Terrestrial RaYs Analysis and Detection (TRYAD) Cubesat Mission

Division of Atmospheric and Geospace Sciences (AGS)

JM Wersinger, *Auburn Univ.*
Mike Fogle, *Auburn Univ.*
Michael Briggs, *Univ. of Alabama - Huntsville*
Pete Jenke, *Univ. of Alabama - Huntsville*
Georgia De Nolfo, *NASA Goddard Space Flight Center*

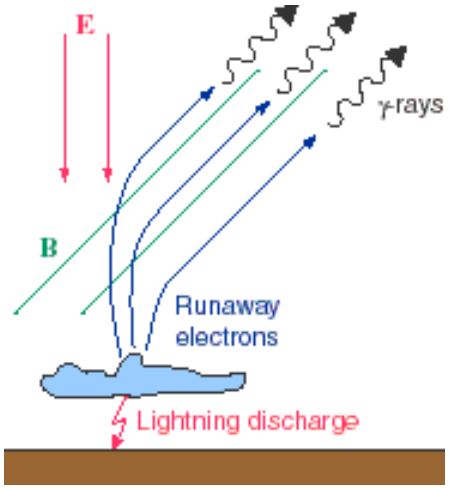
THE UNIVERSITY OF ALABAMA IN HUNTSVILLE

AUBURN UNIVERSITY

TRYAD Science Overview

Primary Science Goal:
Multi-point Observations of Terrestrial Gamma-ray Flashes (TGFs) to test TGF Beam Models

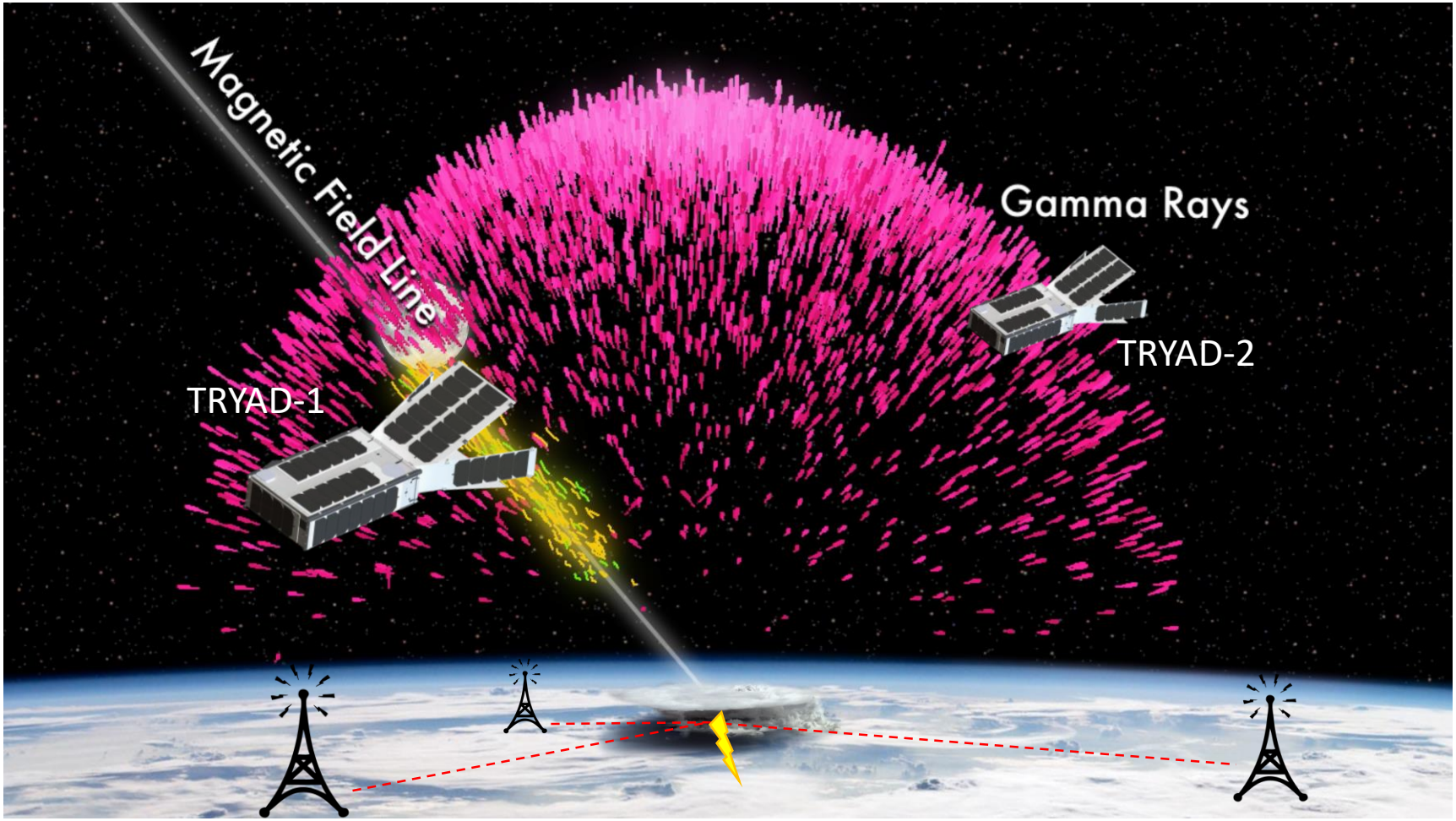
- What are TGFs?
- History of detecting TGFs
- What is unique about the TRYAD mission?



