COSMIC X-RAY BACKGROUND NANOSAT

Spring 2011 CubeSat Developer's Workshop

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MISSION – TEAM

- Morehead State University (MSU)

  Benjamin Malphrus, Kevin Brown, Bob Twiggs, Jeff Kruth, Mike Combs, 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)

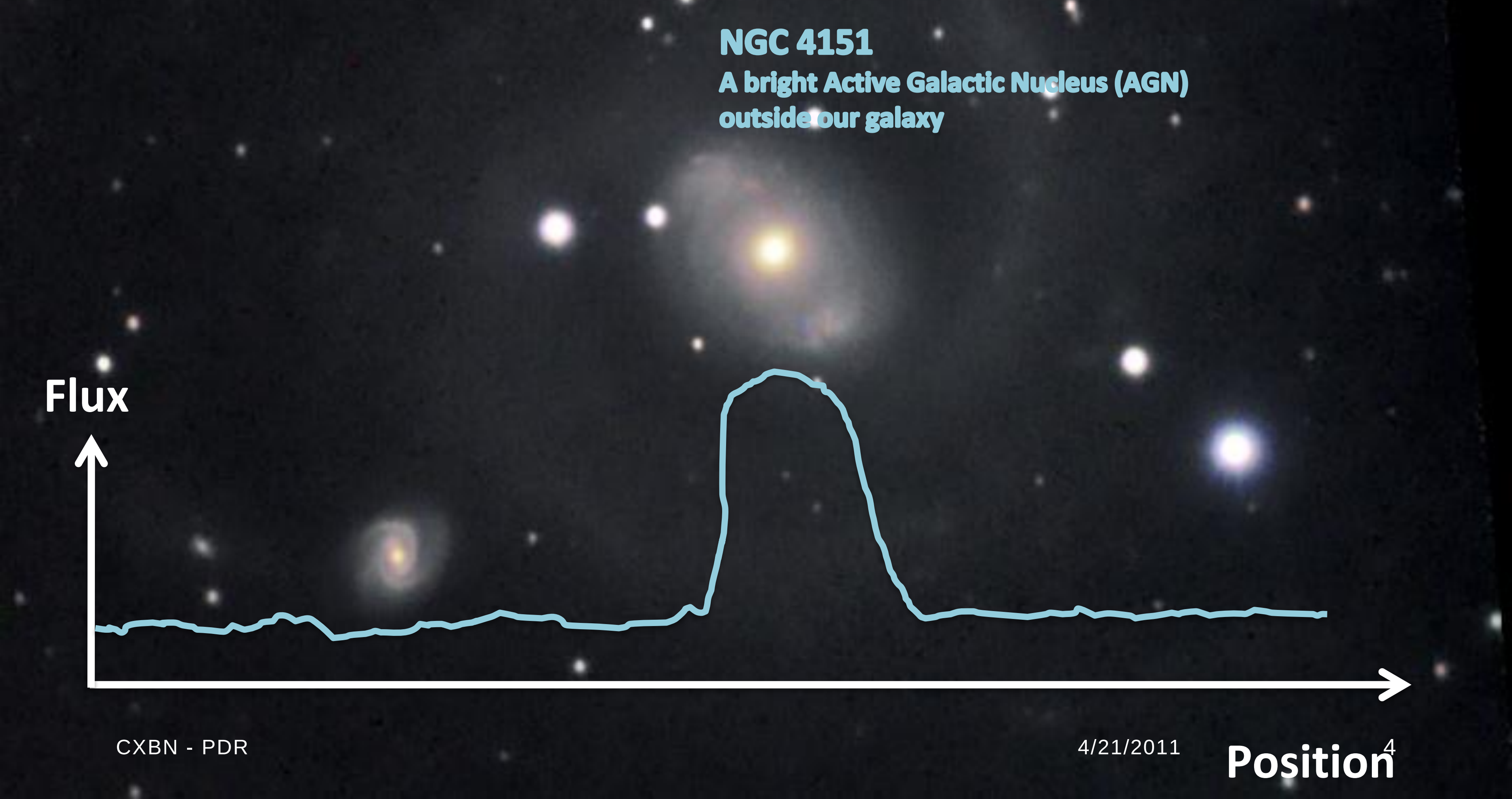
  Steve Anderson, Lynn Cominsky, Kamal Prasad

