National Aeronautics and Space Administration

Astrophysics

CubeSat Portfolio Status

APAC, October 19, 2020

Michael R. Garcia

SmallSats Lead, Astrophysics Division

Ed Griego,

SmallSats Program Executive, HQ

Thomas E. Johnson

Lead Portfolio Manager, WFF/GSFC

John D. Hudeck

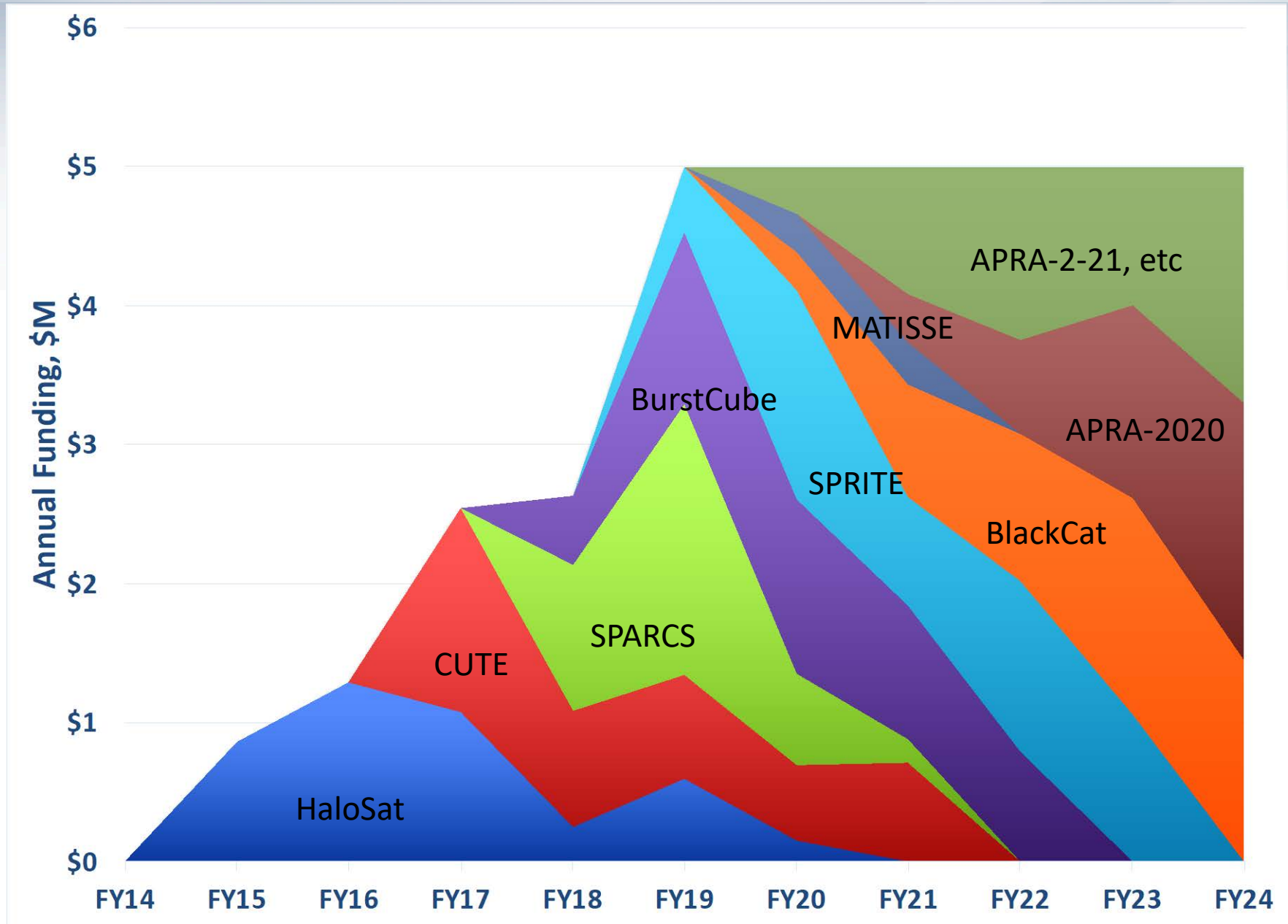
Deputy Portfolio Manager, WFF/GSFC

Astrophysics CubeSats

- Over 2012-2018 we have received <6> CubeSat proposals/year; 6 have been selected, 14% selection rate. APRA average is ~30% for suborbital proposals. Why?
- Is the reason really that Astrophysics is flux starved?
- Learning Curve? Increased capabilities of CubeSat spacecraft/platforms? Better proposals?

