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

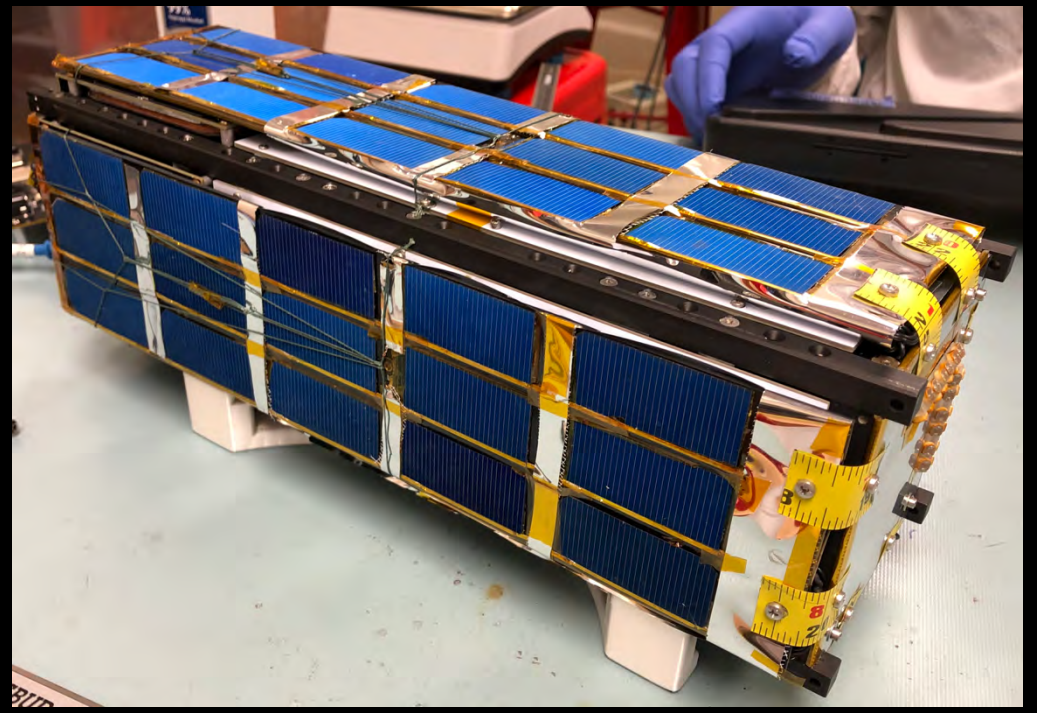
Kyle Rankin, Ian McNeil, Ian Rankin, Steven Stochaj