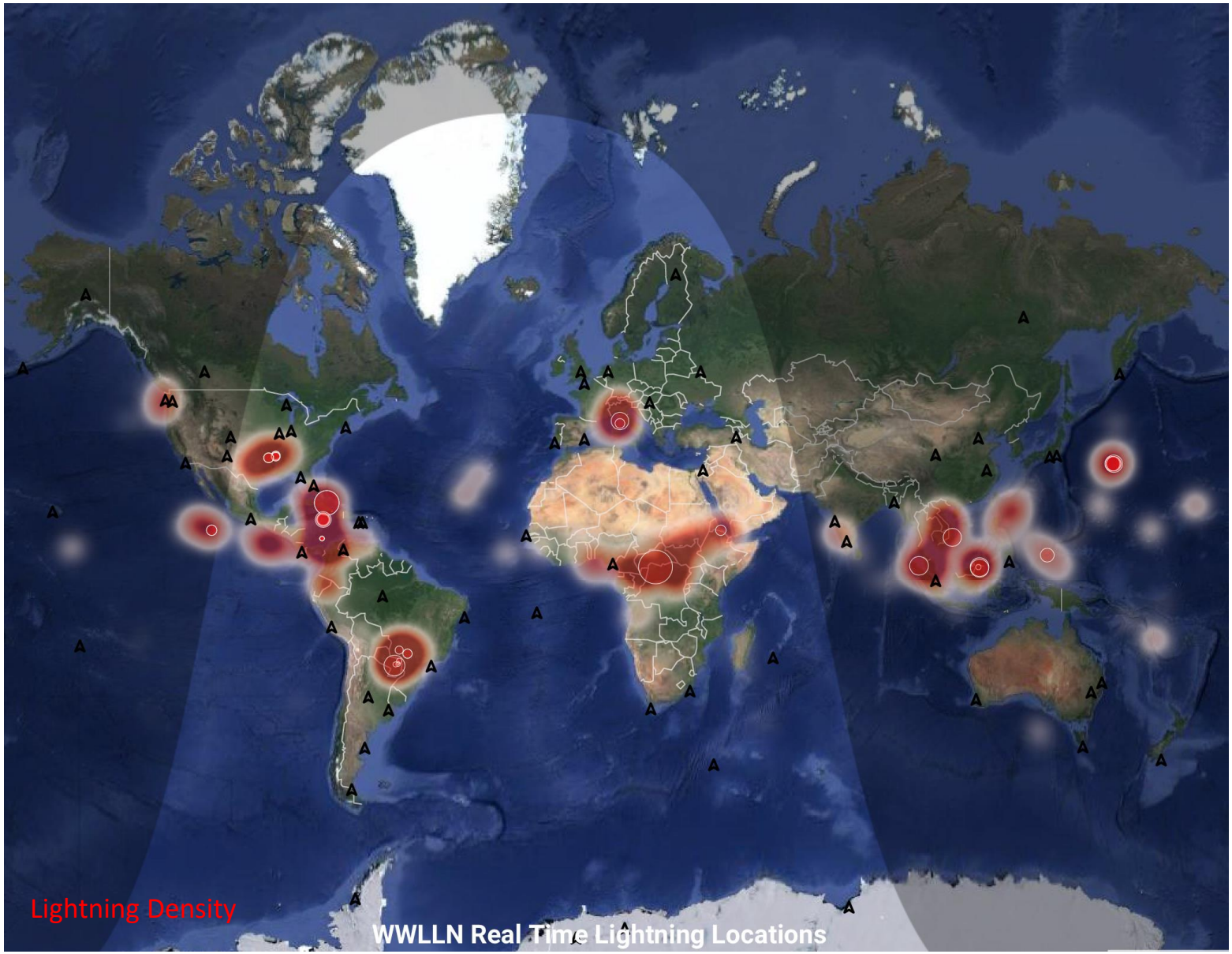
- up to 10's MeV Gamma Rays
- µs to ms timescale pulses
- Production models unverified

Short History of TGF Detection
1994 –Burst and Transient Source Experiment (BATSE) on Compton Gamma-Ray Observatory
2005 – RHESSI satellite detected higher energy TGFs
2009 – Gamma-Ray Burst Monitor on Fermi Gamma-Ray Space Telescope first detects TGFs and positrons
Present – thousands of TGFs are detected routinely

