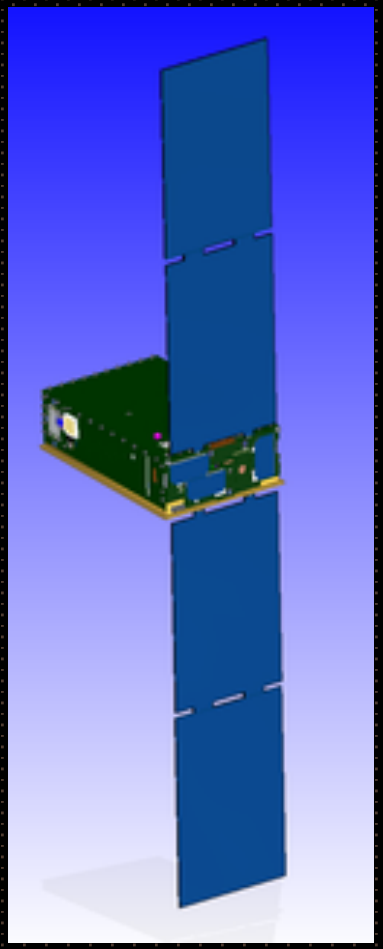
BurstCube: A CubeSat for Gravitational Wave Counterparts

Carolyn Kierans for Judy Racusin (NASA/GSFC)

on behalf of the BurstCube Team

12th INTEGRAL Conference



BurstCube Team

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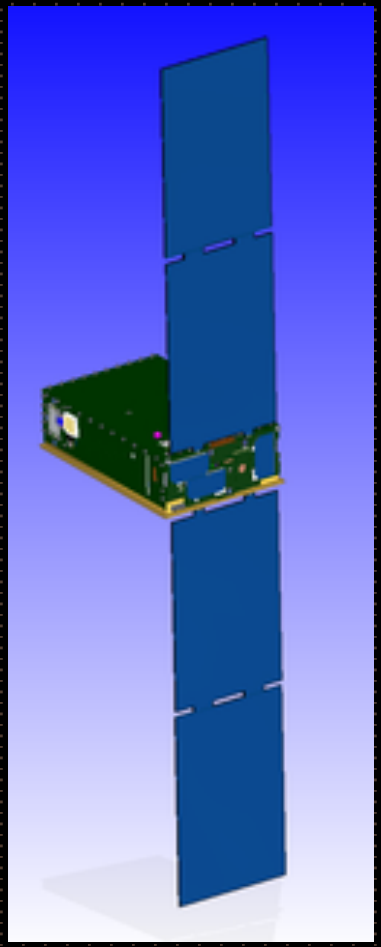
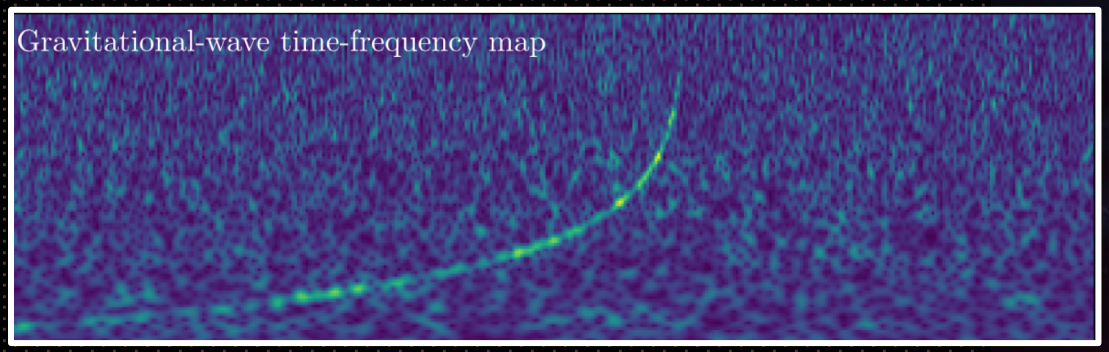
BurstCube Overview