New Mexico State University

krankii@nmsu.edu

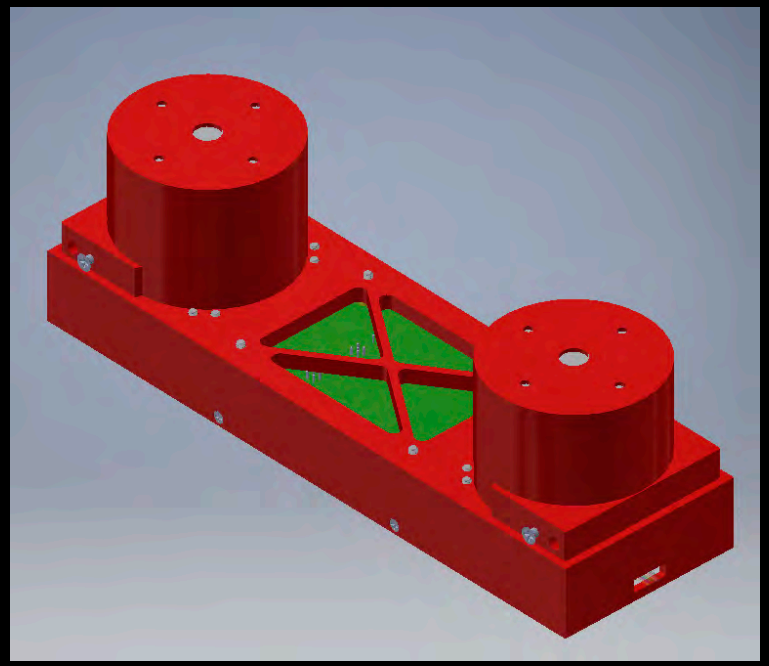
INCA Program Overview

- 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



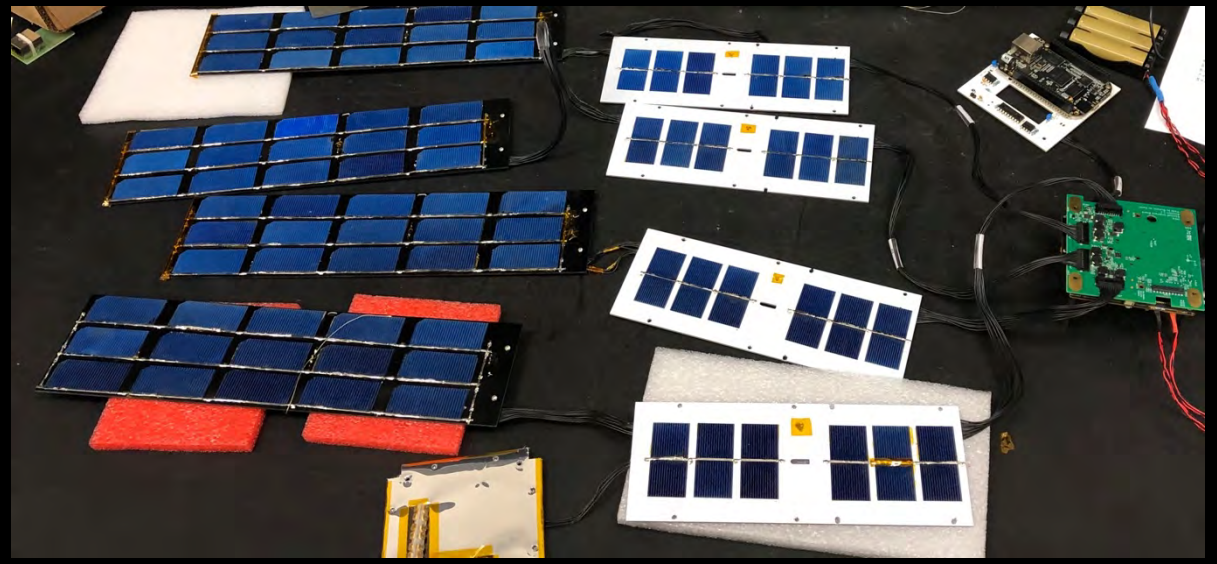
Science Overview

- 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



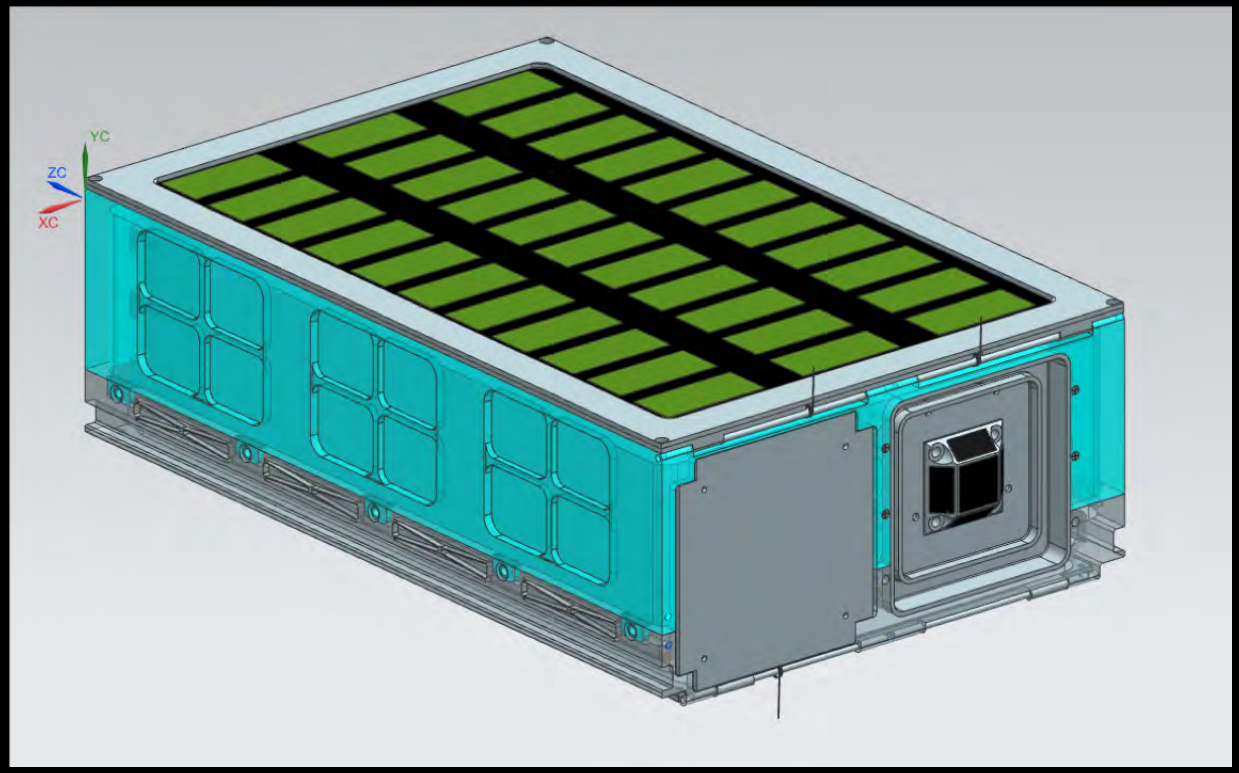