Year	E	E/VG	VG	VG/G	G	F
2012				4	4	1
2013			1	3	2	1
2014			2	2	2	1
2015			3		1	
2016	1		1	1	1	
2017	1	2		1	1	

APD CubeSat Sandchart

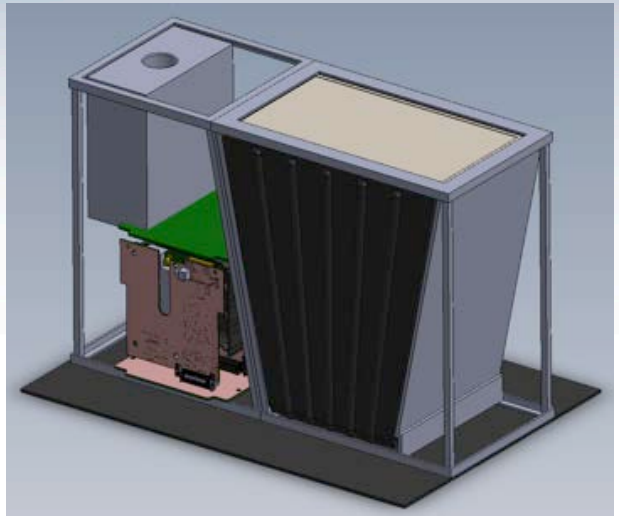


HaloSat launch at WFF

The day before the launch, the Iowa HaloSat team met Astronaut Kay Hire. Phil Kaaret talk next

BlackCAT: Black Hole Coded Aperture Telescope

A CubeSat Mission to explore the transient sky



- **APRA-2018 CubeSat Proposal**
- **PI**: Abe Falcone, Penn State University
- **LRD**: 3 years from initiation
- **Science Objectives:** Detect bursts from high redshift GRBs arising from early universe stars, look for EM counterpart to gravity wave events, X-ray Sky Monitor for transients and flares, and High-energy Multimessenger Astrophysics
- **Operations**: checkout + 1 year nominal operations, with possibility of extended life

Key Facts:

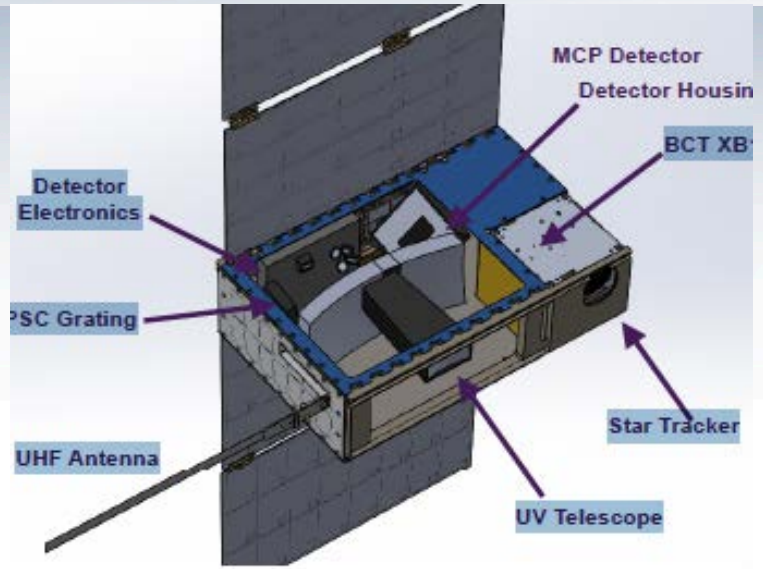
Science: Probe distant and nearby black holes from stellar mass to $>10^9$ M_{solar}. Will discover high redshift GRBs, enabling studies of star formation rate and properties; monitor/finder for ground-based follow-up. Transient finder of Galactic transients, short GRBs (during ALIGO epoch), tidal disruption events, XRFs, supernova shock breakouts, blazar flares (possible neutrino event counterparts), etc. Optimum combination of wide FOV and X-ray sensitivity with rapid position alerts will allow gravity wave EM counterpart searches and general multi-messenger event monitoring.