MISSION – DESCRIPTION

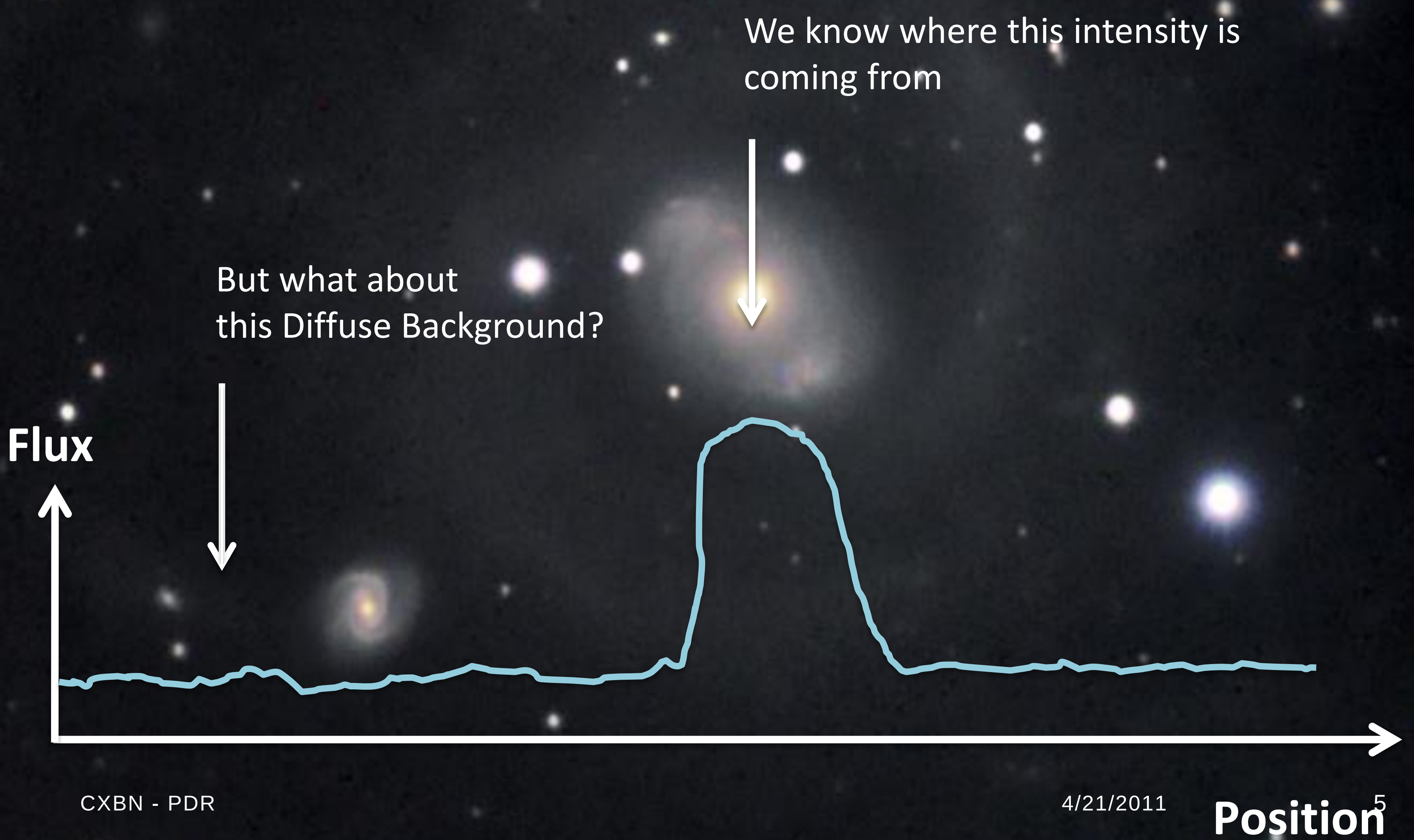
- Very few flux measurements of high energy cosmic X-ray background have been made
- Goal: Make precise measurements of the cosmic X-ray background (CXRB)
  - Intended range: 30-50 keV
  - Valuable for many reasons:
    - Ensure proper background subtraction when studying objects near the same emission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

MISSION – X-RAY BACKGROUND

- Slides Courtesy of Lance Simms, LLNL



MISSION – X-RAY BACKGROUND



MISSION – X-RAY BACKGROUND

- Is the Cosmic X-Ray Background (CXRB) due to AGN that are too distant to resolve with our telescopes or something else?

