COSMIC X-RAY BACKGROUND NANOSAT

Spring 2011 CubeSat Developer's Workshop

Tyler G. Rose, *Student Project Lead*

Benjamin K. Malphrus, *Mentor*

Kevin Z. Brown, *Mentor*

MISSION – TEAM

- Morehead State University (MSU)

  Benjamin Malphrus, Kevin Brown, Bob Twiggs, Jeff Kruth, Robert Kroll, Thomas Pannuti, Margaret Powell, Andrew Cavins, Jedidiah Reader, Brad Schneider, Tyler Rose

- UC Berkeley

  Garrett Jernigan

- Noqsi Aerospace, Ltd.

  John Doty, Matthew Wampler-Doty

- Lawrence Livermore National Laboratories (LLNL)

  Lance Simms

- Sonoma State University (SSU)

  Steve Anderson, Lynn Cominsky, Kamal Prasad

MISSION – DESCRIPTION

- Very few flux measurements of high energy cosmic X-ray background have been made
- Make precise measurements of the cosmic X-ray background (CXRB)
  - Intended range: 30-50 keV
  - Valuable for many reasons:
    - Ensure proper background subtraction when studying objects near the same emission (outskirts of clusters and groups of galaxies)
    - About 30% of the emission is unaccounted for considering discrete sources and clustered phenomena
      - Origin?
    - Lends insight into the evolution of primordial galaxies

MISSION – DESCRIPTION

- Selected for ELaNa VI with expected flight for 2012
- Orbit
  - Moderate inclination
  - Altitude approximately 500 km
- 2U CubeSat
  - 1U – Payload
  - 1U – Support

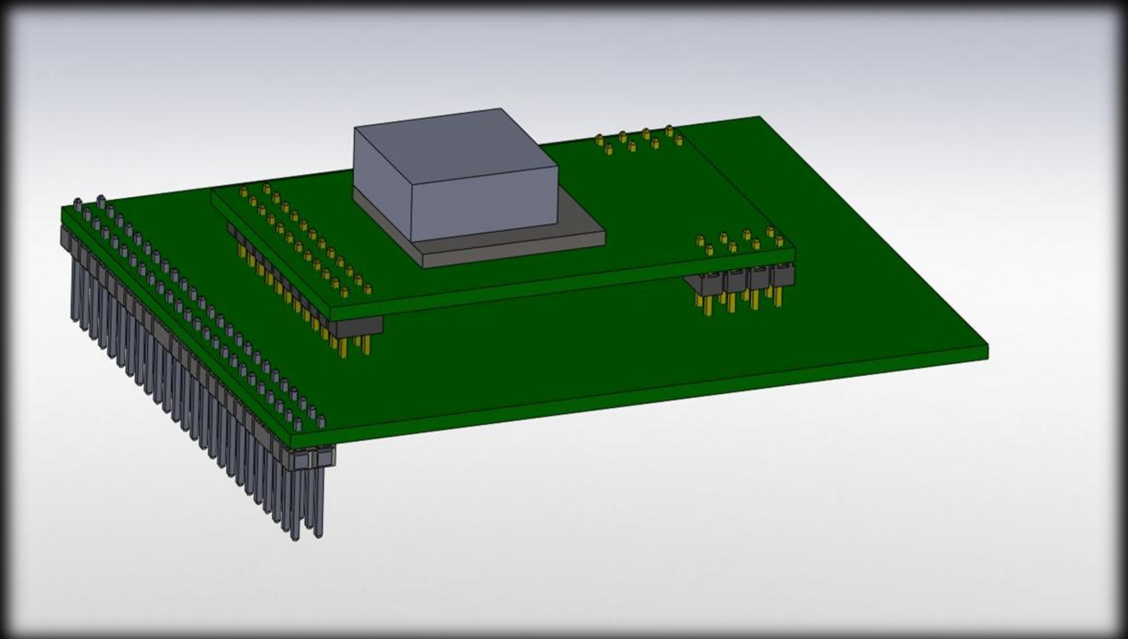
MISSION - CONSTRAINTS

- Time – project completion date scheduled for Dec. 2012
  - Keep it simple
- Drive costs to a minimum
  - Keep it simple
  - Maximize subsystem reuse
  - Utilize internal resources – prototyping, manufacturing, testing
- 3 degrees, 3 sigma accuracy for attitude knowledge
  - Post-process ADCS sensor data to reduce payload data
  - Spin stabilize

PAYLOAD

- Cadmium Zinc Tellerium (CZT) Detector Array
  - Goal: < 5% flux measurement precision
  - Designed by UC Berkeley, LLNL, Noqsi Aerospace, and SSU
  - Features a collimator for preventing stray particles
  - Shielding - layered lead, copper, and tantalum

PAYLOAD



Early CAD model of payload CZT detector array

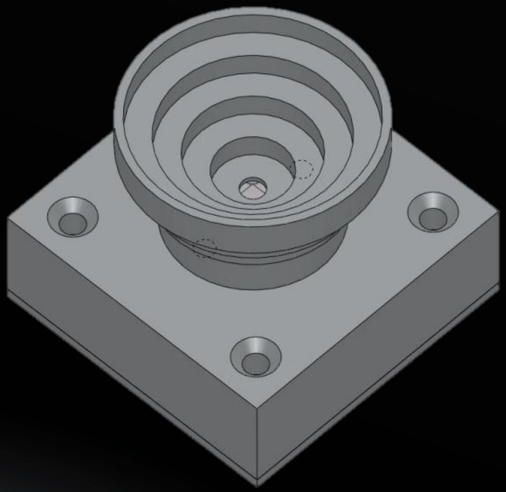
ADCS

- Determination
  - Sun Sensors
    - Coarse (CSS)
    - Medium (MSS)
    - Fine (FSS)
  - Canopus Pipper
  - Magnetometer
  - MEMS Gyro
- Control
  - Magnetorquers
  - Simulink simulation for control tuning