Spacecraft Architecture

- 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 then 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

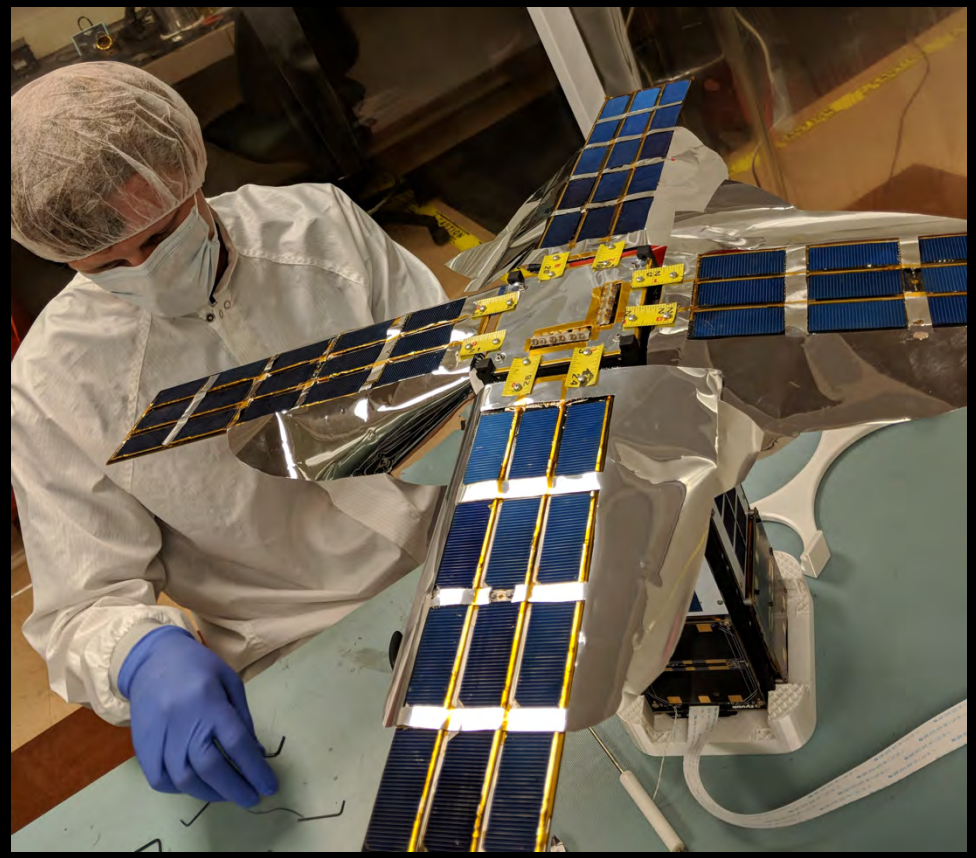
Partnerships

- Rewarding but complex
- Communicate communicate communicate
  - 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



Questions?