Technologies: Wide-sky near-continuous X-ray monitoring Coded Aperture Telescope with filter made by Luxel; operates in 0.5-20 keV band. Next generation hybrid CMOS X-ray detector technology. Rapid event alerts use **Globalstar 24/7** coverage while bulk science data use 1/day S-band passes, **Clyde-space bus.**

Orbit: Sun Sync polar

SPRITE

Supernova remnant and Proxies for ReionizationTestbed Experiment.

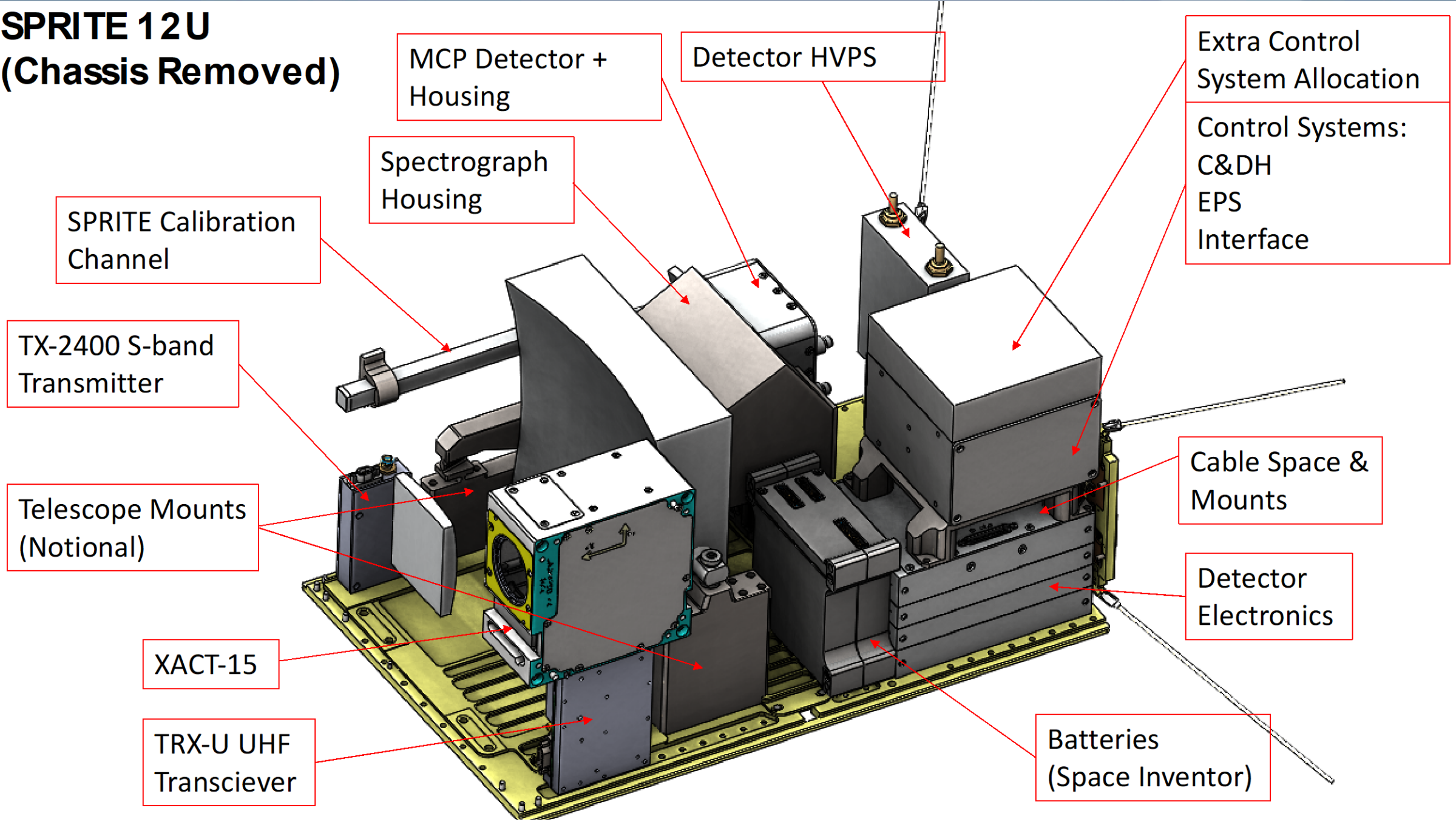


- **APRA-17 CubeSat Proposal** (ARTEMIS)
- **PI**: Brian Fleming, CU Boulder.
- **LRD**: 2.5 years from initiation
- **Science Objectives:** Determine ionization rate of IGM from galaxies and AGN, trace feedback within galaxies driven by star-forming regions, using low-resolution imaging UV spectrograph.
- **Operations**: 1.5 years to complete full survey,
- **Cost**: $4.5M over 4 years

