

# High School and University CubeSat Collaboration in Idaho

Dennis Zattiero

Caldwell High School

[dzattiero@caldwellschools.org](mailto:dzattiero@caldwellschools.org)

Stephen Parke

Northwest Nazarene University

[sparke@nnu.edu](mailto:sparke@nnu.edu)



NORTHWEST NAZARENE  
UNIVERSITY

★ Boise

IDAHO

# CubeSat Collaboration Background

- Existing relationship & trust between our schools
  - VEX Robotics Collaboration and travel together
  - Dual Credit Program together
- Initial plan was for 2016-17 school year relaxed schedule for a 2018 ELaNa20 flight
- But...in August 2016, SmallSat created opportunity for jumping onboard ELaNa14 with a very tight timeline



# Caldwell High School Science

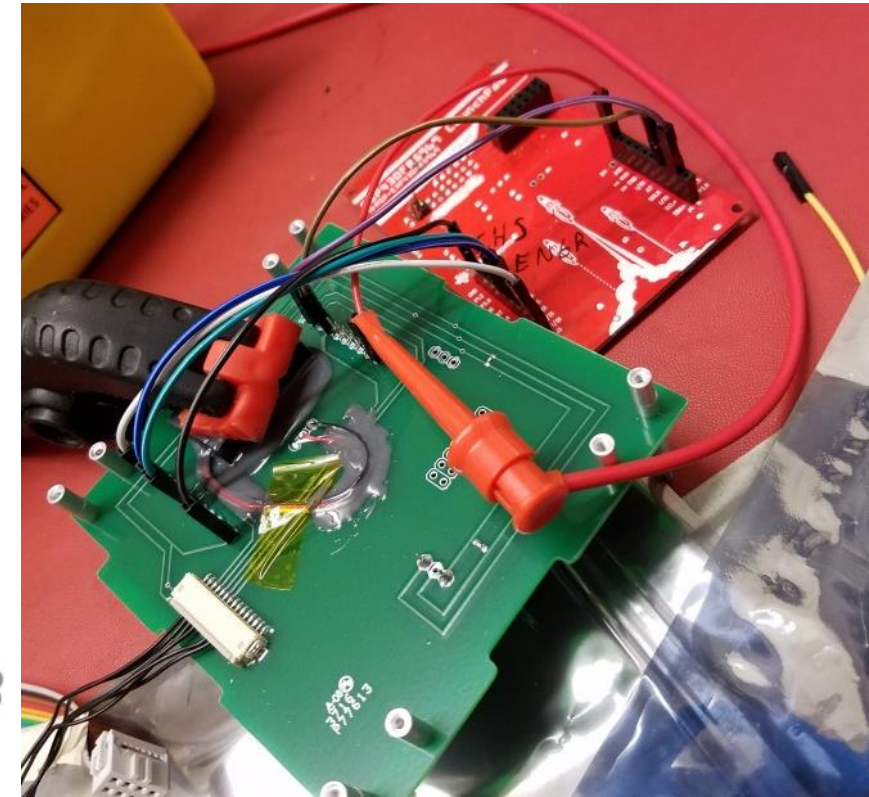
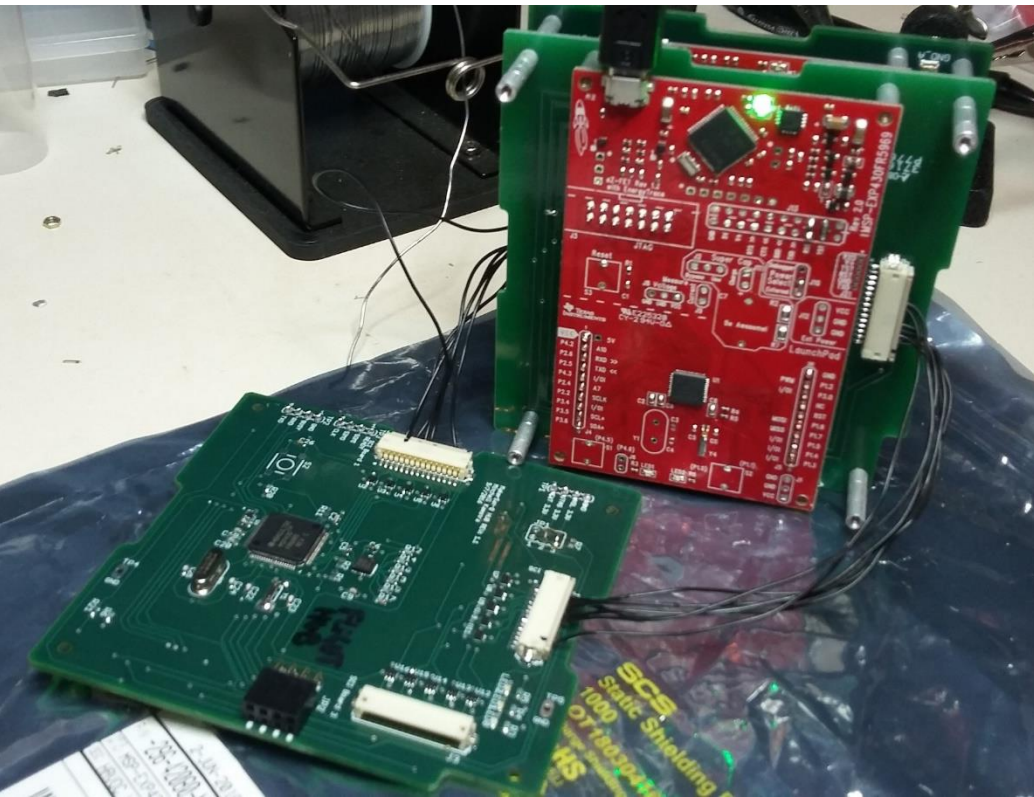
- Initial Science Ideas
  - VHF/UHF radio
  - Visible light beacon
  - CCD imaging camera
  - Total ionizing dose radiation (RadFET for TID)
  - ✓ Ionizing radiation particle counter “Space Weather” experiment
- Harsh Realities
  - Only two months to flight qualified hardware
  - Financial limitations, parts procurement time
  - No previous satellite experience

# CubeSat 101: Drinking from a firehose

- 8/6/16 Decision to join ELaNa14 mission
- How to rapidly build & integrate?
- 9/6 ENGR boards 1<sup>st</sup> pass build
- 9/13 ENGR boards 1<sup>st</sup> pass tested
- 9/14 ENGR boards 2<sup>nd</sup> pass build
- 9/20 ENGR boards 2<sup>nd</sup> pass tested
- 9/25 FLIGHT boards build @ Plexus
- 10/1 FLIGHT boards tested
- 10/5 NNU&CHS FLIGHT boards integ.
- 10/8-16 Integ. w/ BUS @ NSL Indiana
- 10/17-23 Environ tests @ SDL Utah
  - Shake and Bake
- 10/31-11/4 Shock test @ Tyvak
- 11/4 All test reports submitted
- This morning...Mission Readiness Review
- September 2017 Launch into Polar, sun-synchronous orbit

# TI MSP430 “LaunchPad” microcontroller daughterboard on simple science sensor motherboard: QUICK DEV. STRATEGY

- PIN Diode sensor w/3-wire interface from NSL
- TI MSP430 LaunchPad daughterboard (red)
- Simple 2-layer sensor motherboard (green)