ADCS - DETERMINATION

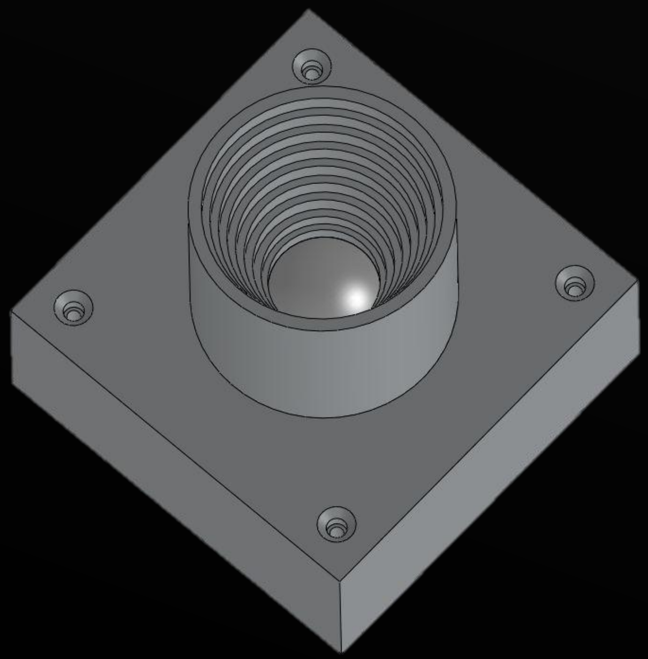
- Sun Sensors
  - Coarse, Medium, and Fine angular resolution
  - Sun pointing
    - Boresight
  - Testing through rapid-prototyped parts

- (Right) CAD Model
- (Right Top) Rapid-prototyped sun sensor assembled



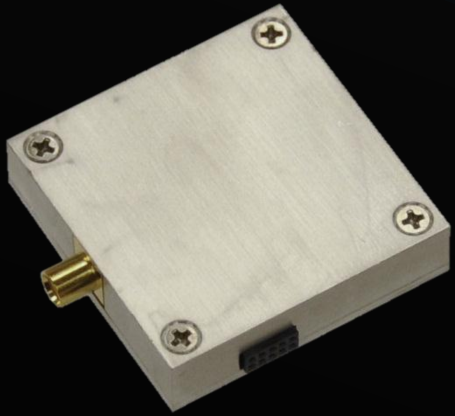
ADCS - DETERMINATION

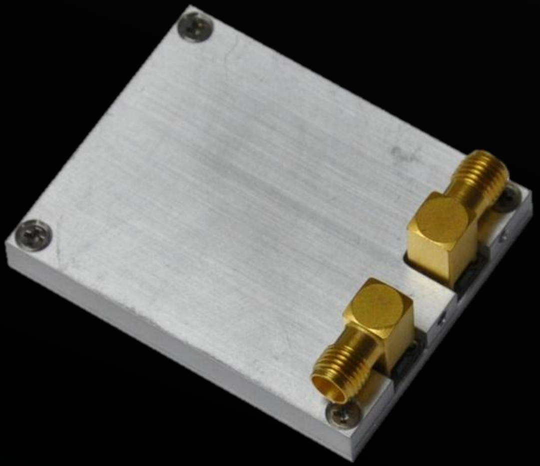
- Canopus Pipper
    - Star Sensor
    - Determine roll rate
    - Testing
        - Rapid-prototype frame and collimator
        - Calibrate on ground
- (Right) CAD Model



COMM

- Radios:
  - AstroDev CII:
    - UHF-UHF Transceiver
  - AstroDev Beryllium 2:
    - S-Band Transmitter
- Antennas:
  - Steel tape whip antennas





C&DH PROCESSOR

- Texas Instruments:
  - OMAP 3530
    - ARM Cortex-A8, 720 MHz
    - Linux OS
    - Power efficient

POWER

- Body mount solar cells and fold out panels
    - Sun pointing: moderate incident angles - no MPPT
- Batteries – lithium ion
    - Higher capacity
- In-house designed direct energy transfer
    - Keep it simple
    - Quick turn-around

STRUCTURE

- Complete CAD model before manufacturing
  - Leverages previous design work
- Rapid-prototyped and machined onsite
  - Quick turn-around
  - Lower costs

GROUND STATIONS

- 21 meter Space Tracking Antenna at MSU
  - S-Band communication
- Dual Band Yagi Antenna
  - UHF communication
- Portable Satellite Tracking Kits
  - Primarily an E / PO effort
  - Dual Band Yagi Antennas

ESTIMATED TIMELINE

Cosmic X-Ray Background Nanosat (CXBN) Mission Timeline

		2011											
#	Event	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
1	Science Mission Concept												
2	Spacecraft Design Concept												
3	Payload Requirements Defined												
4	Design / Prototype Phase												
5	Development / Production Phase												
6	Preliminary Design Review												
7	Eng. Model Prototype & Production												
8	Eng. Model Functional Testing												
9	Interface Control Document Received												
10	Critical Design Review												
11	Flight Unit Orders												
12	Flight Systems Fabrication / Assembly												
13	Flight Payload Fabrication / Assembly												
14	Flight Payload Integration												
15	Flight Model Functional Testing												
16	Test Results Provided												
17	Preflight Testing onsite (2U Only)												
18	Preflight Testing offsite (2U Only)												
19	Comprehensive Test Report												

CONCLUSION

- On pace for delivery of a rapidly constructed 2U
    - Start to finish – 8 months!