> *"… the cosmic X-ray background (CXRB), still remains one of the most interesting topic of X-ray astronomy and observational cosmology."*
>
> - Revnivtsev et al., A&A 444, 2005

MISSION – DESCRIPTION

- Selected for ELaNa VI with expected flight for 2012
- Orbit
  - Moderately-high inclination
  - Altitude approximately 500 km
- 2U CubeSat
  - 1U – Payload
  - 1U – S/C
- Sun-pointing

MISSION – CONSTRAINTS

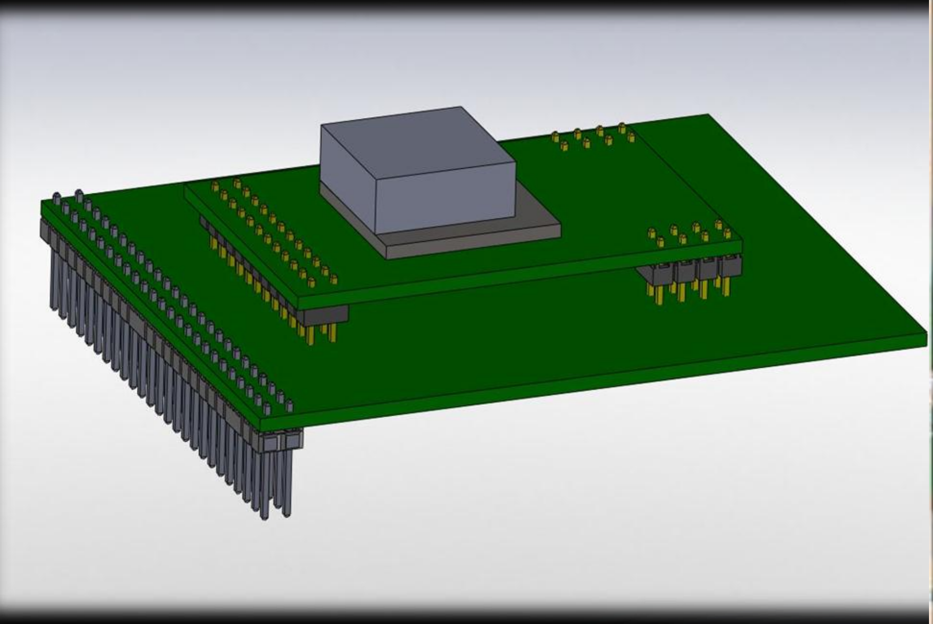
- Time – project completion date scheduled for Dec. 2012
  - Keep it simple
- Drive costs to a minimum
  - Keep it simple
  - Maximize subsystem reuse
  - Utilize internal resources – prototyping, manufacturing, testing
- 3 degrees, 3 sigma accuracy for attitude knowledge
  - Post-process ADCS sensor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

PAYLOAD

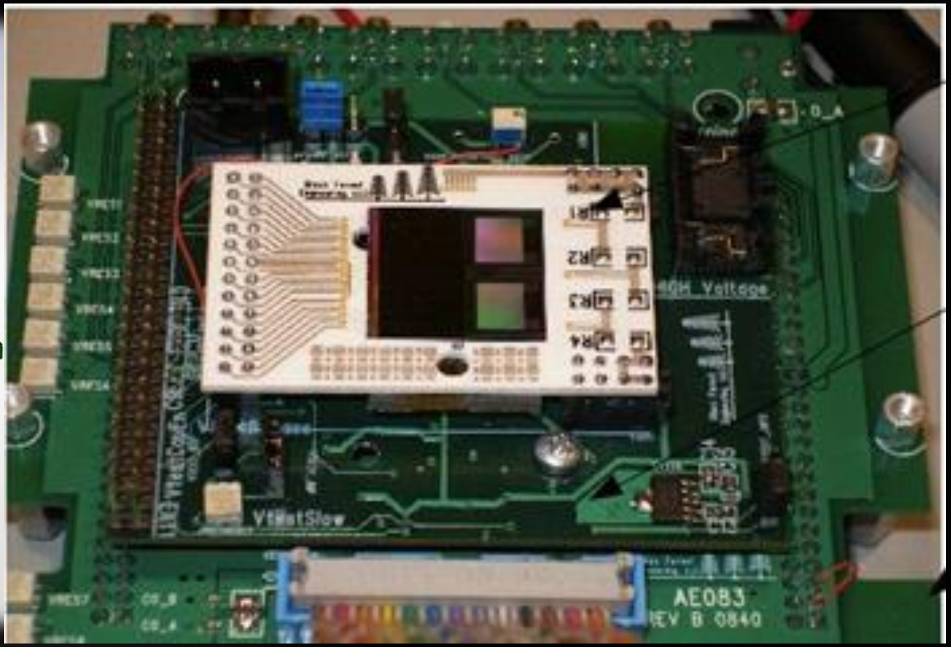
- Cadmium Zinc Tellerium (CZT) Detector Array
  - Goal: < 5% flux measurement precision
  - Designed by UC Berkeley, LLNL, Noqsi Aerospace, and SSU
  - Features a collimator for preventing stray particles
  - Shielding - layered lead, copper, and tantalum

