



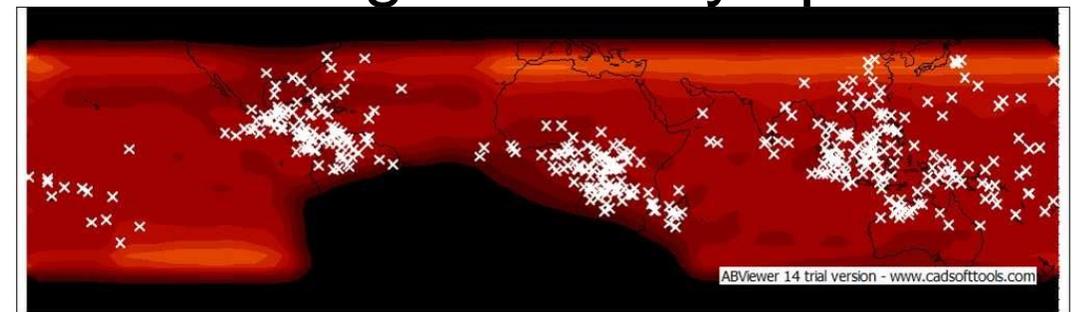
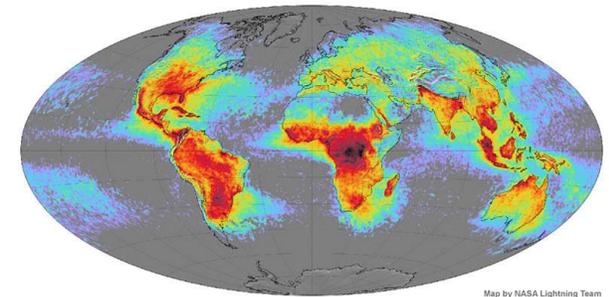
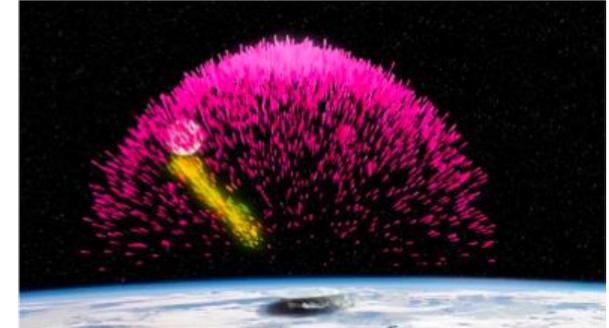
Light-1 CubeSat Detector: RAAD for the study of TGFs

Lolowa Alkindi on behalf of the NYUAD Payload Team

What are TGFs?



- Sub-Millisecond burst of Gamma-rays ($\sim 100 \mu\text{s}$)
- Can reach energies up to 100 MeV
- Produced at 10 - 21 km altitude (thundercloud altitude)
- Channeled upward to space
- Associated with lightning events
- Observed by satellites at altitudes of ~ 500 km
- Concentrated around the equator
- Best described by the RREA model
- Very intense emission with up to several detectable gamma-rays per cm^2 of the detector.