Key Facts:

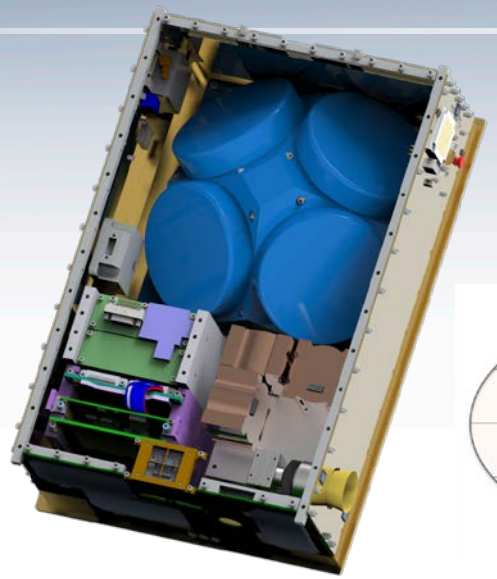
- **Science**: How do galaxies provide ionizing radiation to the IGM? Even JWST cannot solve one critical aspect of the problem: How much of this radiation actually escapes galaxies to reionize the IGM? SPRITE will directly measure the ionizing spectrum in 100 $0.15 < z < 0.3$ galaxies and AGN, a sample that will surpass in number and precision all ionizing escape measurements to date and provide critical interpretive tools for core JWST science.
- **Technologies:** advanced UV/optical coatings and next-generation photon-counting microchannel plate (MCP) detector. Rectangular telescope, compact R~900 imaging spectrograph. **BCT** ACS. Comm, power **in-house build.**
- **Orbit**: ISS-like is fine.

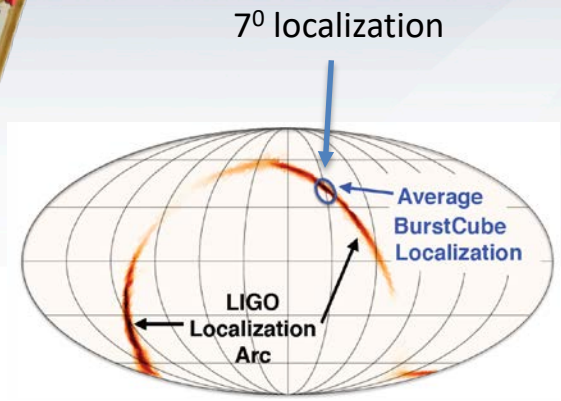
SPRITE 12U (Chassis Removed)



