



NAVAL  
POSTGRADUATE  
SCHOOL

# NPSAT1 Spacecraft Architecture and Technology Demonstration Satellite



Mr. Dan Sakoda  
Space Systems Academic Group  
777 Dyer Rd., Code (SP/Sd)  
Monterey, CA 93943

dsakoda@nps.navy.mil  
(831) 656-3198



# Agenda

- NPS Space Education
- NPS Space Flight Experiments Background
- NPSAT1 Objectives
- Relevance to DoD
- Program Schedule



# NPS Space Education

- Two Curricula: Engineering and Operations
- Broad Scope of Disciplines (interdisciplinary education)
- Master's Thesis Requirement on Space-Related Topic
- “Capstone” Design Course
- Six-Week Experience Tour
- Space Cadre / Space Professional

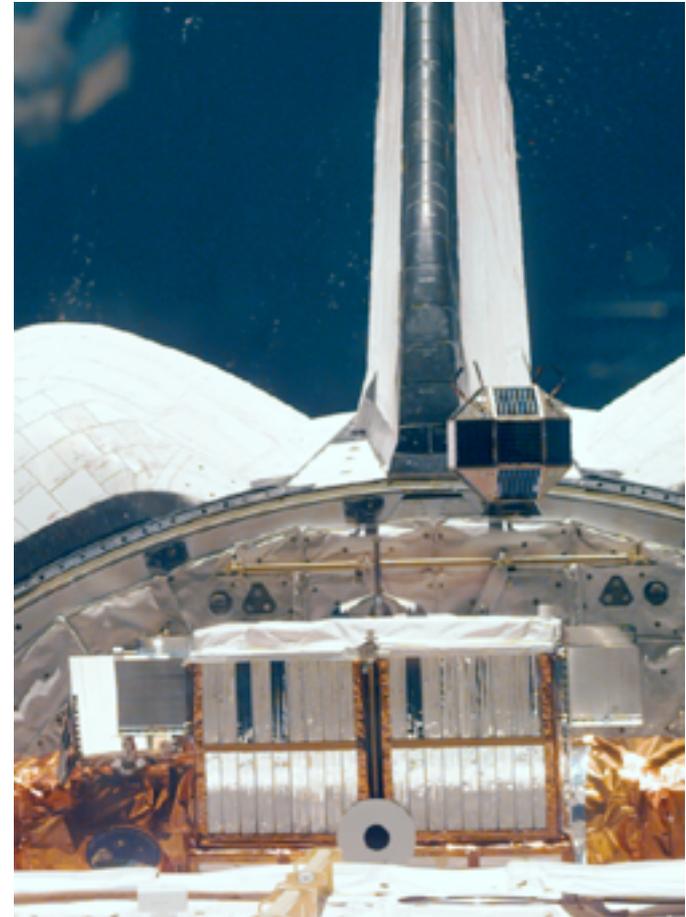


# NPS Space Flight Experiments

- “Hardware-in-the-loop education”
- Space thermo-acoustic refrigerator (STAR)
- Ferroelectric materials in space
  - “Piggyback” experiment
  - APEX & DATASAT-X
- Small Satellite Design Program
  - Full life-cycle development
  - PANSAT (*Discovery* Shuttle, STS-95, 1998)