# Software & Communications

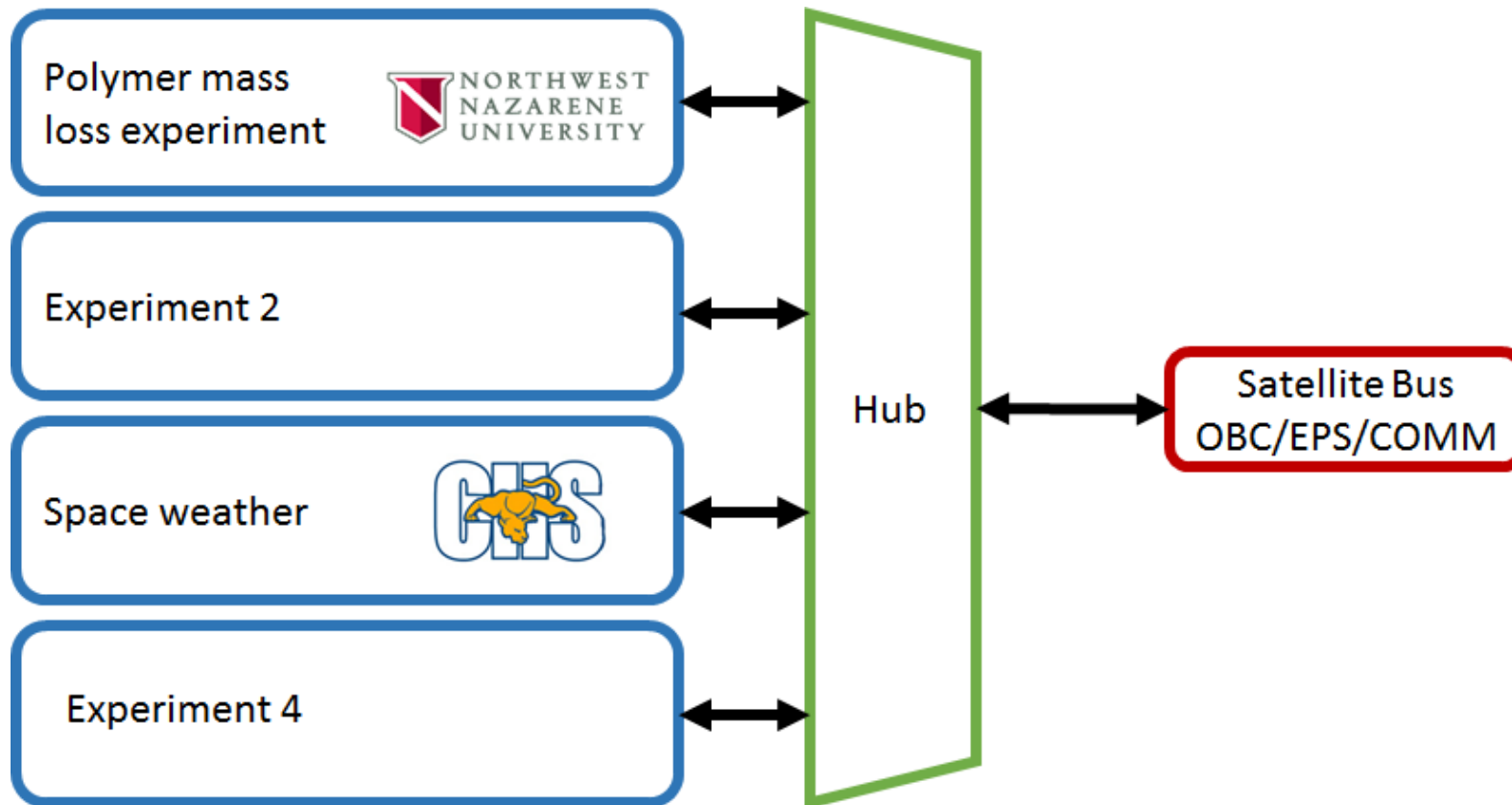
```
WDTCNTL = WDTPW | WDTHOLD; // Stop watchdog timer
//*****
//
// Below is the P1.3 interrupt configuration section.
//
//*****
PM5CTL0 &= ~LOCKLPM5; // Disable the GPIO power-on default
high-impedance mode ABSOLUTELY REQUIRED
P1DIR = 0x01; // Set Port 1 to input (now P1.0 output) was
P1REN |= 0x08; // was 0x02
P1SEL0 = 0x00; // Set as GPIO and not secondary function
P1SEL1 = 0x00;
P1IE |= BUTTON; // P1.3 interrupt enabled
P1IFG &= ~BUTTON; // P1.3 IFG cleared
P1IE |= BUTTON; // P1.3 interrupt enabled (initial function)
_enable_interrupt(); // intrinsic function
//*****
// Below is the TIMER1_A3 interrupt configuration section.
//
//*****
PM5();
continuous mode sourced by ACS
P1IFG(TIMER1_A3);
```

- Interrupt Driven
  - Simple Timer Interrupt
  - External Counter Interrupt
- Data Path
  - Radiation Particle Counter value is measured every 70 mins
  - count forwarded through HUB to
  - NSL Eyestar S2 simplex radio to
  - Globalstar satellite constellation to
  - Ground receiving stations to
  - NSL Data Server to
  - CHS & NNU student researchers cellphone or laptop app

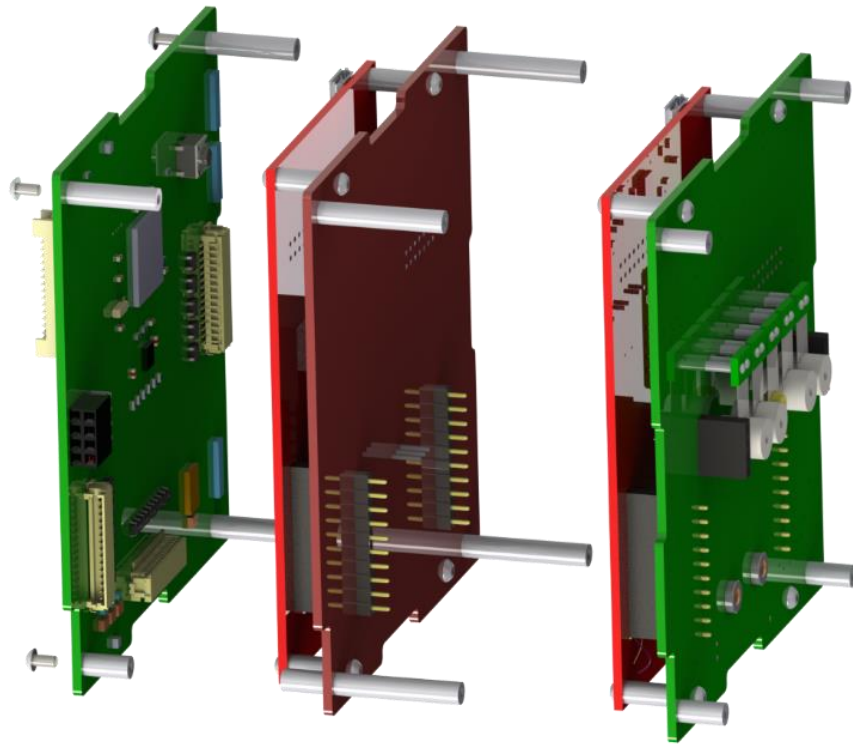
# HUB Architecture

MakerSat Multi-Project Satellite Architecture

Science “HUB” provides round-robin power control, data buffering, and radio communication to 4 science experiments.