PAYLOAD

Early CAD model of payload



CZT Array on development boards



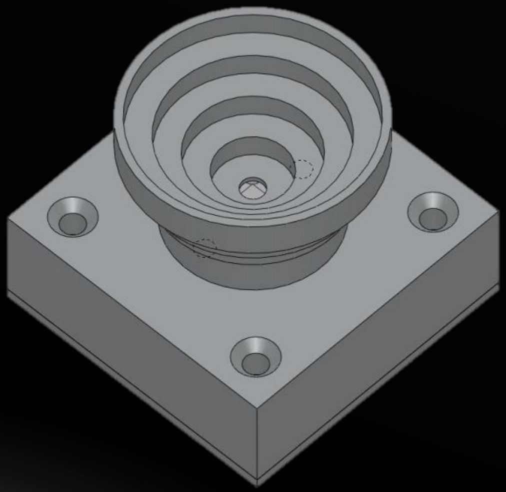
ADCS

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

ADCS – DETERMINATION

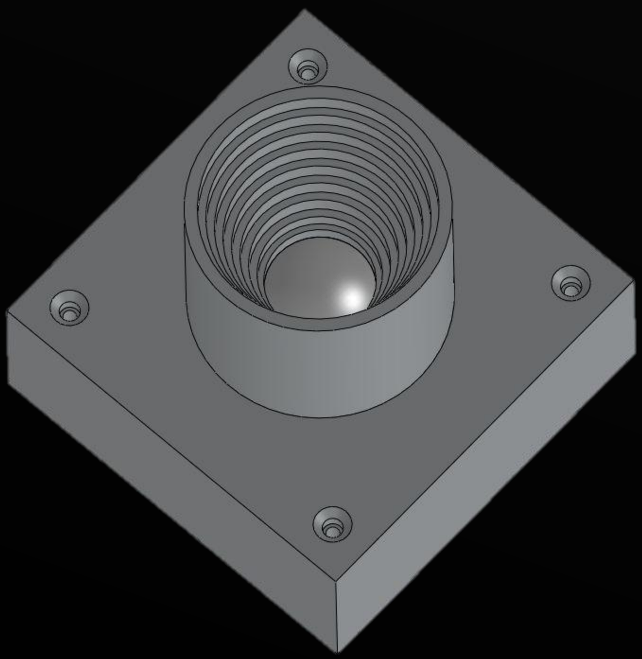
- Sun Sensors
  - Coarse, Medium, and Fine angular resolution
  - Sun pointing
    - Boresight
  - Testing through rapid-prototyped parts

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



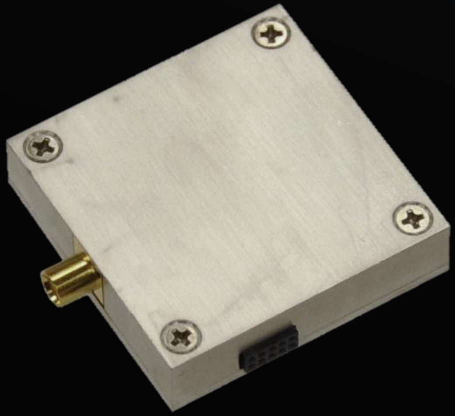
ADCS – DETERMINATION

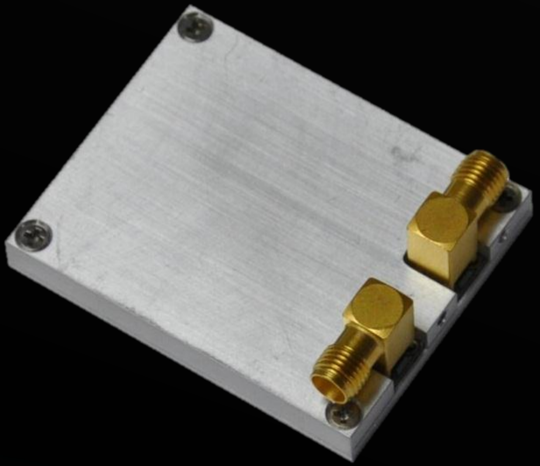
- Canopus Pipper
  - Star Sensor
  - Brightest star in S.Hemisphere
  - Determine roll rate
  - Testing
    - Rapid-prototype frame and collimator
    - Calibrate on ground
- (Right) CAD Model



