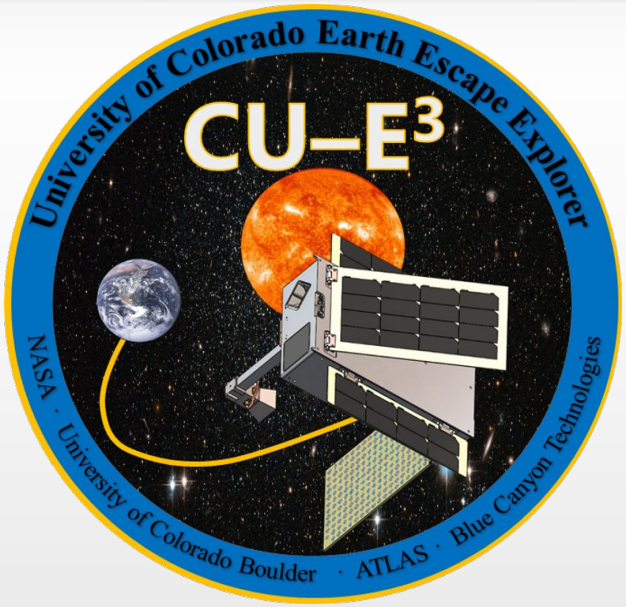


CU-E^3: Bringing Deep Space Communications Within Reach

Sarah Withee, Communications Team Lead

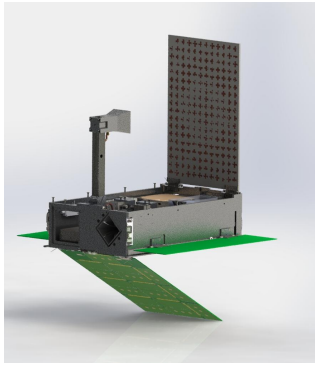
FIRST RF Corporation™

ATLAS Space Operations

BCT

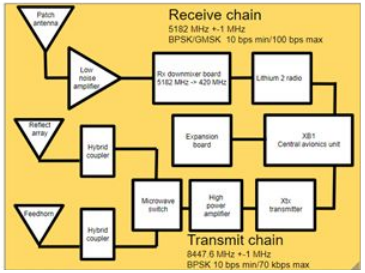
NORTHROP GRUMMAN

Presentation overview



CU-E^3 Background and Mission

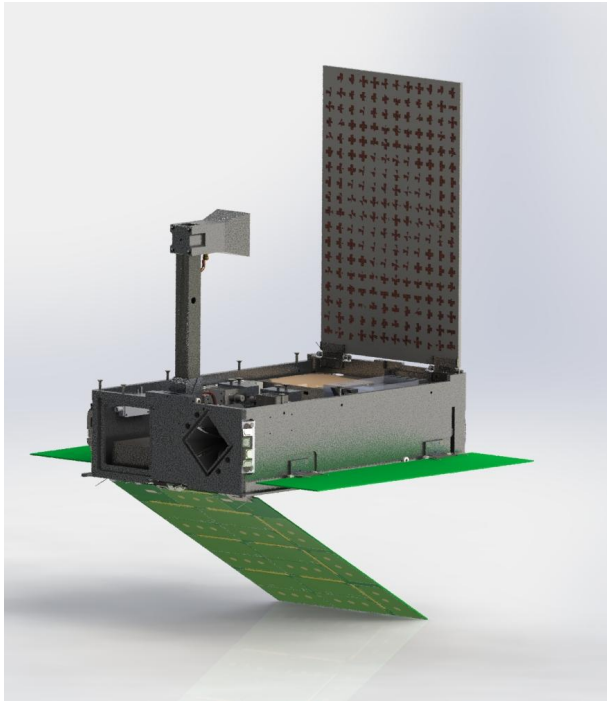
Deep space communications challenges



CU-E^3 system overview and communications system architecture