## PANSAT Launch & Deploy (Oct. '98)

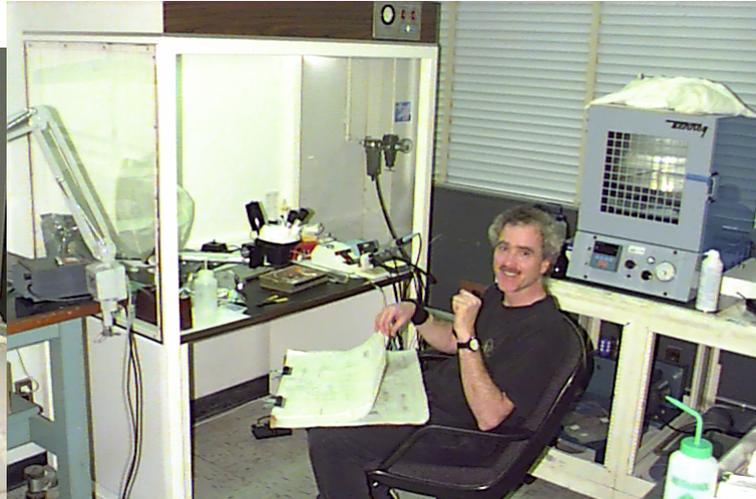




# NPS Facilities



Vibration Shaker



Electronics  
Development &  
Test

Thermal-  
Vacuum  
Chamber





## NPS Facilities (cont'd.)

- PANSAT ground station
- EMI shielded enclosure
- Solar simulator
- CAD/CAE Tools
- Tensile-testing
- Spherical air bearing
- Battery test
- Clean room\* (class 100,000)
- N<sub>2</sub> -purged, component storage
- Precision machining (CNC mills)
- Other test instruments (RF, digital, analog)

\*- Building upgrades starting in FY02 for spacecraft integration & development will accommodate class 10,000 clean area



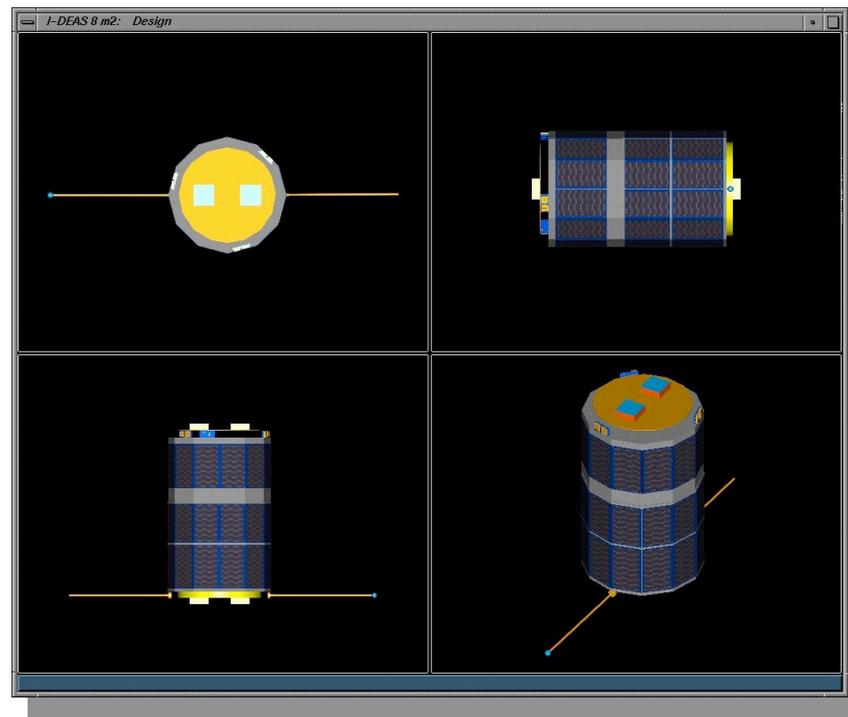
# NPSAT1 Objectives

- Address lessons learned with PANSAT
- Develop more capable microsatellite bus
- Support education and space research with military relevance
  - Space system engineering and operations officer students
  - NRL-sponsored experiments
  - NRO-sponsored experiments
  - Low-cost small satellite technologies