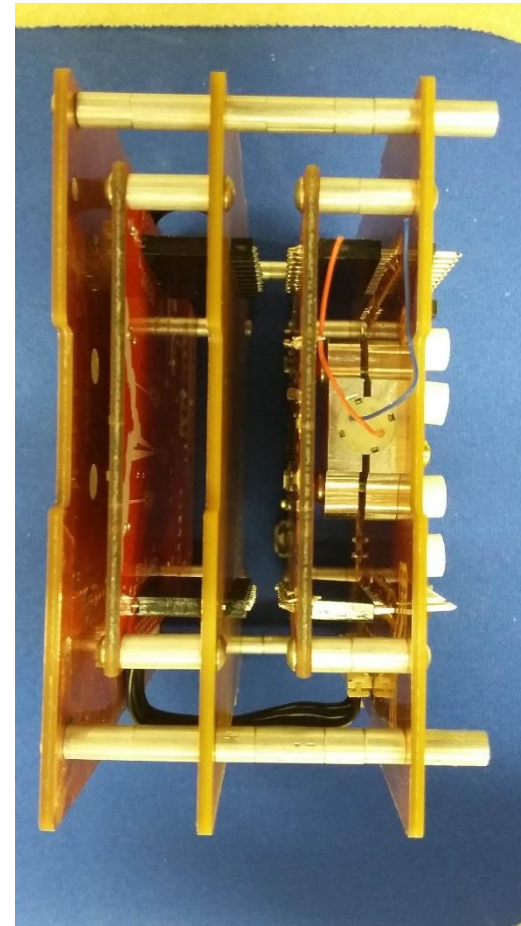
# Science Hub+CHS+NNU payload integration stack