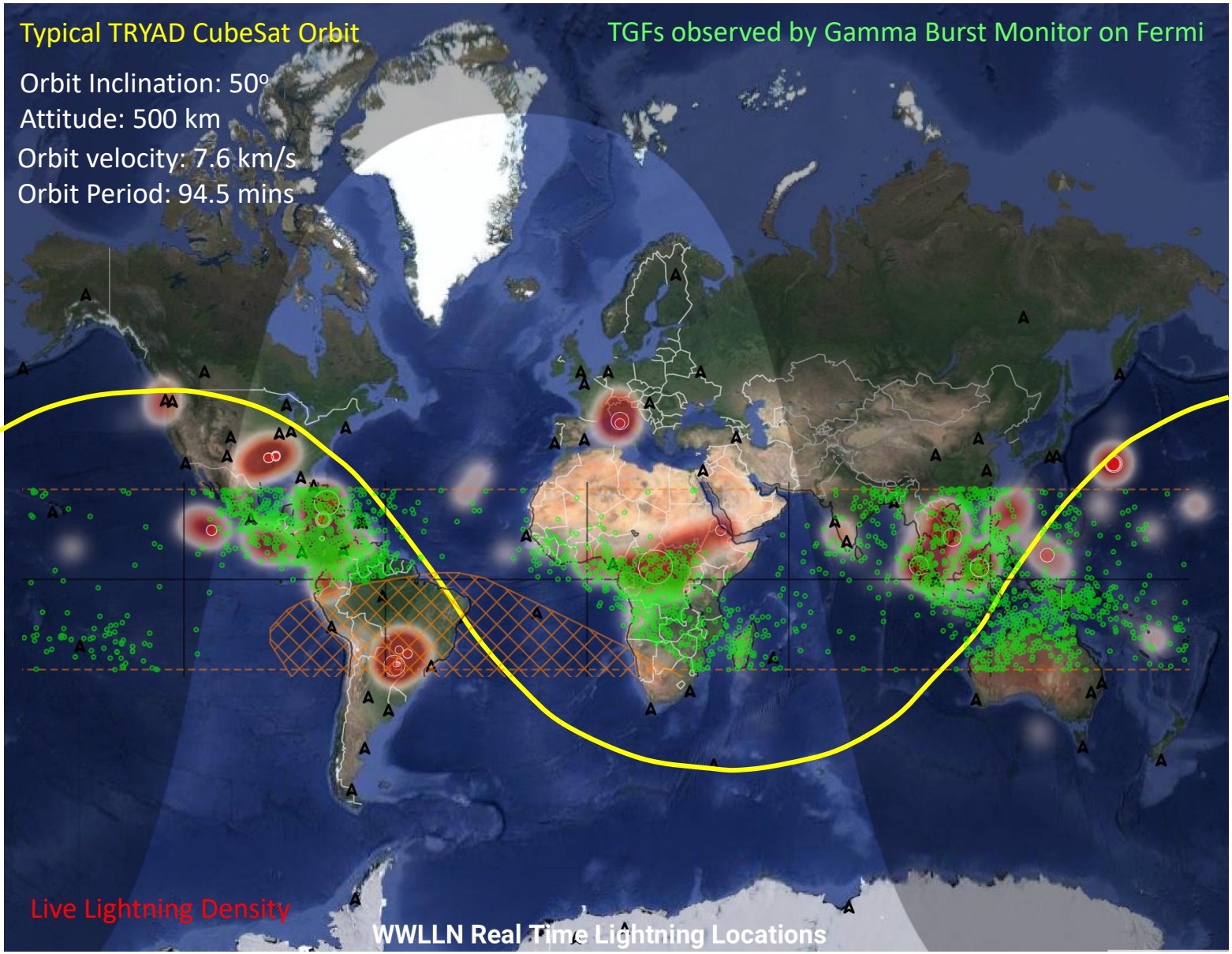
TRYAD Science Overview



TRYAD uses two 6U CubeSats to make coincident measurements of TGFs and correlates to ground-based lightning detection data



http://wwlln.net/new/map/lightning_map.html



http://wwlln.net/new/map/lightning_map.html

TRYAD 6U CubeSat

Command and Data Handling System (C&DHS)

- Embedded Linux
- Beagelbone w/ programmable realtime units

Attitude Determination and Control System (ADACS)

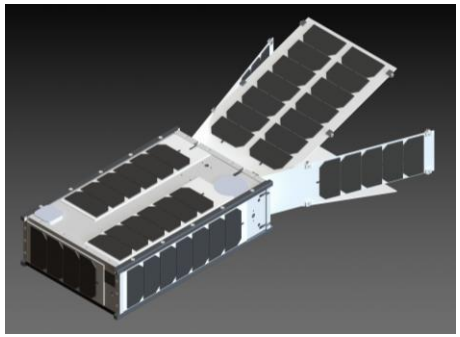
- Magnetometers, rate gyros, sun angle sensors, orbit propagator
- Novatel GPS
- Magnetorquers & reaction wheels