Fishman et.al. (1994) correlated TGFs with high thunderstorm activity

Launch on December 21st

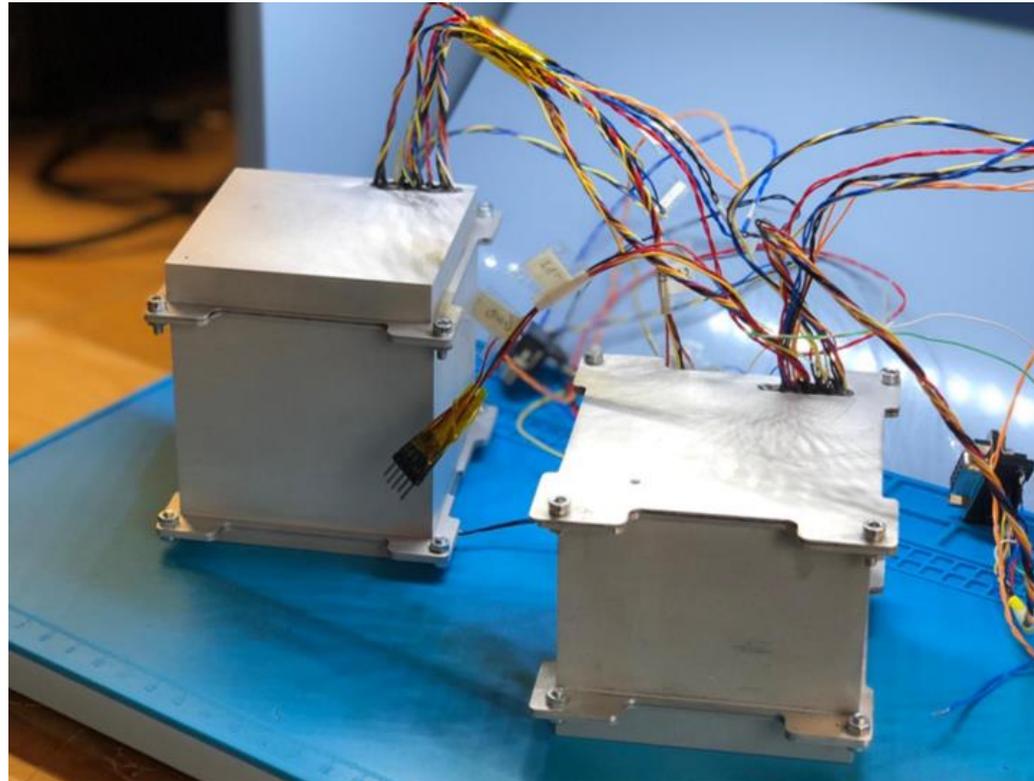


1.0 Introduction to RAAD



RAAD (Rapid Acquisition Atmospheric Detector) is the Light-1 3U CubeSat Payload. It is composed of two detectors designed and optimized for the study of Terrestrial Gamma-Ray Flashes. It is now on the ISS.

PMT Detector >



< SiPM Detector



1.1 Components Parameters

Each detector is made by coupling a Scintillating Crystal with a Photosensor. The types of crystals and photosensors used are as follows:

Photo-sensor Parameters

	PMT R11265-200 Photomultiplier Tubes	SiPM S13361-6050AE-04 Hamamatsu Silicon Photomultipliers
Peak Sensitivity [nm]	~400	~450
Operating Voltage[V]	900	55
Gain at Working Point	~ 10^6	~ 10^6
Operating temperatures [°C]	-30 to +50	-20 to +60



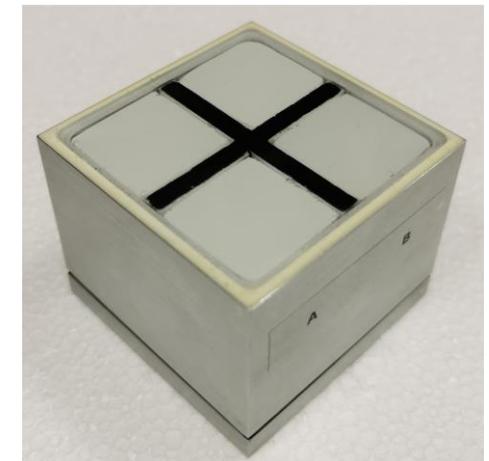
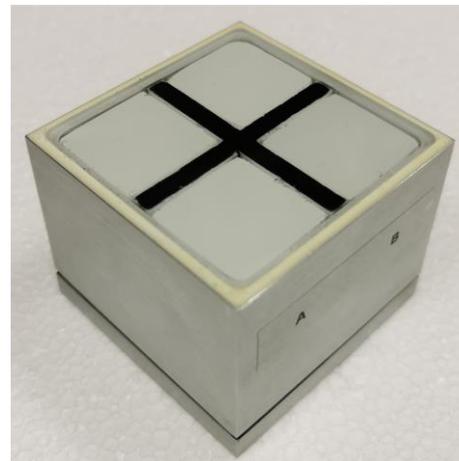


1.1 Components Parameters

Scintillating Crystal Parameters

	CeBr₃ (LB) Low Background Cerium Bromide	LBC Lanthanum BromoChloride
Density [g/cm ³]	5.1	4.9
Typical resolution @122 keV [%]	10	7
Typical resolution @662 keV [%]	4	3
Decay Time [ns]	~20	~35
Activity [Bq/cm ³]	<0.01	~1

Both arrays look alike and have approximately similar sizes with each crystal being 23 mm X 23 mm X 45 mm in size. The 4 crystals are housed in an aluminum shell to avoid moisture contamination and kept optically independent by using a Teflon optical separator.