BurstCube

6U CubeSat with four CsI detectors sensitive to gamma-rays from 10 keV to 1 MeV





- **PI:** Jeremy Perkins (GSFC)
- **Science Objectives:**

1) Rapid localizations for high-significance LIGO/Virgo detections coincident with short GRBs
2) Correlate short GRBs with LIGO/Virgo sub-threshold signals, increasing volume
3) Search of gamma-ray transients
4) Positions to ~7degrees, few dozen NS-NS detections per year

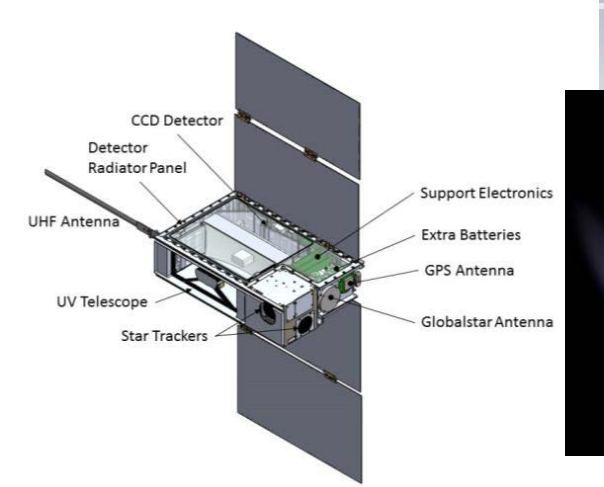
- **Operations**: 4 years development, 1 year operations. S-band to TDRS for alerts, NEN for bulk data

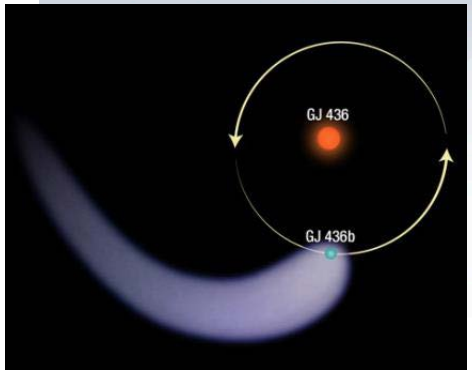
Key Facts:

- **Science**: BurstCube autonomously detects GRBs onboard, rapidly downlinking data for timing and localizations that are disseminated to ground-based observers to maximize the chances of detecting afterglows. BurstCube will increase the rate of concurrently detected sGRBs and GWs by enhancing the sky coverage beyond current sensitive instruments.
- **Technology:** 6U divided into a 4U instrument package and 2U spacecraft subsystems. Spacecraft highly leverages Dellingr, developed at GSFC. Instrument is similar to Fermi-GBM, except BurstCube uses CsI for 10 keV – 1 MeV.
- **Orbit**: Low earth orbit with no major orbital or observational constraints