- **6U CubeSat** designed to detect and characterize short gamma-ray bursts (sGRB)
- Detectors: **four CsI scintillators** coupled with arrays of compact low-power Silicon photomultipliers (**SiPMs**)
  - Energy range: 30(50) keV - 1(2) MeV
- Spacecraft: based on NASA/GSFCs 6U platform with many commercially-off-the-shelf components
- Complement existing/future facilities (Swift, Fermi/GBM, Glowbug, MoonBEAM, GRID, Nimble, Bia …)
  - **interim GRB instrument** before next generation missions fly
- BurstCube is funded, in the design phase, ready to **launch late 2021**
  - 6 month mission (1 year goal)



BurstCube Science I: GW Counterparts

- The recent coincident detection of GRB 170817A/GW170817 has provided concrete proof that at least some sGRBs are produced by binary neutron star mergers.
- BurstCube will increase the sky coverage for short (<2 s) GRBs, especially important in the era of GW discoveries.
- Advanced GW Network will reach design sensitivity in early 2020's

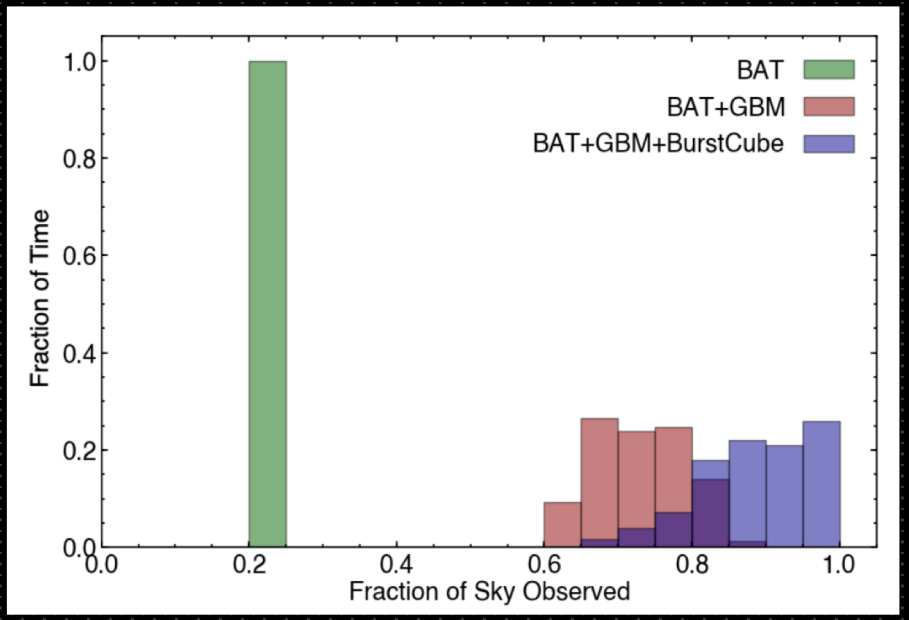


BurstCube Science II: General

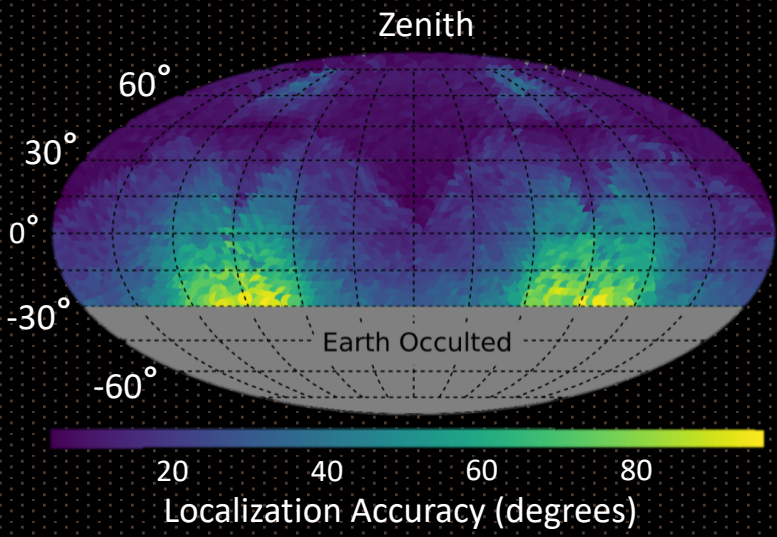
- BurstCube will detect GRBs from the **entire unocculted** sky
  - Broadband spectra
  - Rough localization for follow-up
  - Accurately timed light curves
- BurstCube will also detect **solar flares**, **magnetar flares**, and **other hard X-ray transients**, as well as persistent sources via occultation analysis
- On its own, BurstCube could provide all-sky coverage for a **small fraction of the cost** of an Explorer.

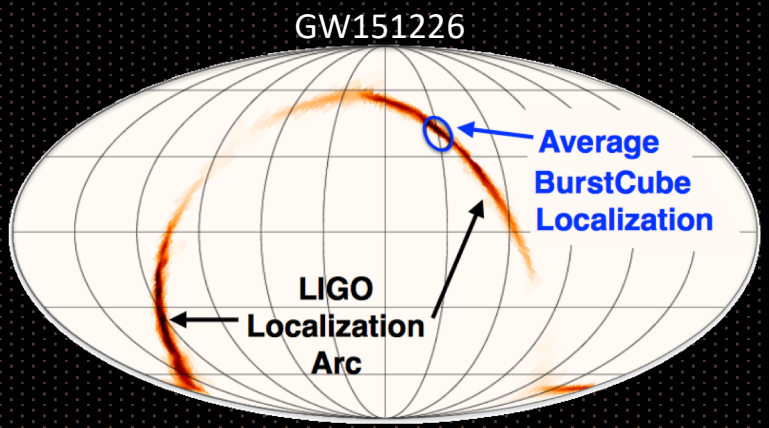
BurstCube Mission I: Concept

- BurstCube will **detect**, roughly **localize**, and **characterize** GRBs
- This approach is **complementary** to existing or upcoming facilities (e.g. Swift, Fermi/GBM, Glowbug, MoonBEAM, GRID, Nimble, Bia …)
  - Especially if there is a gap between GRB missions operating at the peak of the GW observatory operations.
- Pioneer **low cost**, wide field-of-view **monitoring** of short GRBs.