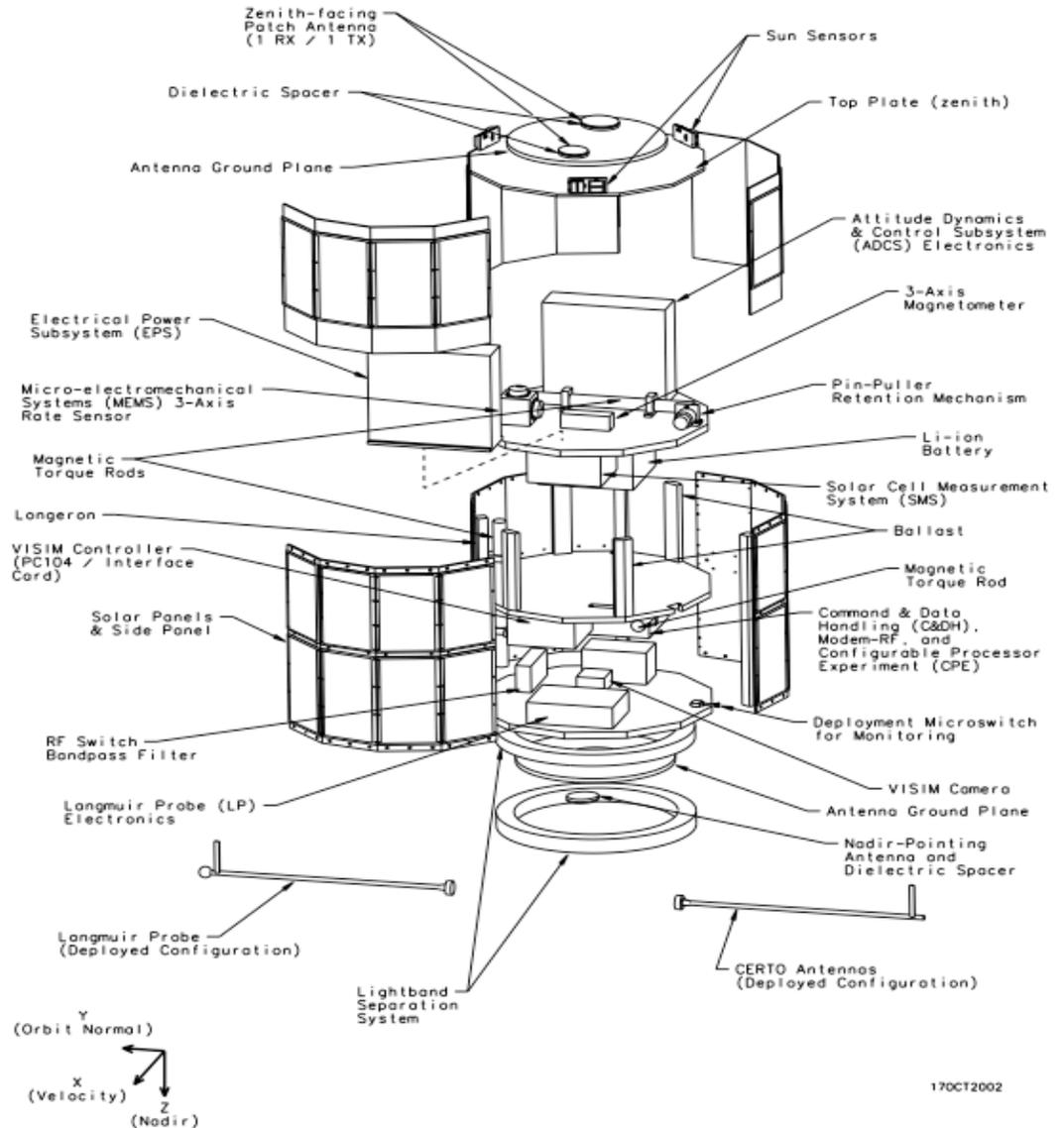
# NPSAT1 Overview

- Class D spacecraft
- Higher risk
- Minimal cost effort
- Mission (STP-1) Parameters
- 560 km  $\pm$  10 km alt., circular
- 35.4° inclination
- ESPA on Atlas V (medium EELV)
- Earliest launch: Oct. 2006