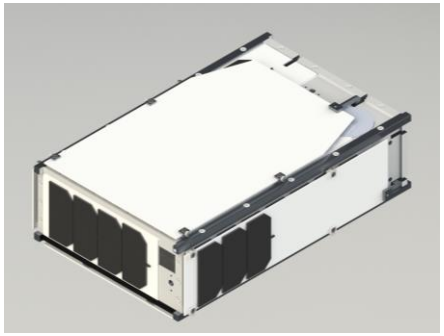
Electrical Power System (EPS)

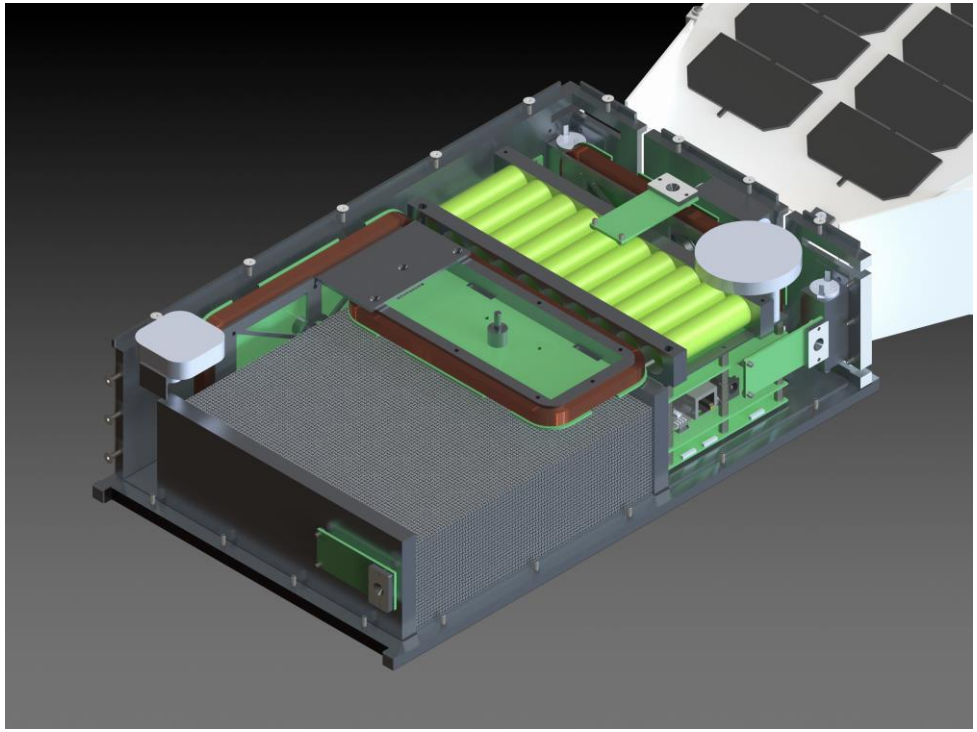
- 60 solar cells (29% eff.)
- Max power point trackers
- 10 Li-ion batteries

Communications

- Globalstar bent pipe COMM
- Full Duplex Command & Control @ 256 kb/s over 45% of orbit
- Simplex telemetry beacons over 90% of orbit







Mechanical Systems

- Monolithic Al structure panels
- Driven deployable solar panels
- Passive thermal design

Station Keeping

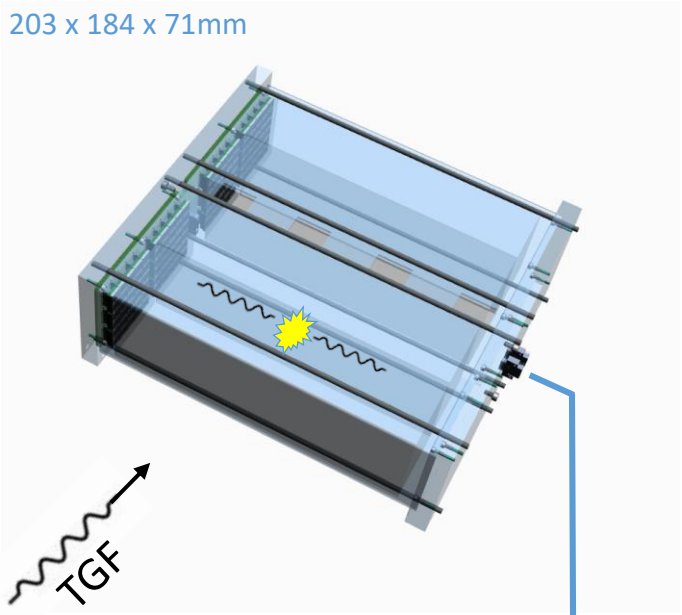
- Deployable “Dart” configuration for passive orientation augmentation
- Station keeping and satellite separation control via aerodynamic differential drag