BurstCube Mission II: Localizations

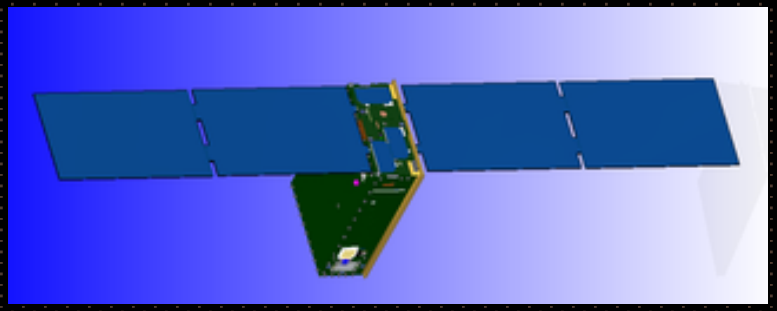


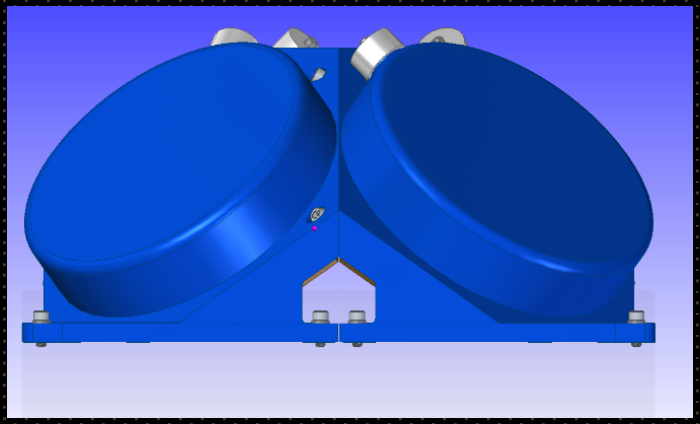


- Enable wide-field follow-up observers in afterglow detection and redshift measurement.
- Will lead to:
  - additional insight into cosmological parameter estimation,
  - constraint on the neutron star equation of state, and
  - an inventory of r-process elements in the Universe constrained by the faint short GRB kilonova signature (seen in the most recent event).

BurstCube Mission III: Implementation

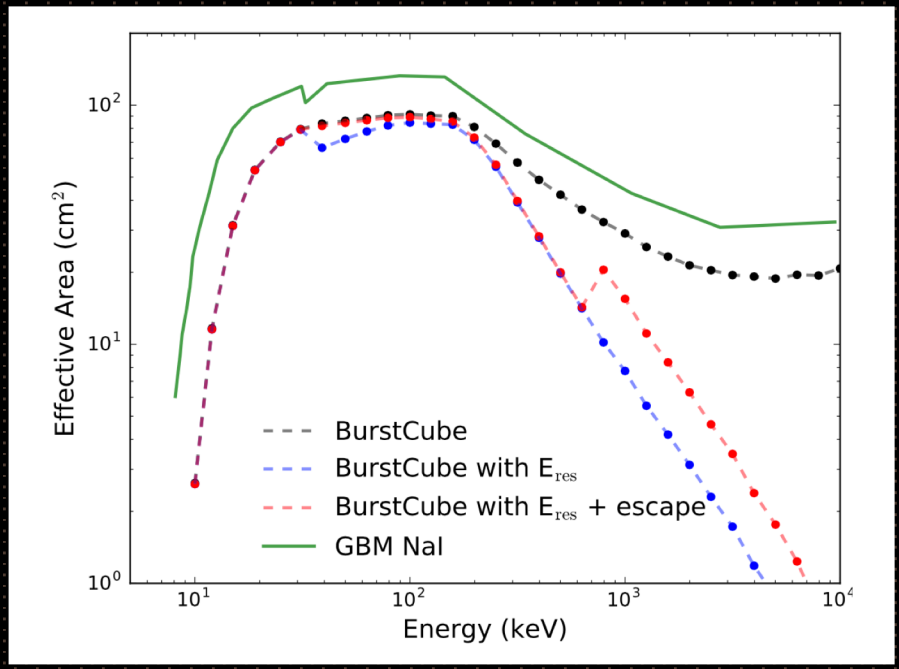
- BurstCube is a 6U CubeSat
  - Deployable Solar Panels & Full ACS
  - 10 cm x 20 cm x 30 cm
- Instrument Package
  - 4 CsI scintillator crystals coupled to arrays of low-power SiPMs with custom electronics
  - 9 cm diameter, 1.9 cm thick
- Zenith/sun pointing
- BurstCube will relay data to the ground via TDRSS
  - 5-15 minute goal
- The instrument hardware and flight software has strong heritage from Fermi-GBM.