Science Hub

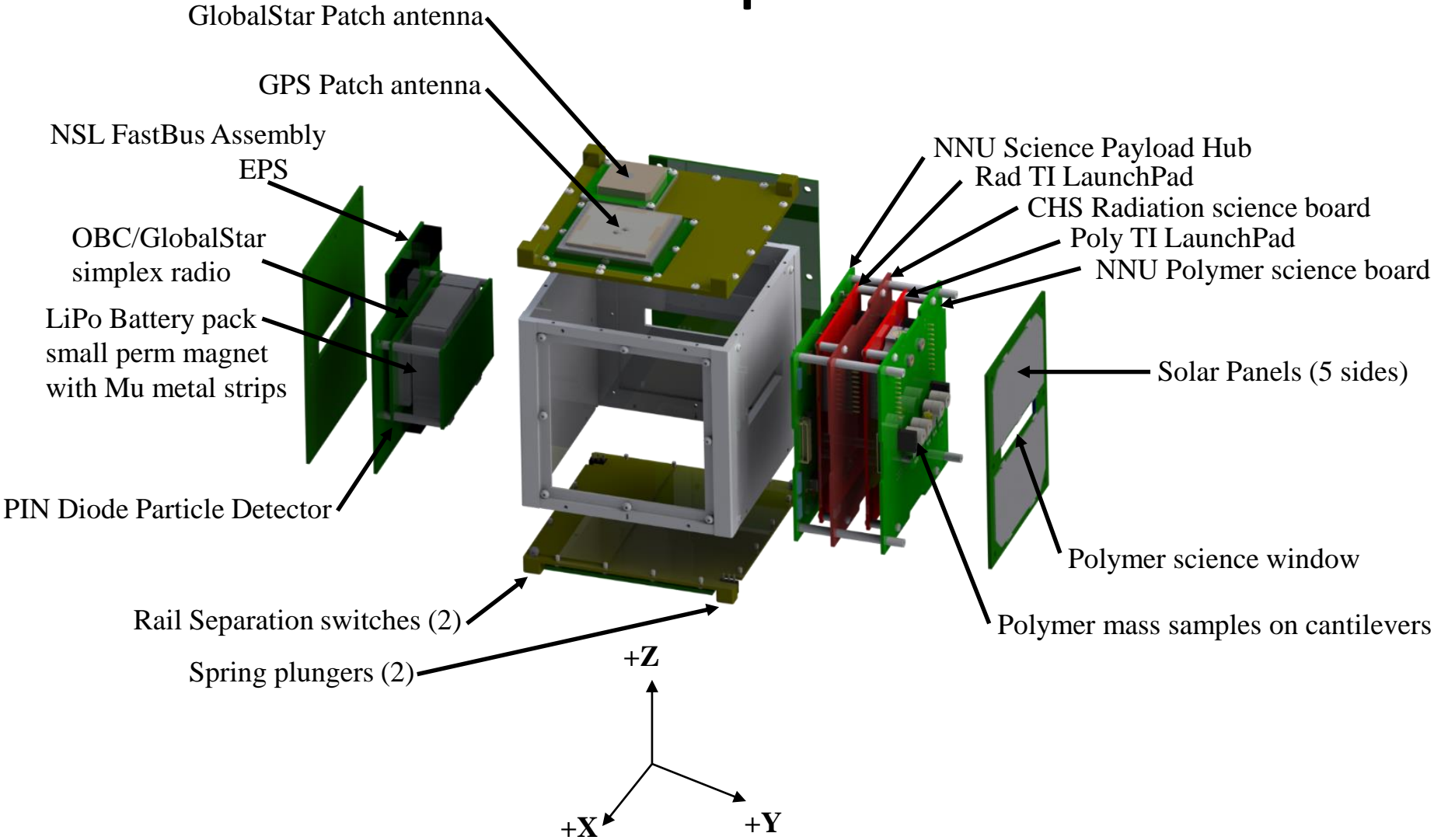
CHS Radiation  
Counter  
Experiment

NNU Polymer  
Mass Loss  
Experiment