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

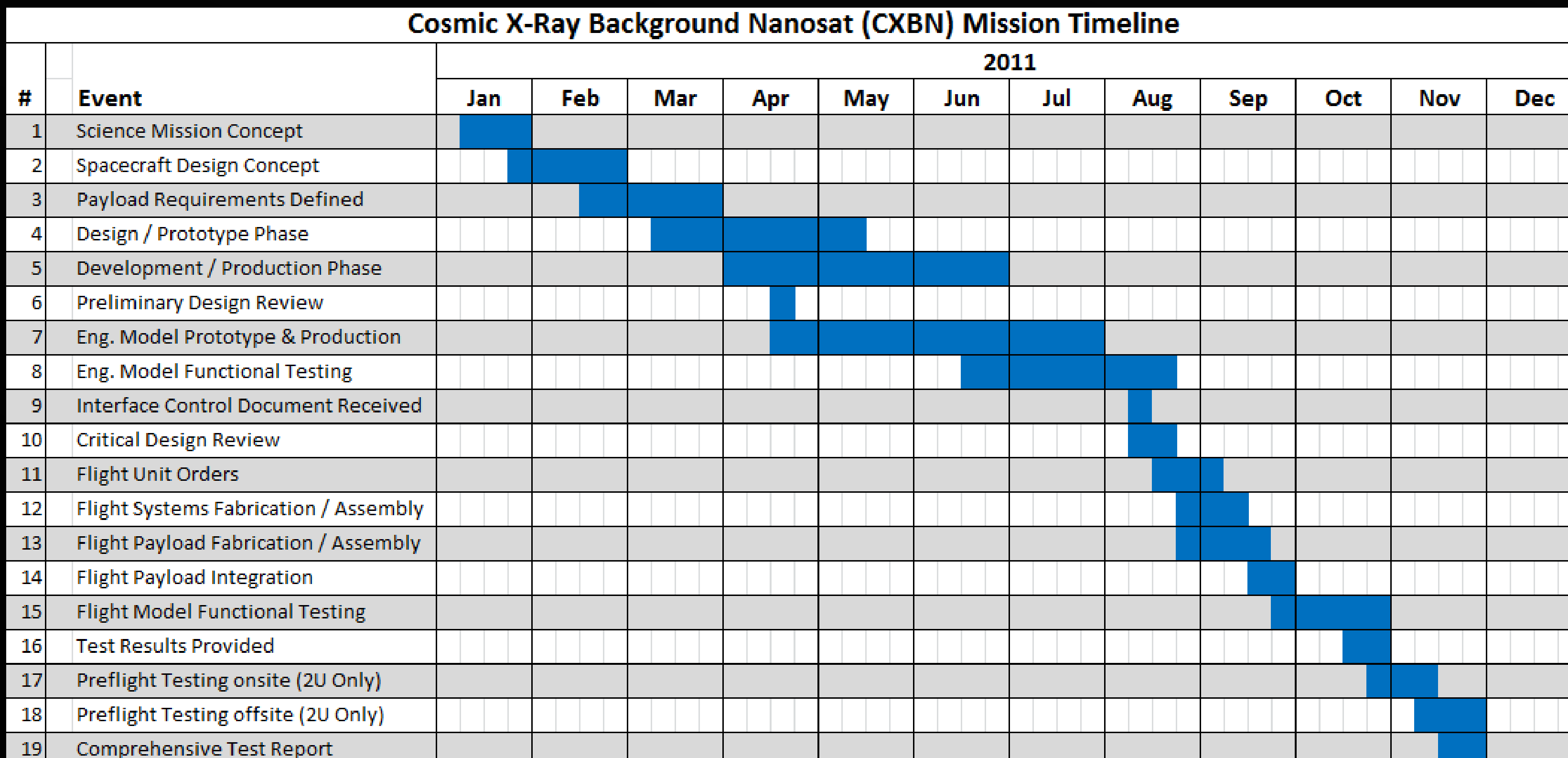
STRUCTURE

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

GROUND STATIONS

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

ESTIMATED TIMELINE



CONCLUSION

- CXBN team is very excited for this opportunity
- On pace for delivery of a rapidly constructed 2U
    - Start to finish – 8 months!

ACKNOWLEDGEMENTS

- NASA ELaNa
- SRI International
- CXBN Team