BurstCube Mission IV: Performance

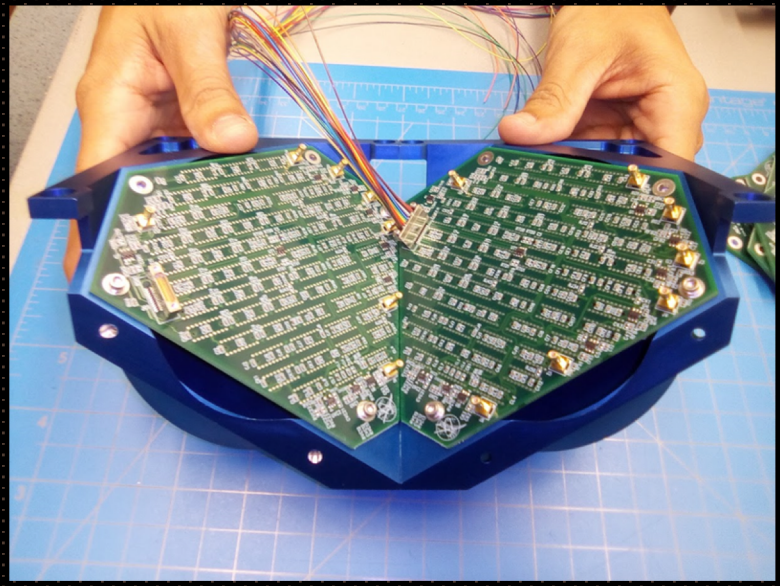
- **Continuous science** operations (except SAA)
- Expected detection of **~25 sGRBs/year**
- Expected detection of **>100 long GRBs/yr** in addition to other gamma-ray transients (solar flares, SGRs, etc.)
- Localizes GRBs based on relative detector intensities
- BurstCube has **competitive performance** with Fermi/GBM

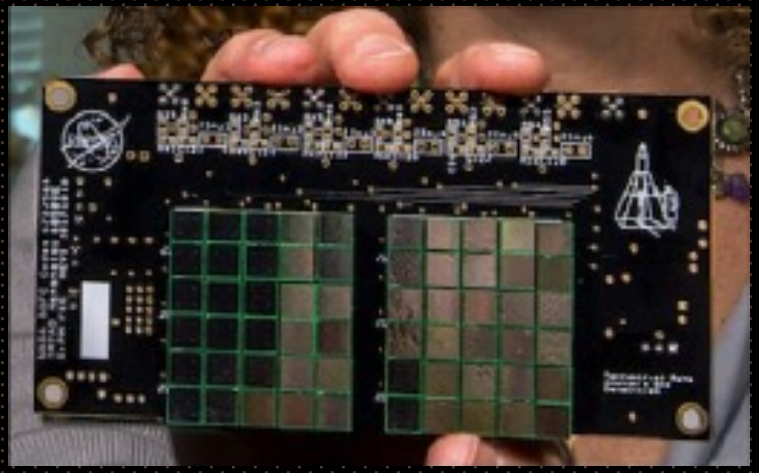


Effective area is 70% that of the larger GBM NaI detectors at 100 keV and 15 degree incidence (MEGAlib based sims)

BurstCube Updates

- Design and buildup for BurstCube is underway
  - Mechanical
  - Electrical
  - Communications (TDRSS)
- Prototype/Flight units of CsI crystals, SiPMs, and front-end electronics are ordered and in hand soon (some now)
- Testing current SiPM array designs and Front-end electronics
  - Two sets of 30 6-mm SiPMs in Arrays





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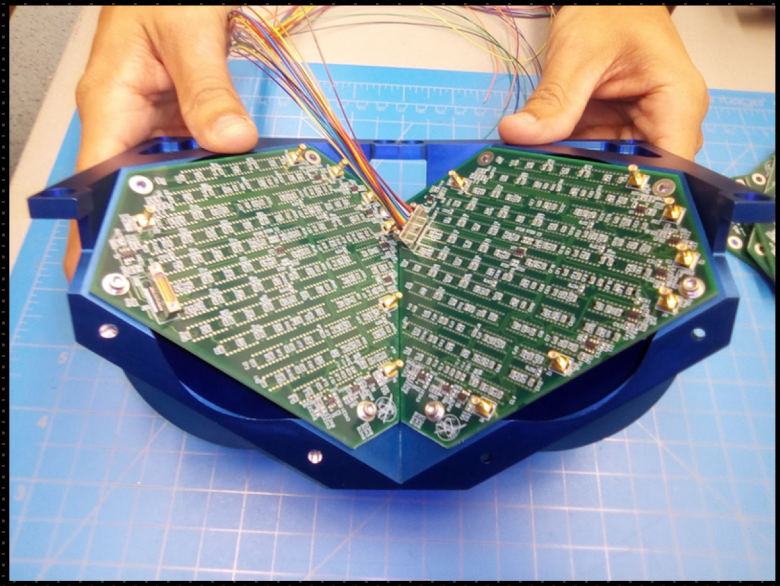