Background


CubeQuest
CHALLENGE
A NASA CENTENNIAL CHALLENGES COMPETITION
NASA
#321techoff



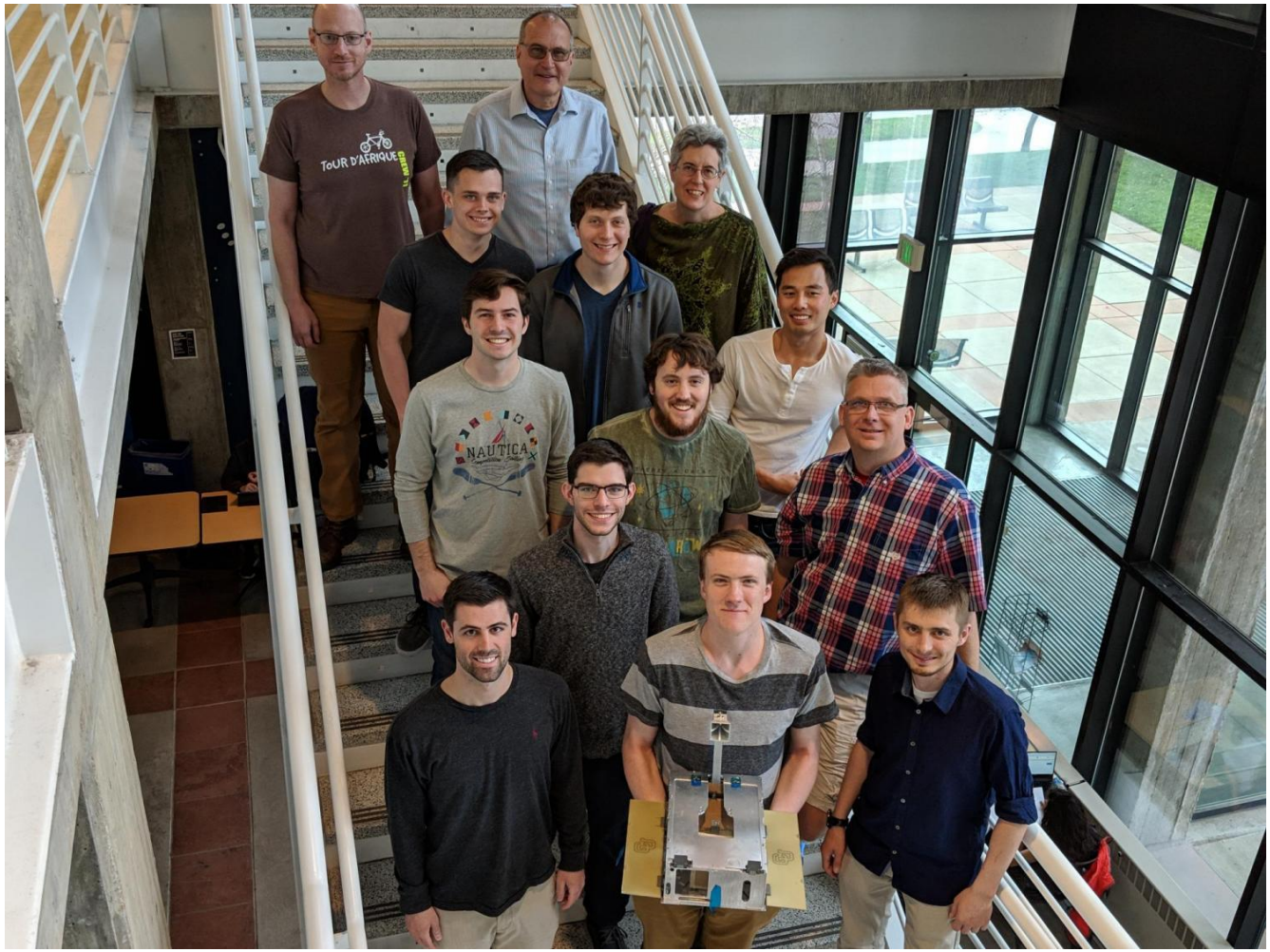
Prizes for Deep Space Derby

Challenge starts 4 million km from Earth surface

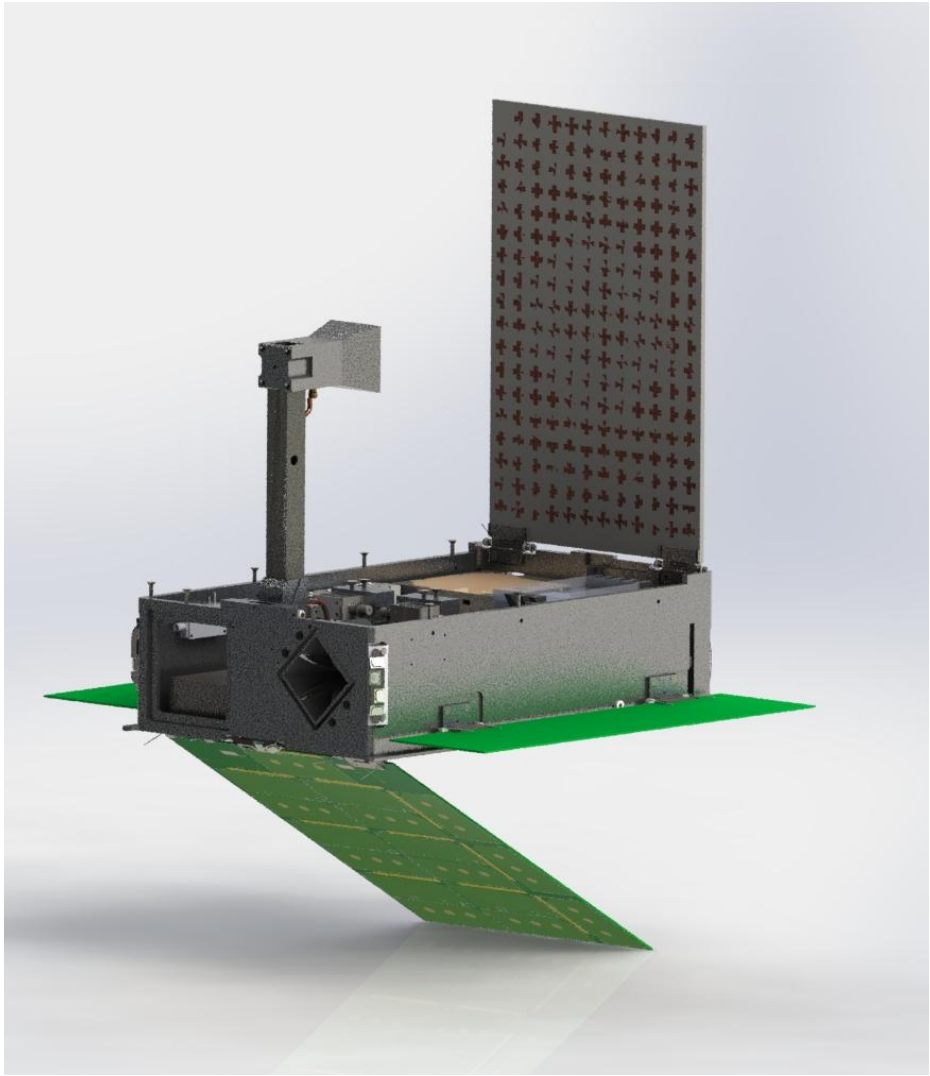
Prize	Award- 1st / 2nd Place	Floor Value	Condition
Best Burst Data Rate	$225k / $25k	One 1024-bit data block	Highest error-free blocks in any 30-minute window
Largest Aggregate Data Volume Sustained Over Time	$675k / $75k	One thousand 1024-bit data blocks	Highest error-free blocks in any 28-day window
Spacecraft Longevity	$225k / $25k	28 days	Elapsed days between the first, and very last, receptions of 1024-bit data blocks
Farthest Communication Distance From Earth	$225k / $25k	4,000,000 km	At least one 1024-bit data block

Total of $1.35 Million

Project team Spring 2019



Overview



Mission Overview

- **CubeSat**
  - Solar arrays (3)
  - Feedhorn/Reflectarray (X-Band)
  - No propulsion system
  - **6U:** 36.5 x 23.9 x 11cm / 11.2kg