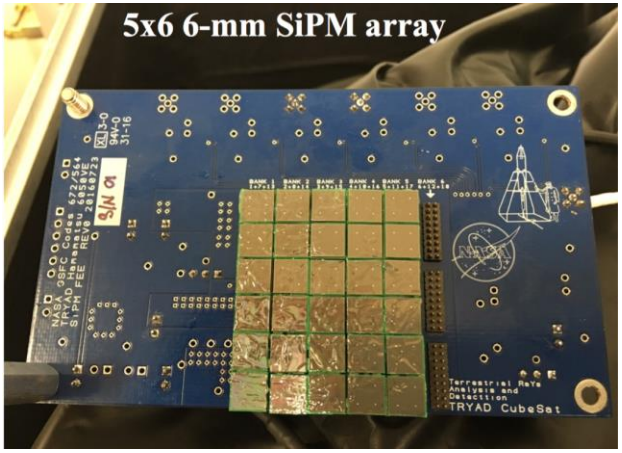
Science Payload

- Plastic Scintillation gamma-ray detector w/ next generation Si photomultipliers (SiPMs)
- >1 M sample/sec event time tagging to 2 μs accuracy in real time (slaved to GPS clock)
- ROI’s commanded based on weather and lightning data

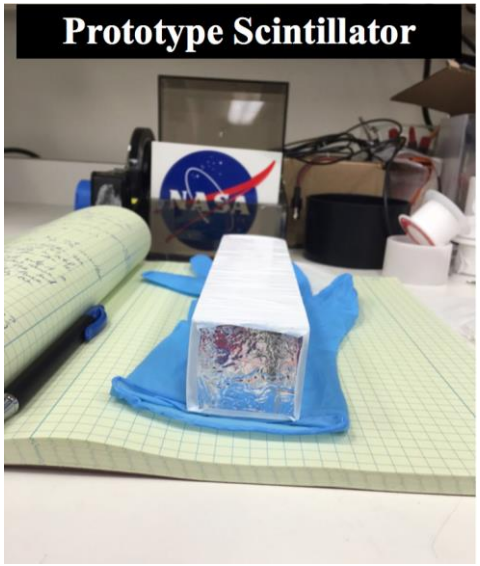
Science Payload

203 x 184 x 71mm

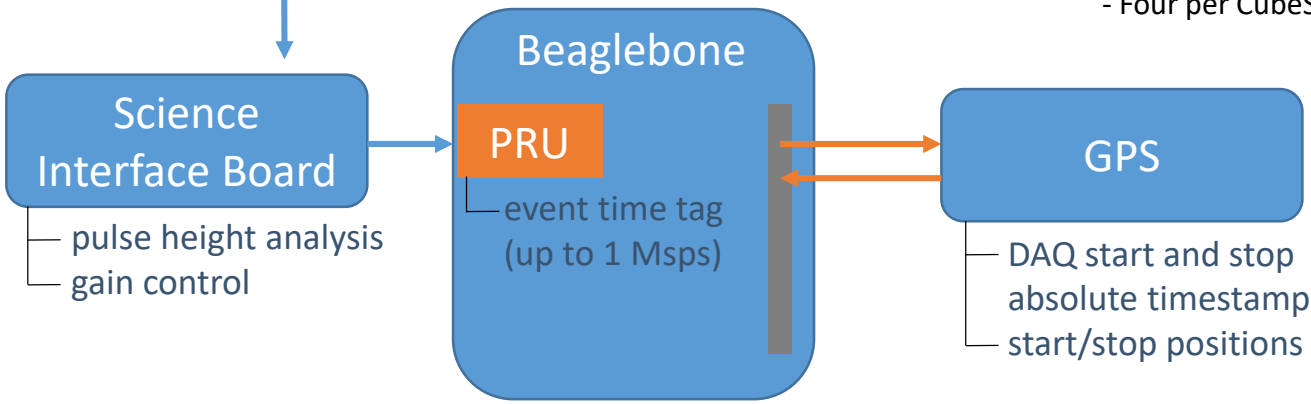




- Hamamatsu Si Photomultiplier (SiPM) Array
- Eight arrays per CubeSat (240 SiPMs)