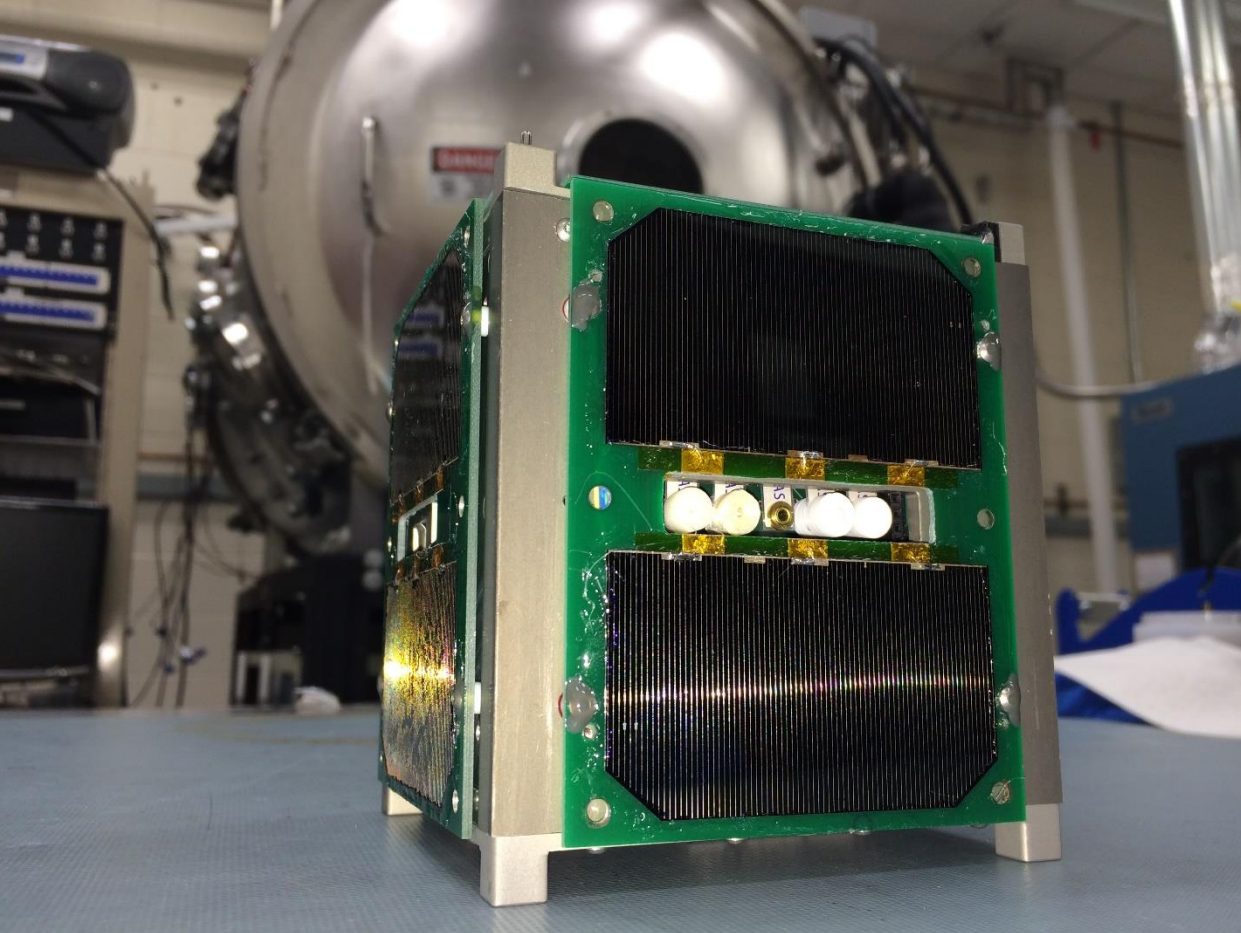


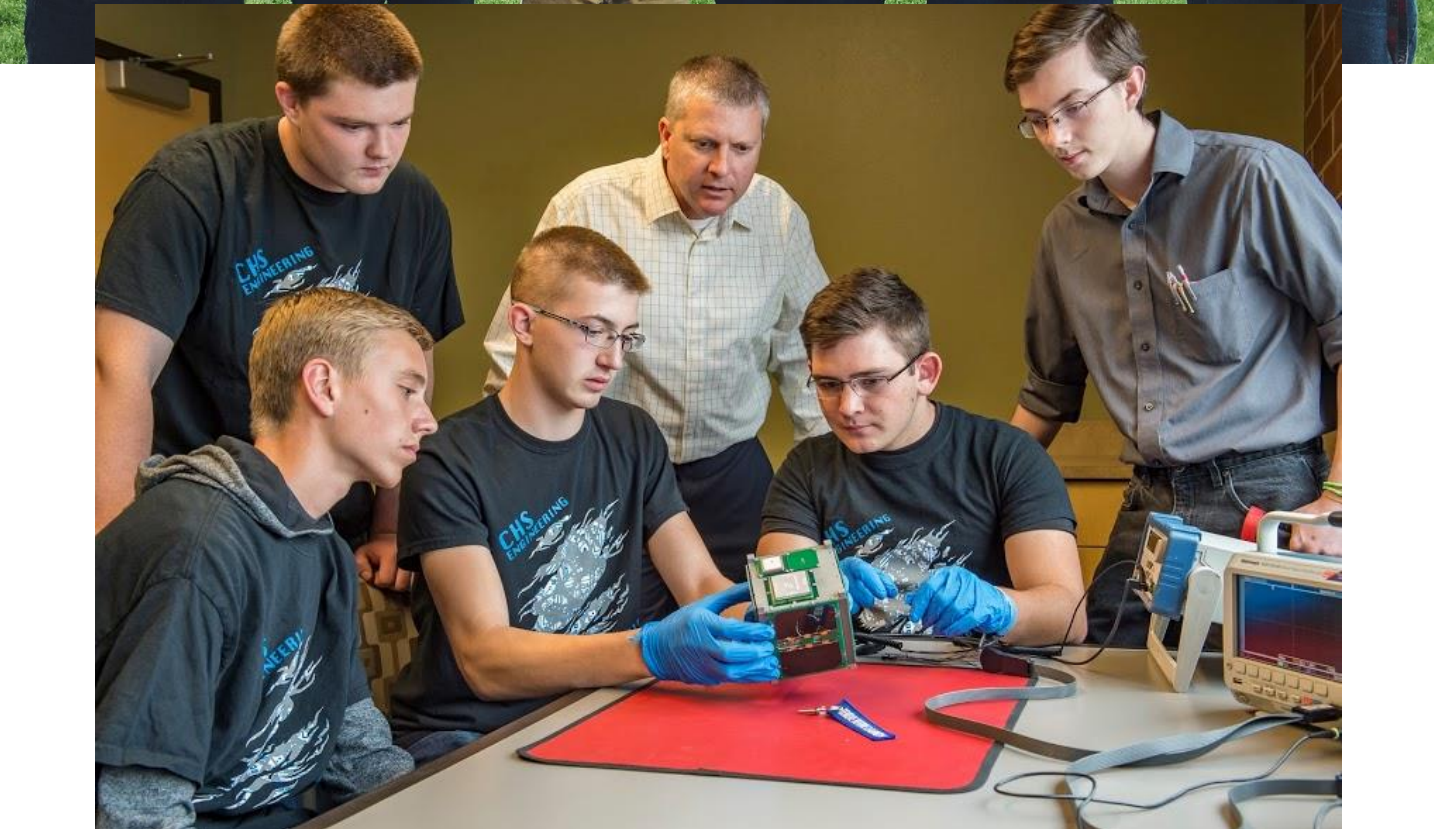
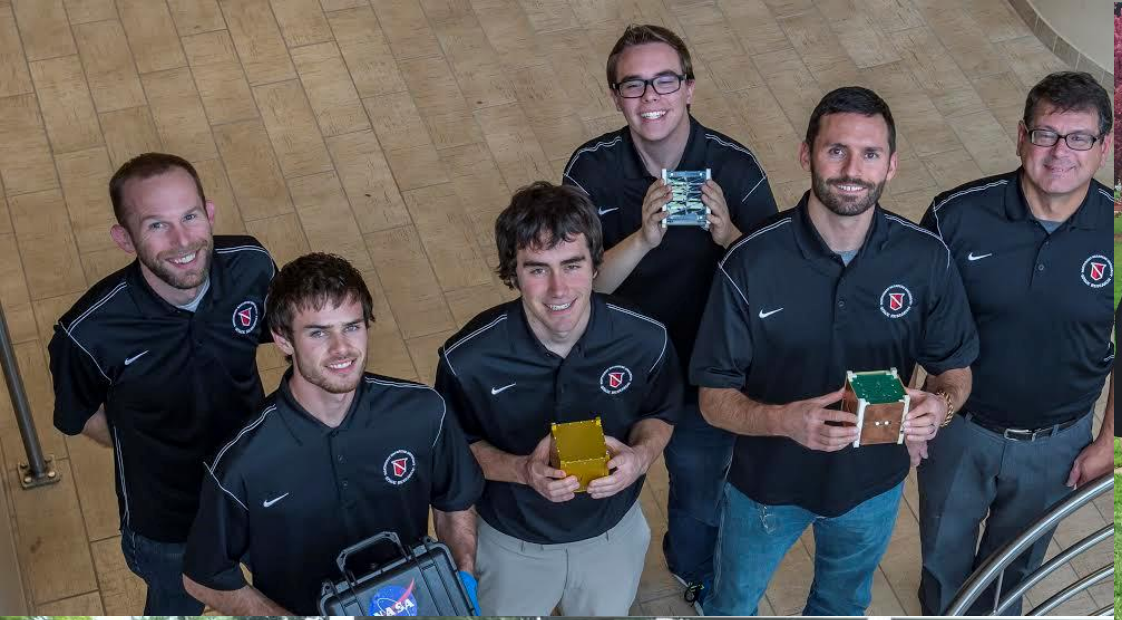