0 Payload Transit

1 Commissioning

4 Million km Point

2 Competition

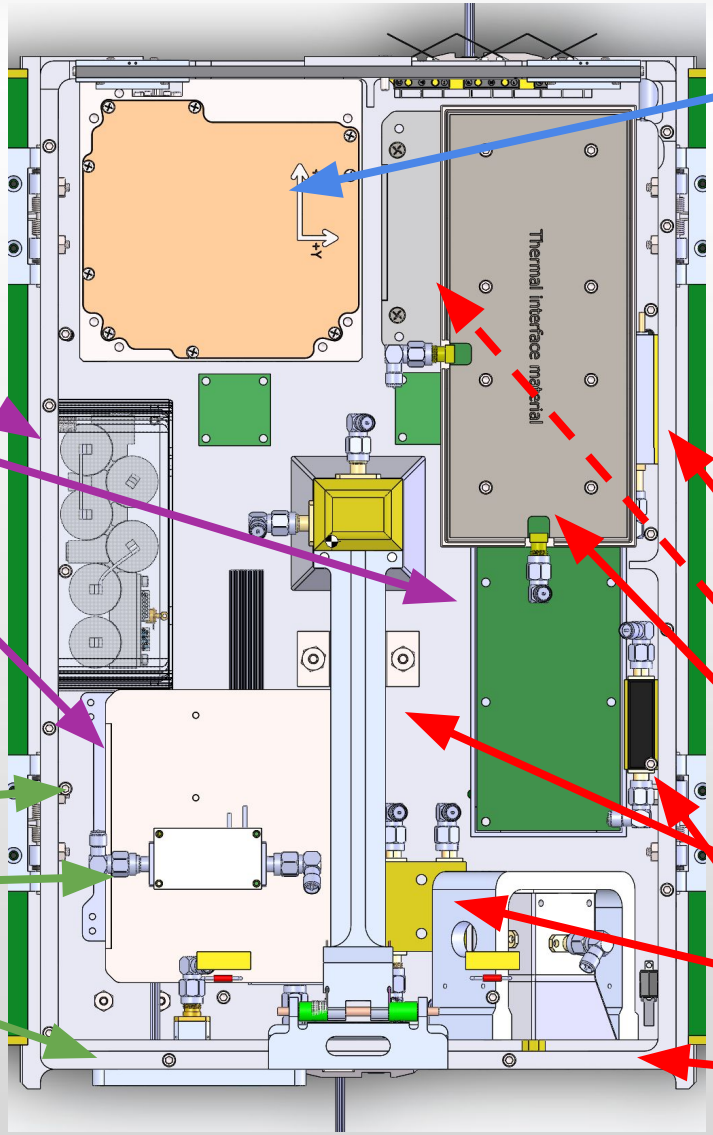
3 Cruise

- **Student designed and built to compete in NASA CubeQuest challenge**
  - Guaranteed launch slot on NASA's SLS EM-1
  - Won $80,000 in GT2, GT3, & GT4

- **Demonstrate:** Deep space (4 mil km+) communication technology (no on-board science instrument)
  - X-Band Downlink
  - C-Band Uplink