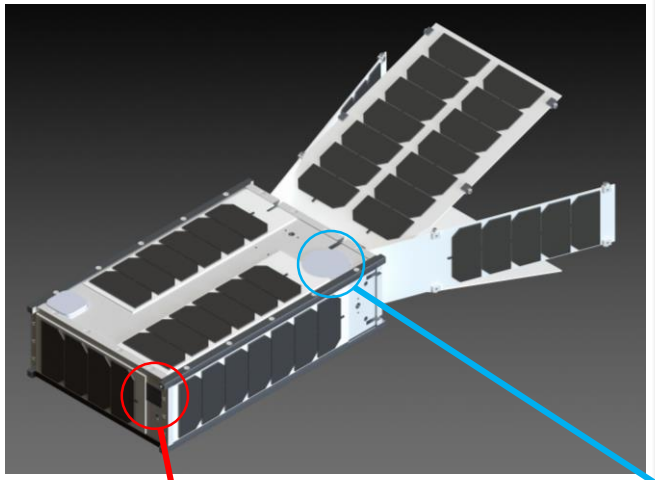


- 5% Lead-doped Plastic
  (40 x 51 x 166mm)
- Four per CubeSat



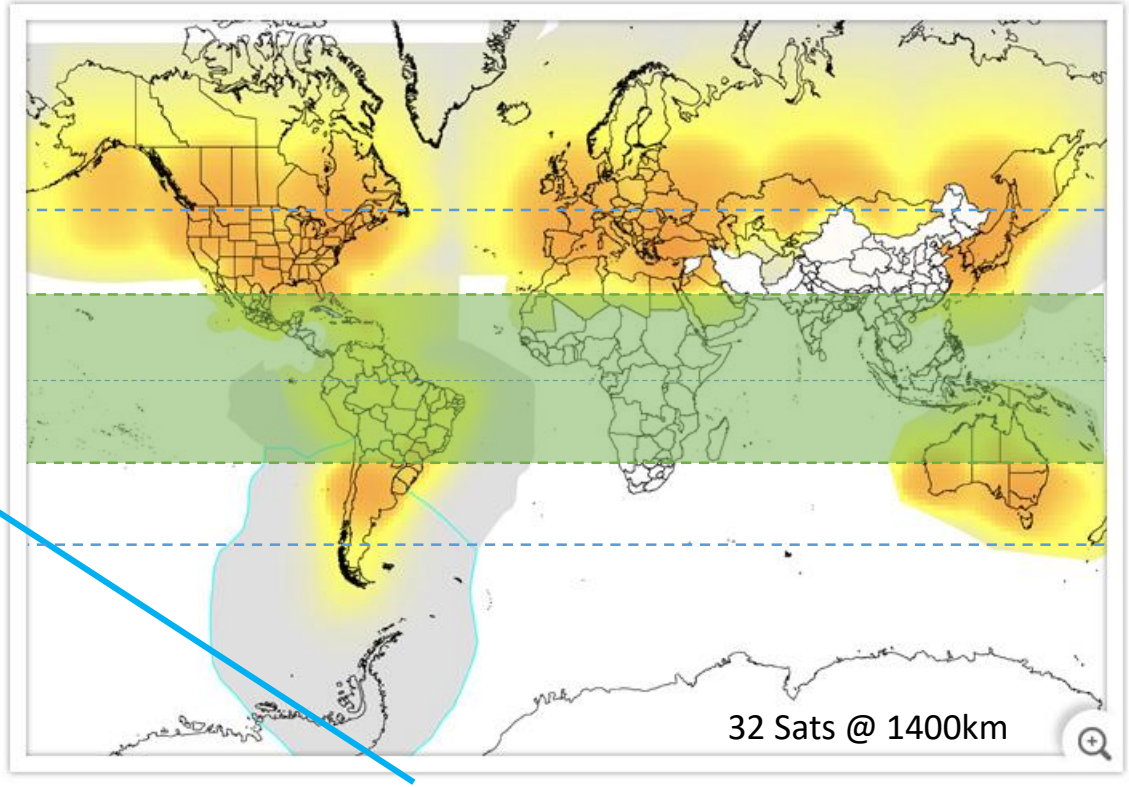
Timing Accuracy Goals: 2 µs relative event time tag, 20 µs between CubeSats, 200 µs w.r.t. ground-based VLF detection

Communications



**Radios provided by sci_Zone, Inc*

Globalstar Duplex Coverage



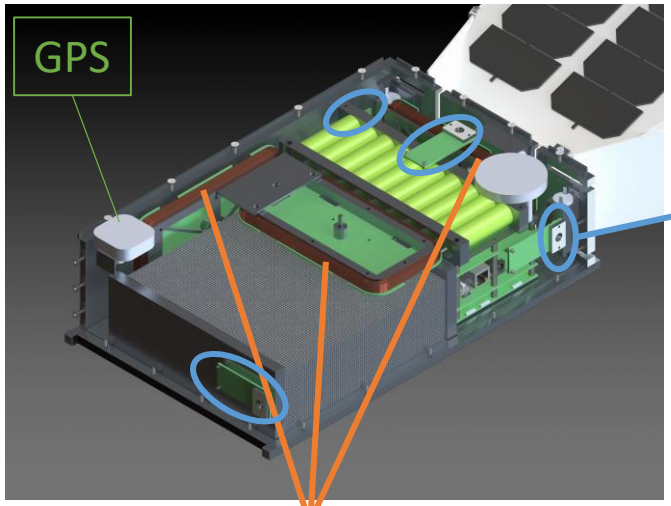
Simplex Radio

- Beacon for post-launch phase
- 80-90% orbital coverage
- Abridged telemetry
- Broadcast mode (quasi-roll resistant)