# Science Payload integration with 1U FastBus from NearSpaceLaunch



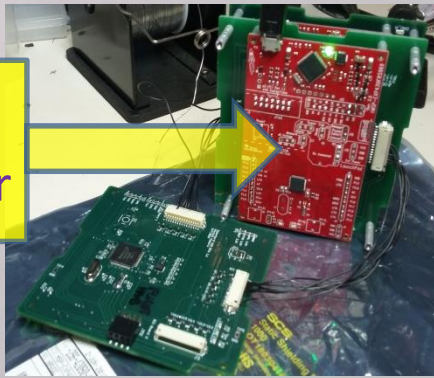
# Completed MakerSat-0



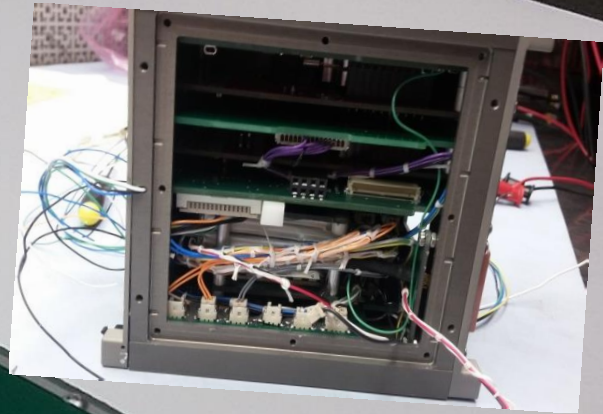


# CHS Engineering CubeSat Student Satellite Project

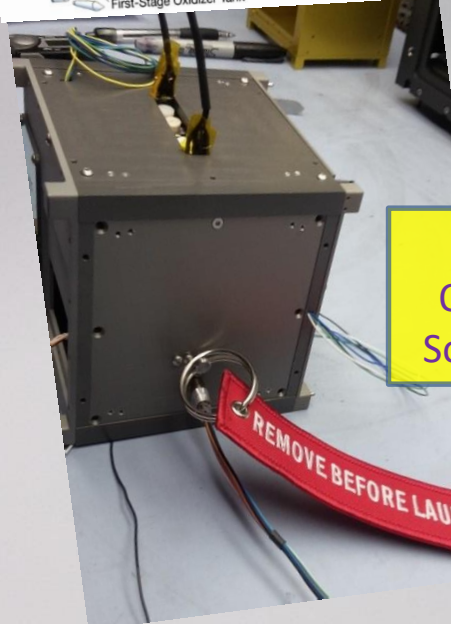
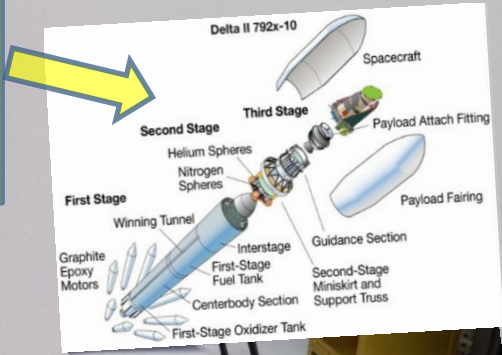
TI MSP430  
Microprocessor



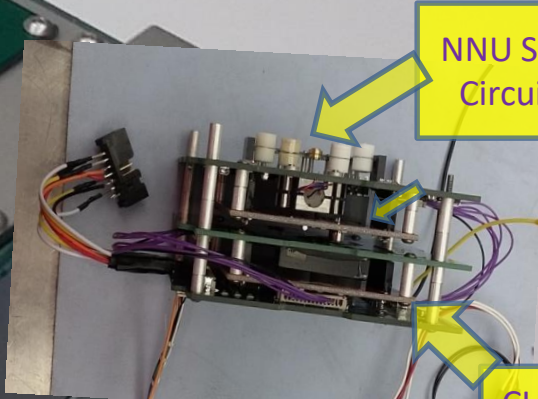
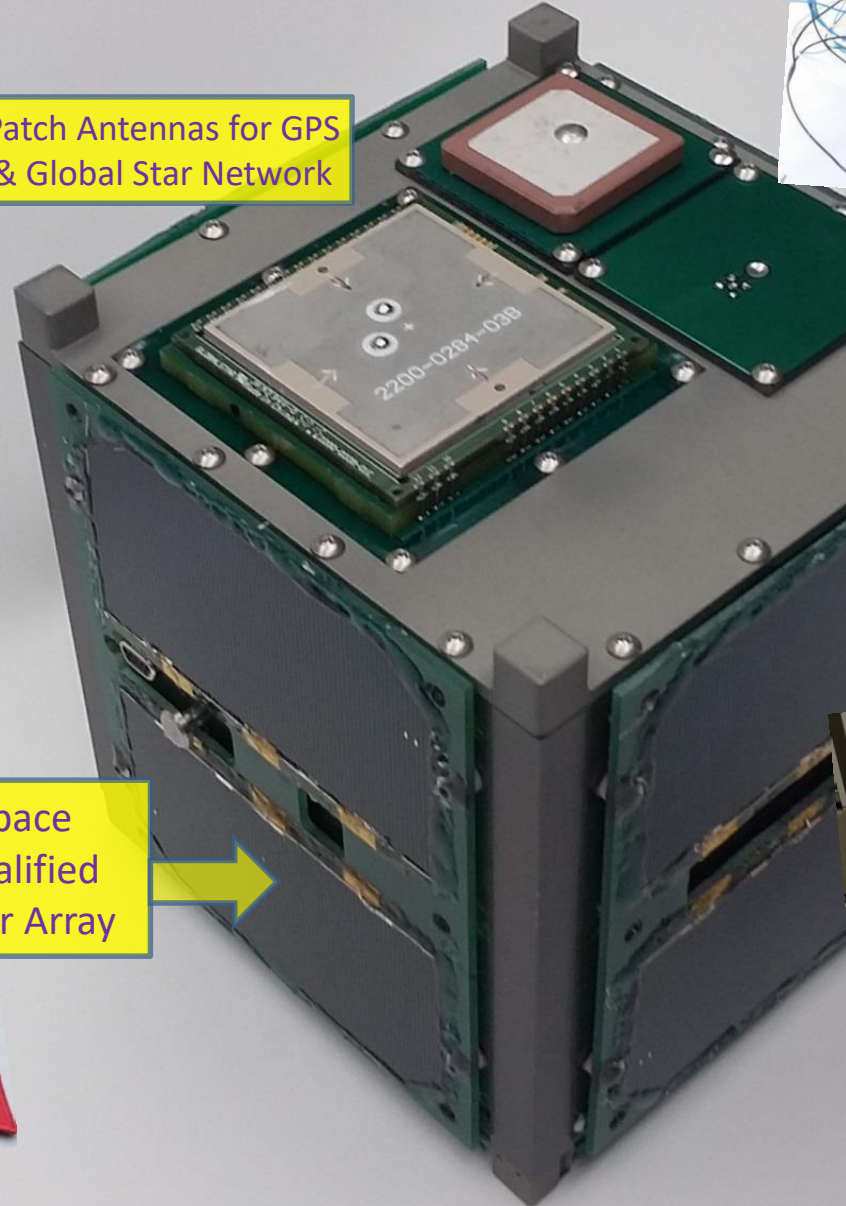
Patch Antennas for GPS  
& Global Star Network