Challenges

System Overview



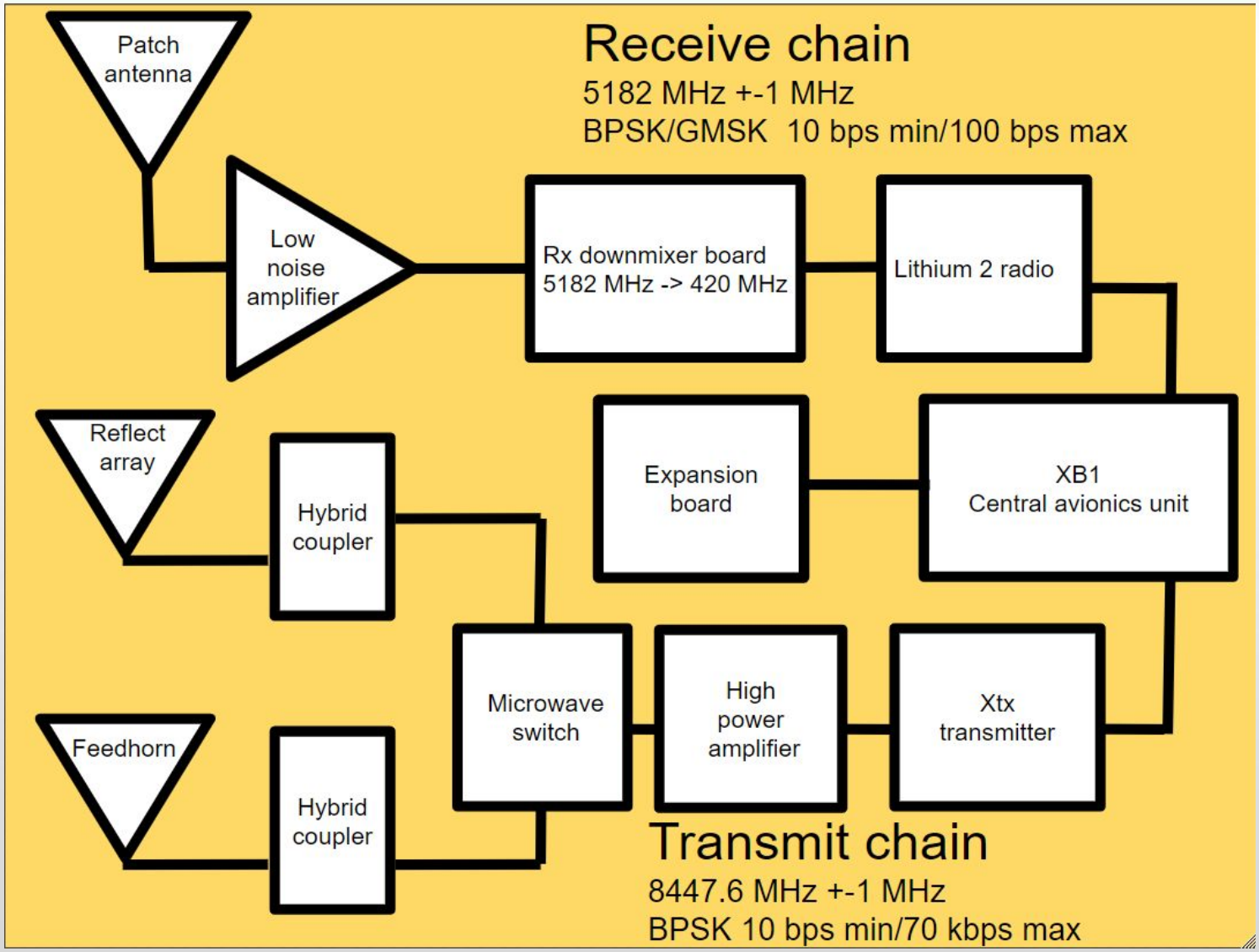
EPS
Batteries
Expansion EPS PCB
Main EPS PCB

COMM (Receive)
Receive Chain PCB
LNA
Patch Antenna

XB1 (ADCS/C&DH)
Reaction Wheels
Star tracker
Flight Computer

COMM (Transmit)
RF Switch
XTX
High Power Amplifier (HPA)
Primary Feedhorn
Hybrid Coupler (2)
Secondary Feedhorn

CU-E^3 Communications System



CU-E3 Sponsors/Stakeholders

CU Boulder Aerospace Engineering Sciences Department
Support of the CU-E3 program, providing mentorship, organization, funding, and facilities

NASA
Sponsoring the CubeQuest Centennial Challenge, providing guidance and monetary rewards.

Blue Canyon Technologies
Donating XB1 spacecraft system and Xtx transmitter.

Northrop Grumman
Mission donor

First RF
Communication product testing and consultation

ATLAS
Donating ground system support

RT Logic
Donating ground system radio

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