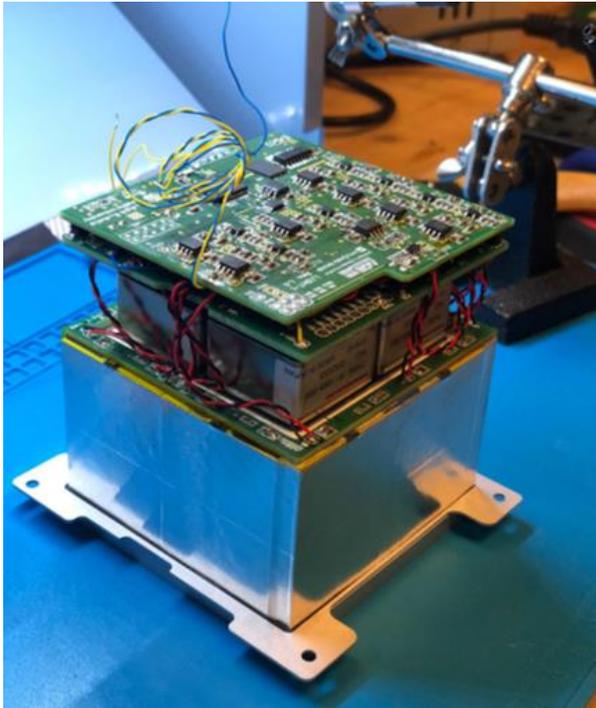


1.2 Detector Assembly



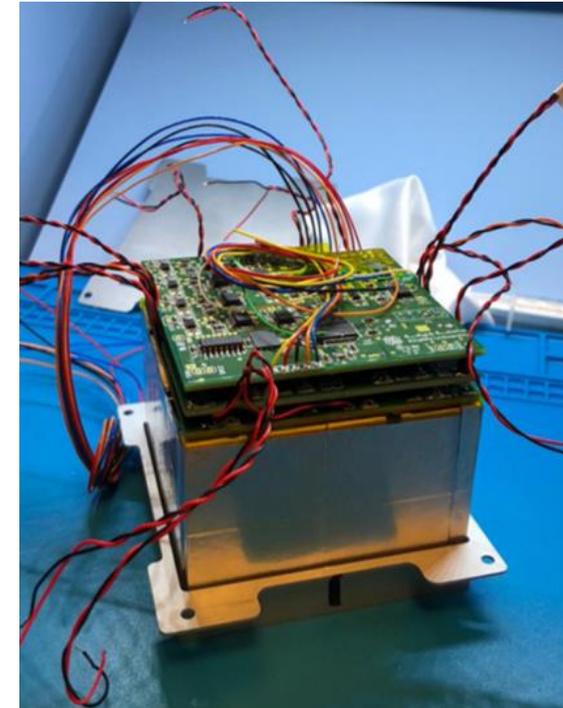
PMT Detector:

Composed of coupling four PMTs with two CeBr₃ Crystals and two LBC Crystals.



SiPM Detector:

Composed of coupling four SiPMs with four CeBr₃ Crystals.



2.0 Payload Preliminary Specifications



	PMT Detector	SiPM Detector
Size (mm ³)	74 × 74 × 86	74 × 74 × 68
Spectral Resolution [%]	~ 21 @ 50 keV ~ 6 @ 600 keV ~ 4 @ 1.5 MeV	
Effective Area [cm ²]	~ 20 @ 50 keV ~ 10 @ 600 keV ~ 5 @ 1.5 MeV	
Time Resolution (ns)	~ 100	
Deadtime (ns)	< 200	

3.0 Payload Requirements



Parameter	Value
Detection Energy Range	~ 20 keV - 3 MeV
Spectral Resolution	15% @ 20 keV, < 5% @ 511 keV
Relative Timing	< 200 ns
Absolute Timing	< 2 μ s
Effective Area	40 cm ² @ 50 keV, 20 cm ² @ 511 keV
PMT Payload Size (Fits in 1U)	74 x 74 x 86 mm
SiPM Payload Size (Fits in 0.75U)	74 x 74 x 68 mm
PMT Payload Weight	1,130 g
SiPM Payload Weight	942 g
Power Consumption	< 4.5 W average 5.92 W assuming 100% Duty Cycle
Data Budget	~50 MB/day
Operational Temperature Range	Between -20° C to 40° C
Survival Temperature Range	Between -40° C to 60° C



Questions?