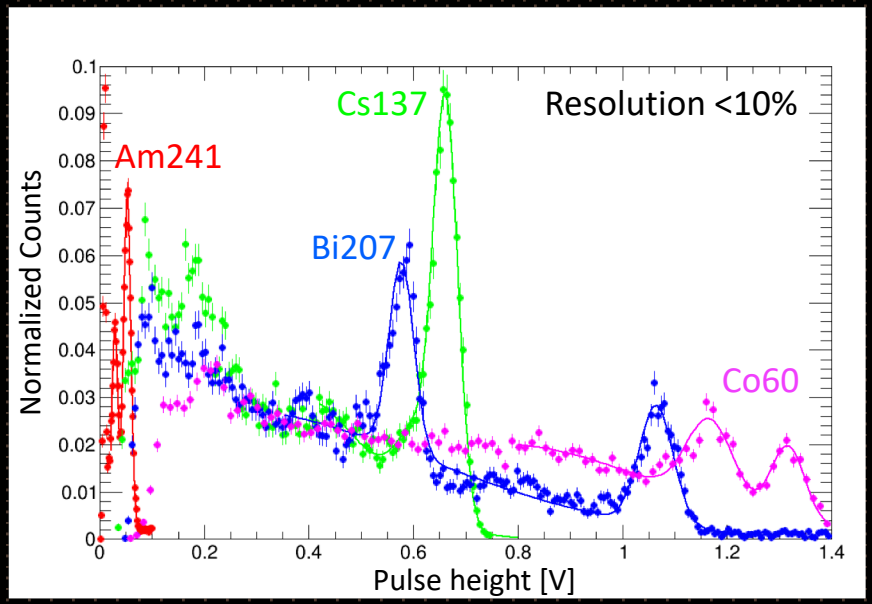

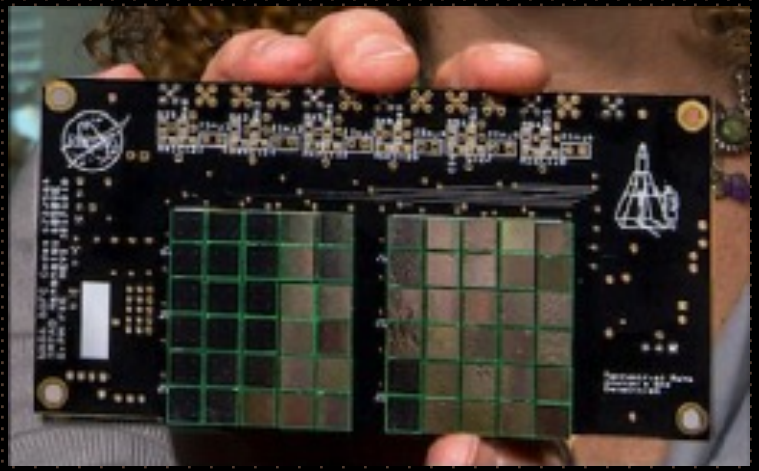

Conclusions

- BurstCube: a **6U CubeSat** that will **detect and localize** GRBs
  - focus on counterparts of gravitational wave (GW) sources
- Utilizes **four CsI** scintillators coupled with arrays of compact low-power **SiPMs**
- Complements existing facilities and could be an **interim GRB instrument** before next generation missions fly
- BurstCube **will fly in 2021**