Delta II  
Launch  
Vehicle

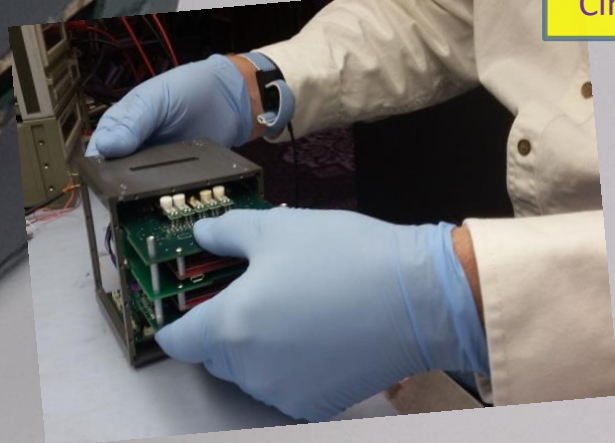


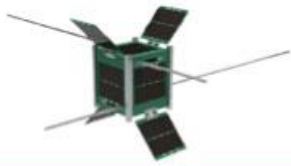
Space  
Qualified  
Solar Array



NNU Science Payload  
Circuit Board Stack

CHS Science Payload  
Circuit Board Stack





# 2016 CSLI Selections



# CubeSat Launch Initiative

## 2017 Selections

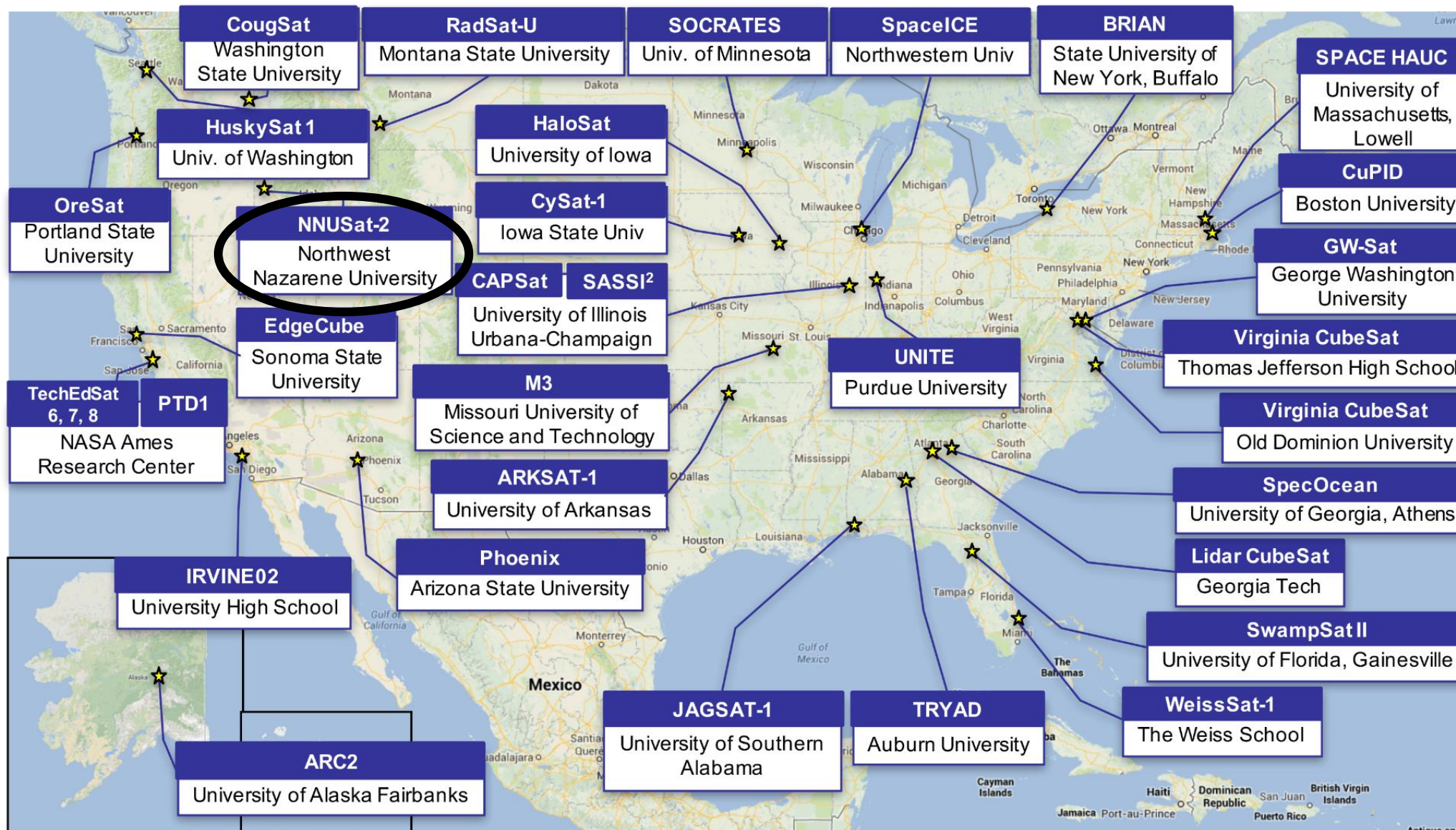
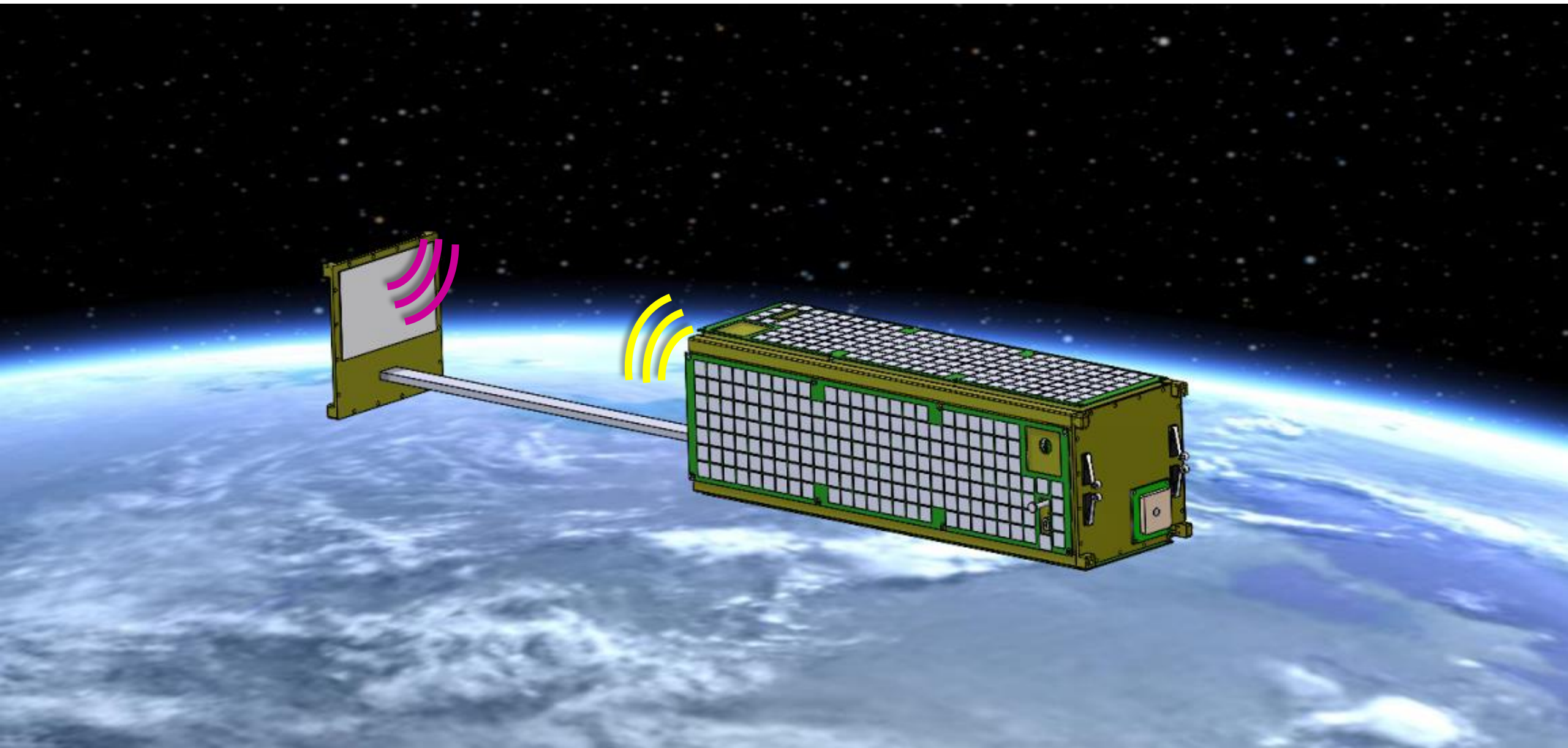
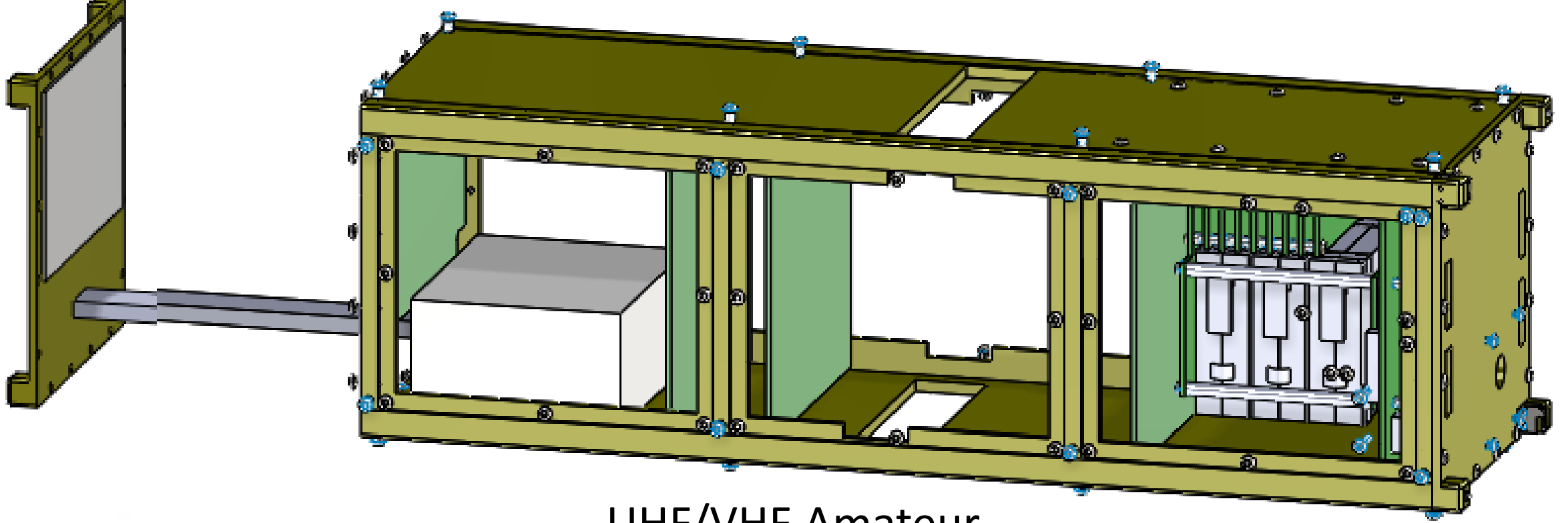