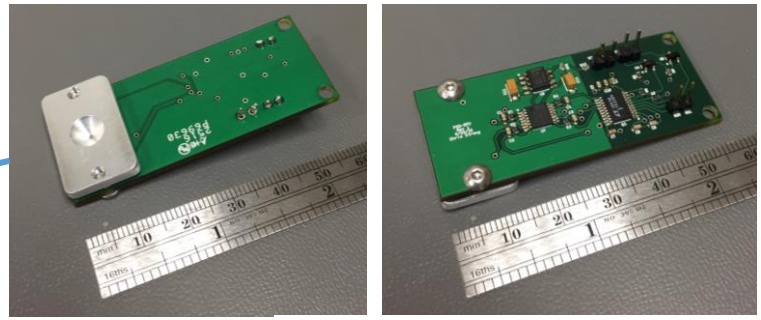
Duplex Radio

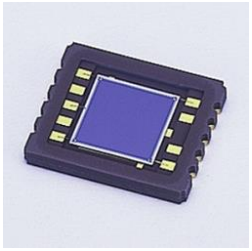
- 256 kb/s, full duplex
- 40-50% orbital coverage
- Science Data / Telemetry
- Command & Control
- Requires +/- 40^{o} zenith antenna pointing

Attitude Determination and Control System (ADACS)

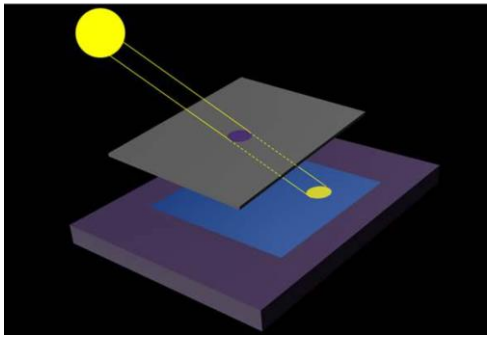


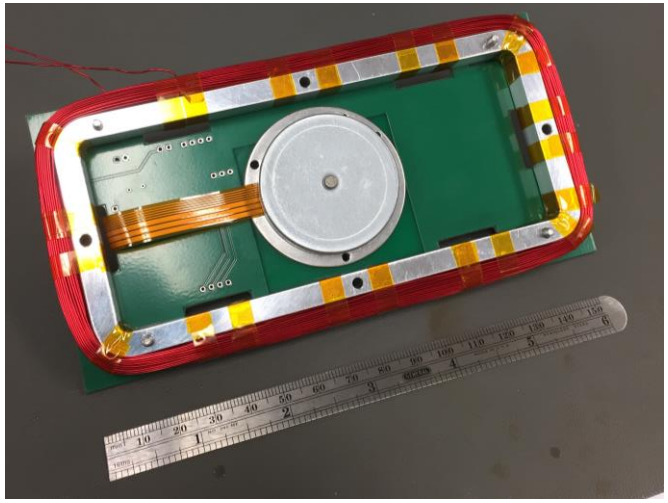
Sun Angle Sensor





Hamamatsu PSD





Magnetorquer
180 x 60 x 5 mm
$\mu = 0.91\ Am^2$

Reaction Wheel
45mm brushless DC
8,000 rpm

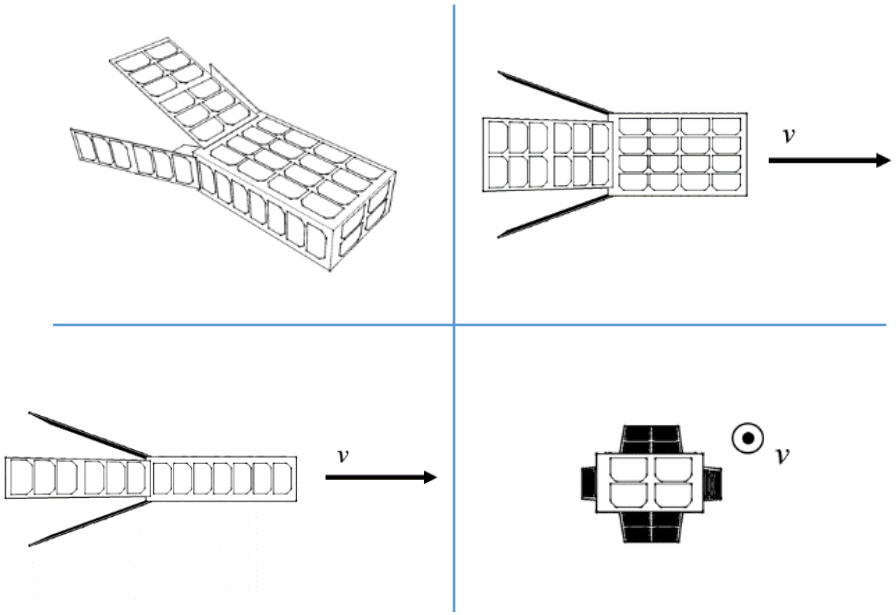
Reaction Unit: Magnetorquer + Reaction Wheel

