High School and University CubeSat Collaboration in Idaho

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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)
  ñ 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\textsuperscript{st} pass build
- 9/13 ENGR boards 1\textsuperscript{st} pass tested
- 9/14 ENGR boards 2\textsuperscript{nd} pass build
- 9/20 ENGR boards 2\textsuperscript{nd} 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
• TI MSP430 LaunchPad daughterboard (red)
• Simple 2-layer sensor motherboard (green)
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 Payload integration with 1U FastBus from NearSpaceLaunch

- NSL FastBus Assembly
- EPS
- PIN Diode Particle Detector
- OBC/GlobalStar simplex radio
- LiPo Battery pack
  small perm magnet
  with Mu metal strips
- Rail Separation switches (2)
- Spring plungers (2)
- GlobalStar Patch antenna
- GPS Patch antenna
- NNU Science Payload Hub
- CHS Radiation science board
- Poly TI LaunchPad
- NNU Polymer science board
- Solar Panels (5 sides)
- Polymer science window
- Polymer mass samples on cantilevers
- GPS Patch antenna
- GlobalStar Patch antenna
- NNU Science Payload Hub
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Completed MakerSat-0
Software & Communications

- **Interrupt Driven**
  - Simple Timer Interrupt
  - External Counter Interrupt

- **Data Path**
  - Radiation Particle Counter value is measured every 70 mins
  - 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
CHS Engineering CubeSat
Student Satellite Project

- Delta II Launch Vehicle
- TI MSP430 Microprocessor
- CHS Science Payload
- Circuit Board Stack
- NNU Science Payload
- Circuit Board Stack
- Patch Antenna for Global Star Satellite Phone Data Downlink
- Space Qualified Solar Array
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 / It's not for show
• Students must be willing to hold themselves accountable
• Time / Logistics
• Cost
• But it is worth it!
Thank you!
Questions?