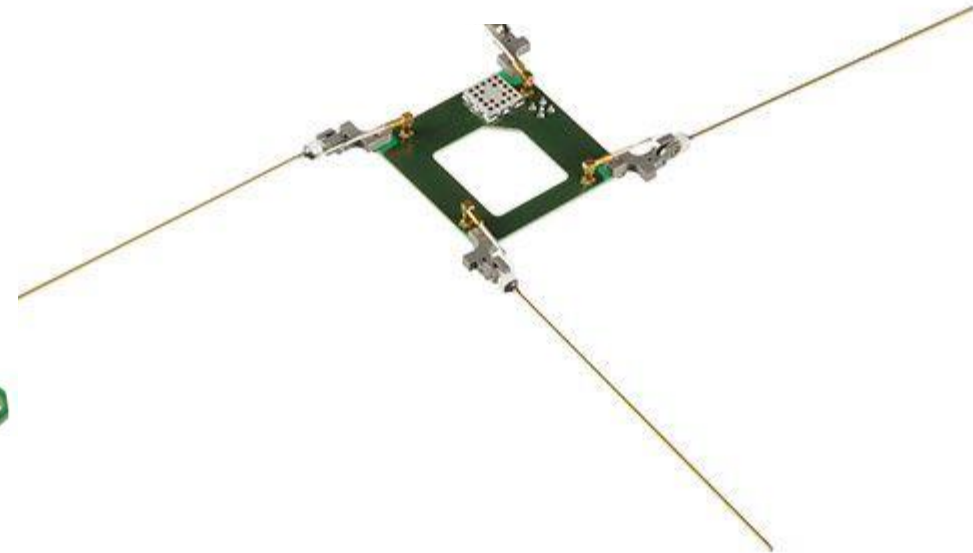
Image credit: NASA

# Second Collaborative CubeSat: Radio Frequency Tag (RFTSat) 2017-18





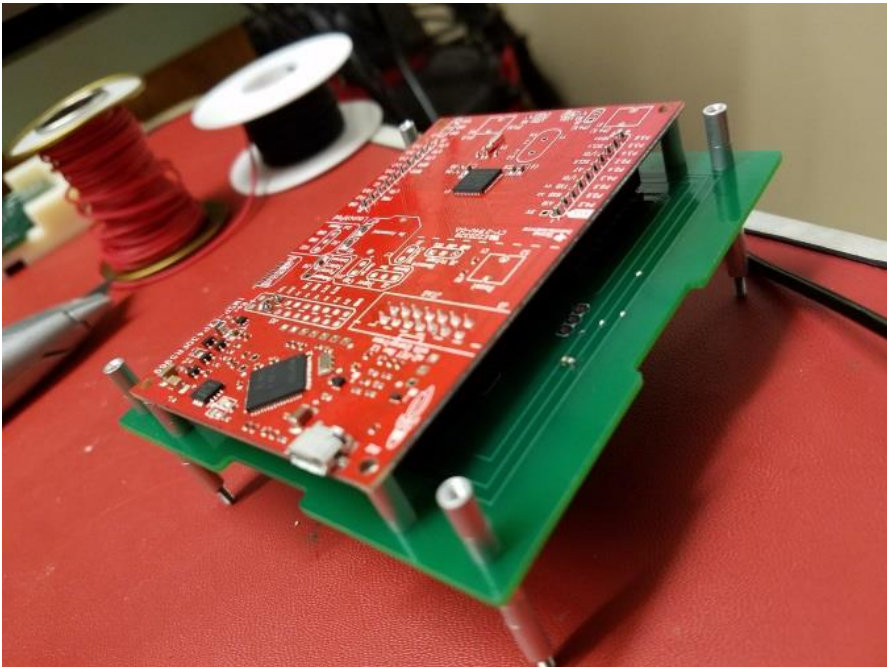
UHF/VHF Amateur  
Radio and camera





# Challenges

- University vs. high school setting
  - Skill levels, Logistics, Curfew
  - SolidWorks, Eagle CAD, Code Composer, Git Hub
- Qualification Testing



# A Recipe for Others to Follow?

- Workable Partnerships / Time to build Relationships
- STEM Education / Its not for show
- Students must be willing to hold themselves accountable
- Time Management / Logistics
- Cost

IT'S ABSOLUTELY WORTH IT !



Whiteboard content (handwritten notes):

- 2/11 - 10:00 AM
- 1/17 - 10:00 AM
- 1/24 - 10:00 AM
- 1/31 - 10:00 AM
- 2/7 - 10:00 AM
- 2/14 - 10:00 AM
- 2/21 - 10:00 AM
- 2/28 - 10:00 AM
- 3/6 - 10:00 AM
- 3/13 - 10:00 AM
- 3/20 - 10:00 AM
- 3/27 - 10:00 AM
- 4/3 - 10:00 AM
- 4/10 - 10:00 AM
- 4/17 - 10:00 AM
- 4/24 - 10:00 AM
- 5/1 - 10:00 AM
- 5/8 - 10:00 AM
- 5/15 - 10:00 AM
- 5/22 - 10:00 AM
- 5/29 - 10:00 AM
- 6/5 - 10:00 AM
- 6/12 - 10:00 AM
- 6/19 - 10:00 AM
- 6/26 - 10:00 AM
- 7/3 - 10:00 AM
- 7/10 - 10:00 AM
- 7/17 - 10:00 AM
- 7/24 - 10:00 AM
- 7/31 - 10:00 AM
- 8/7 - 10:00 AM
- 8/14 - 10:00 AM
- 8/21 - 10:00 AM
- 8/28 - 10:00 AM
- 9/4 - 10:00 AM
- 9/11 - 10:00 AM
- 9/18 - 10:00 AM
- 9/25 - 10:00 AM
- 10/2 - 10:00 AM
- 10/9 - 10:00 AM
- 10/16 - 10:00 AM
- 10/23 - 10:00 AM
- 10/30 - 10:00 AM
- 11/6 - 10:00 AM
- 11/13 - 10:00 AM
- 11/20 - 10:00 AM
- 11/27 - 10:00 AM
- 12/4 - 10:00 AM
- 12/11 - 10:00 AM
- 12/18 - 10:00 AM
- 12/25 - 10:00 AM
- 1/1 - 10:00 AM
- 1/8 - 10:00 AM
- 1/15 - 10:00 AM
- 1/22 - 10:00 AM
- 1/29 - 10:00 AM
- 2/5 - 10:00 AM
- 2/12 - 10:00 AM
- 2/19 - 10:00 AM
- 2/26 - 10:00 AM
- 3/5 - 10:00 AM
- 3/12 - 10:00 AM
- 3/19 - 10:00 AM
- 3/26 - 10:00 AM
- 4/2 - 10:00 AM
- 4/9 - 10:00 AM
- 4/16 - 10:00 AM
- 4/23 - 10:00 AM
- 4/30 - 10:00 AM
- 5/7 - 10:00 AM
- 5/14 - 10:00 AM
- 5/21 - 10:00 AM
- 5/28 - 10:00 AM
- 6/4 - 10:00 AM
- 6/11 - 10:00 AM
- 6/18 - 10:00 AM
- 6/25 - 10:00 AM
- 7/2 - 10:00 AM
- 7/9 - 10:00 AM
- 7/16 - 10:00 AM
- 7/23 - 10:00 AM
- 7/30 - 10:00 AM
- 8/6 - 10:00 AM
- 8/13 - 10:00 AM
- 8/20 - 10:00 AM
- 8/27 - 10:00 AM
- 9/3 - 10:00 AM
- 9/10 - 10:00 AM
- 9/17 - 10:00 AM
- 9/24 - 10:00 AM
- 10/1 - 10:00 AM
- 10/8 - 10:00 AM
- 10/15 - 10:00 AM
- 10/22 - 10:00 AM
- 10/29 - 10:00 AM
- 11/5 - 10:00 AM
- 11/12 - 10:00 AM
- 11/19 - 10:00 AM
- 11/26 - 10:00 AM
- 12/3 - 10:00 AM
- 12/10 - 10:00 AM
- 12/17 - 10:00 AM
- 12/24 - 10:00 AM
- 12/31 - 10:00 AM

MADE IN SPACE

COUGARS

NN

MAHO