550nm).

Quartz window allows scintillation light to escape (the inside of the can is covered in a diffusively reflective material)

Silicon Photo-Multiplier (SiPM) Arrays convert light into electrical signals.

SiPM arrays are mounted to the Instrument Detector Analog Board (IDAB) which sums the signals. A single analog signal (hit) comes out of a detector indicating a single photon interaction. The signal amplitude is proportional to the energy of the gamma-ray.

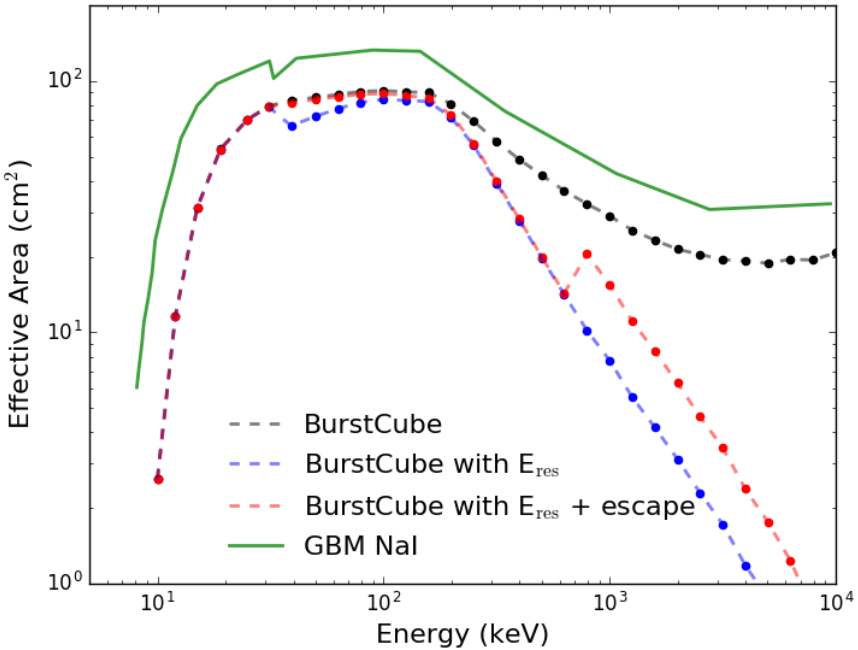
CsI Crystal



6mm Hamamatsu SiPM

Mission Performance-Effective Area

Effective area is 70% that of the larger GBM NaI detectors at 100 keV and 15 degree incidence



See: Jeremy S. Perkins et al. http://dx.doi.org/10.1117/12.2562796

Calibrations

- Calibration Campaigns:
  - Flight spare
  - Instrument
  - Observatory

- Instrument Properties:
  - Channel-energy relationship
  - Energy and angular dependent detector response
  - Effective area
  - Energy range and resolution