How Not to Build a CubeSat – Lessons Learned from Developing and Launching NMSU’s First CubeSat

Kyle Rankin, Ian McNeil, Ian Rankin, Steven Stochaj
New Mexico State University
krankii@nmsu.edu
INCA Program Overview

• NMSU’s first SmallSat in many years
• Student led
• Collaboration between NMSU and NASA Goddard
  • Goddard – Science Instrument
  • NMSU – S/C bus
• 3U CubeSat
• Manifested to launch on ELaNa 20
Science Overview

• Silicon Photo Multiplier (SiPM) based Neutron Detector

• Objectives
  • Demonstrate Functionality of SiPM’s in LEO
  • Measure latitude dependence of neutron flux in LEO
  • Measure temporal dependence of neutron flux in LEO
  • Detect a solar Neutron (stretch goal)

• P-Terphenyl Scintillators

• Measures particle energy by TOF between Scintillators
Spacecraft Architecture

- 3-U Spacecraft based on a COTS CubeSat kit
- Custom solar panels
- Partially custom power system
- Duel computer set up
  - Beaglebone for payload
  - COTS SmallSat computer for avionics
- Custom Sun Sensor
University Nanosat Program

• Started in 2012 under UNP NS-8
• Originally 6U
• Down selected in 2015
  • Mission significantly behind UNP schedule
• Guaranteed launch opportunity if UNP selects you
Converting to a 3U

• 6U larger than strictly necessary
• Few launch opportunities for 6U’s in 2015
• Slightly reduced length of Neutron Detector
  • Minor reduction in energy resolution
Launch Selection

• Applied to CSLI in 2015
  • 6U – Rejected
• Re-Applied to CSLI in 2016
  • 3U – Accepted
• Manifested on ELaNa 20
  • Virgen Galactic’s LauncherOne
• No cost to INCA - sort of
  • Some travel required
  • There are some minor costs – no funds are transferred to NASA
Program Management

• Long term project in university timescales
• Multiple generations of students
• Difficult to make progress with deadlines years away
  • Create closer deadlines with actual penalties
• Test plan
  • Follow it!!!
• Find Experts
  • You might have to pay them
Personnel

- High turnover rate due to graduation
  - Recruit constantly
  - Plan for continuity
    - Documentation
    - Co-Leads

- Pay key students
  - Most undergraduates can’t put necessary hours in while working another job
COTS Parts

• Research companies
  • Some are vary good, some not so much
  • These manufactures will essentially become a part of your team

• S/C COTS are not like consumer COTS
  • Small batches
  • Much more support typically required
    • You will ask your suppliers for information that you would never get from consumer parts
    • Large user groups not typically available
Partnerships

• Rewarding but complex
• Communicate communicate communicate communicate
  • Meet regularly – make sure you have technical people involved
  • Clearly define responsibilities
    • Particularly on interface parts
  • Clearly define interfaces
    • Make ICD’s

Example of creative fix for inadequate interface design.
Conclusion

• Test Early Test Often
• Documentation
• Recruit
• Communicate