CUTE

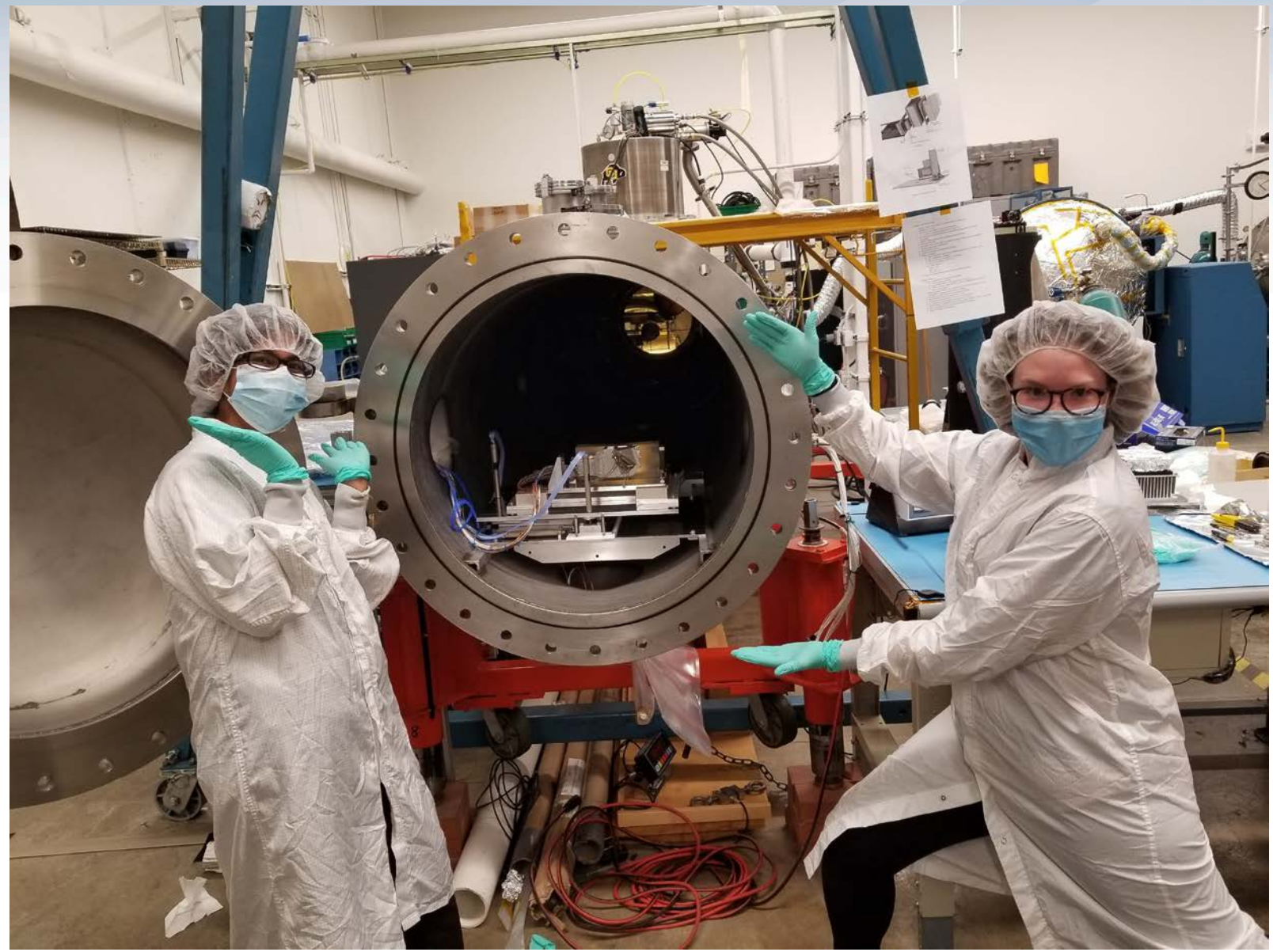
A CubeSat to study atmospheres and B-fields in ExoPlanets





- **APRA-15 CubeSat Proposal**
- **PI**: Kevin France, CU, multiple s/r programs, two Helio cubesats at CU.
- **Launch:** CSLI on LandSat-9, fall 2021
- **Science Objectives:** The Colorado Ultraviolet Transit Experiment (CUTE) will take multiple medium resolution UV spectra of hot Jupiters during transit, in order to measure the composition of the atmosphere being ablated away. Magnetic fields may be detected via the presence of tori or bow shocks
- **Operations**: 1 month minimum, 8 month full survey of 12 exoplanets

Key Facts:

- **Science**: Extreme atmospheric mass loss has been detected by HST on a small sample of short-period planets. The UV has multiple diagnostic lines which can determine the structure and geometry of the escaping atmospheres. This would be the first UV survey of hot Jupiter atmospheres. This would compliment the sole existing APD cubesat, which is X-ray.
- **Technologies:** 6U CubeSat advancing science, using COTS technologies. **Blue Canyon Technologies (BCT)** bus, e2v UV-CCD, exiting cubesat downlink station.
- **Budget:** $4.4M over 4 years
- **Orbit**: sun synchronous, 97.9* 10am LTAN, 550 km

CUTE End2End test – Arika Egan, Ambily Suresh