Magnetometer

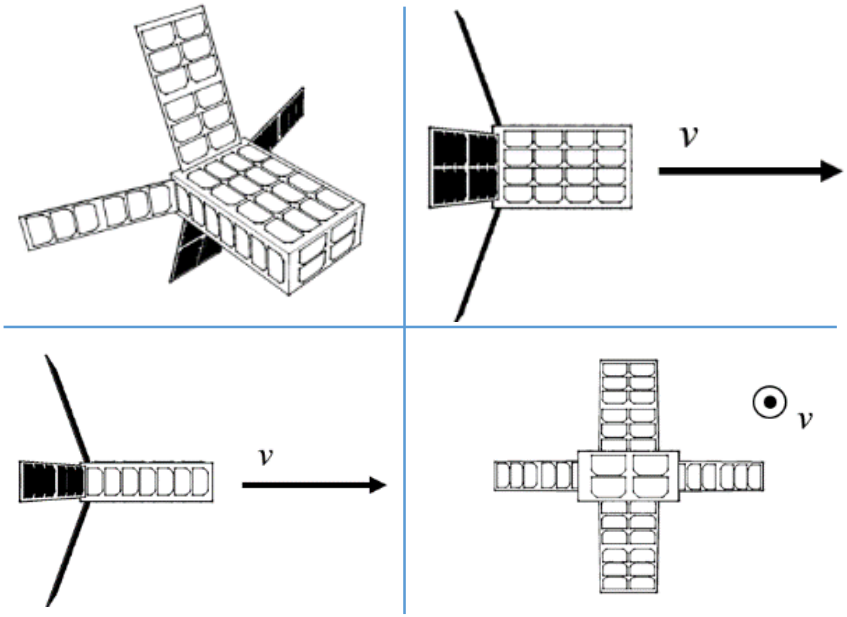
Rate gyro

Station Keeping via Differential Drag

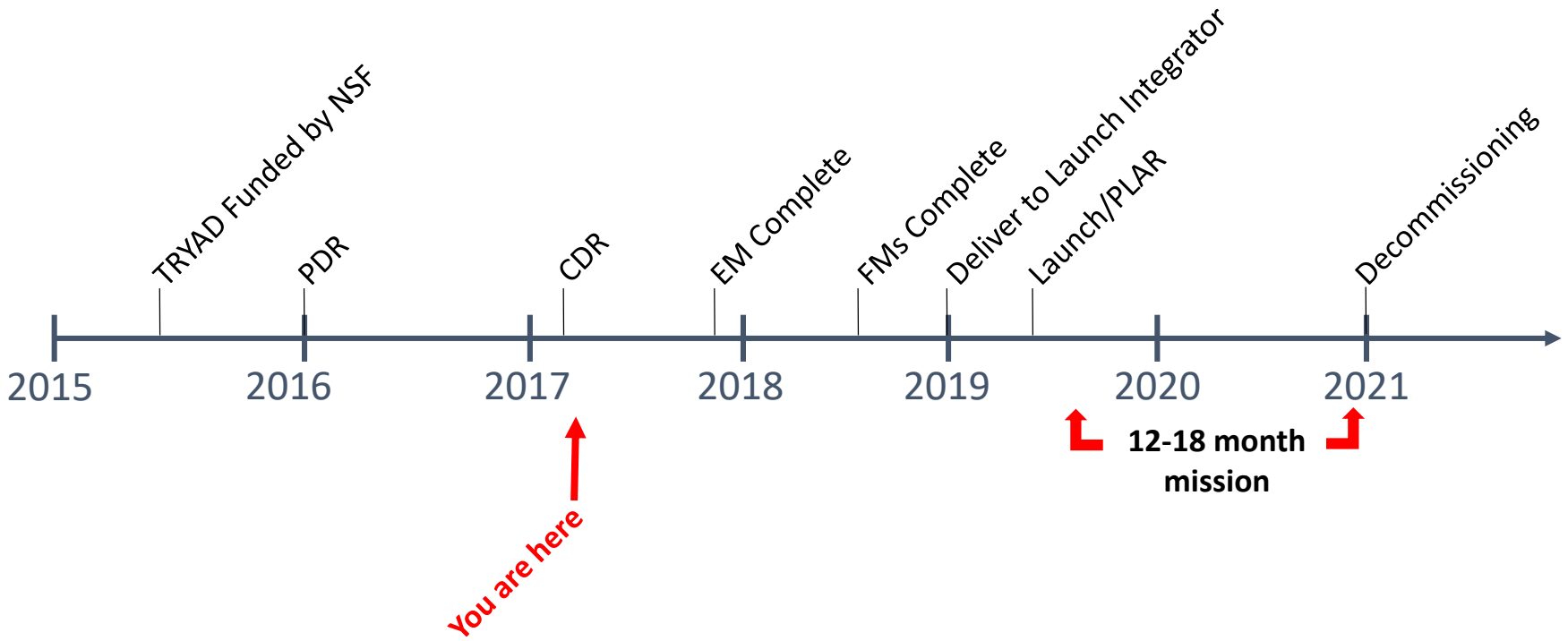
Min Drag



Max Drag



TRYAD Timeline




AUSSP
Auburn University Small Satellite Program
space.auburn.edu
STUDENT SPACE PROGRAM
FAILU
NOT

Thank You!

Funded by

Division of Atmospheric and Geospace Sciences (AGS)

THE UNIVERSITY OF ALABAMA IN HUNTSVILLE

AUBURN UNIVERSITY