# NPSAT1 Configuration

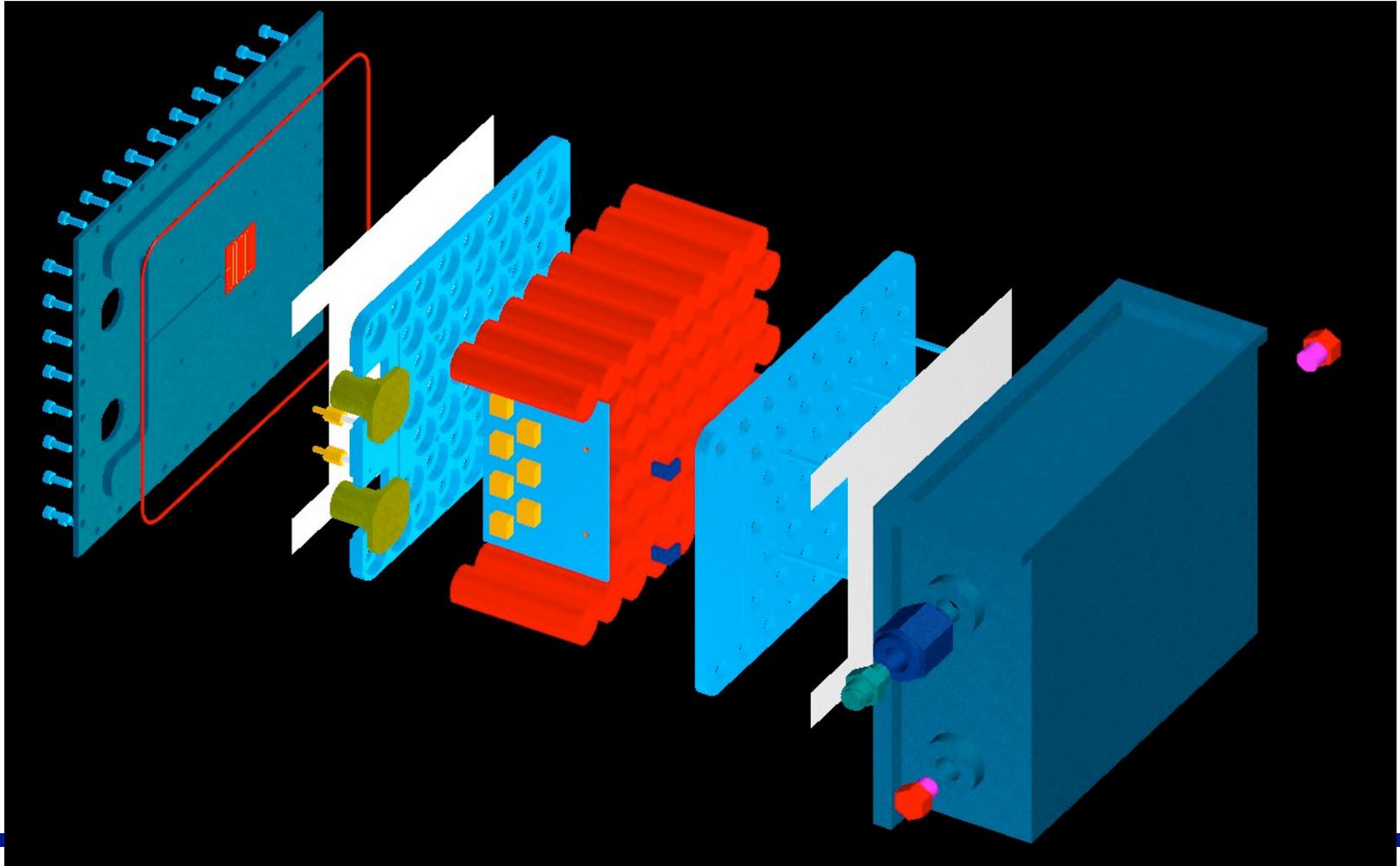




# NPSAT1 Experiments

- Supports current DoD needs and research
  - Lithium ion batteries
  - Advanced triple-junction solar cells
  - Two NRL experiments
    - Coherent electromagnetic radio tomography (CERTO) beacon
    - Langmuir Probe
  - Four NPS experiments

# Lithium-ion Battery





# NPSAT1 Experiments

- NRL Experiments
  - Coherent Electromagnetic Radio Tomography (CERTO)
    - Three-frequency beacon
    - Ground stations measuring phase and amplitude scintillations
    - Total electron content (TEC) in ionosphere in plane of observation
    - Applications to radar, communications, navigation, surveillance

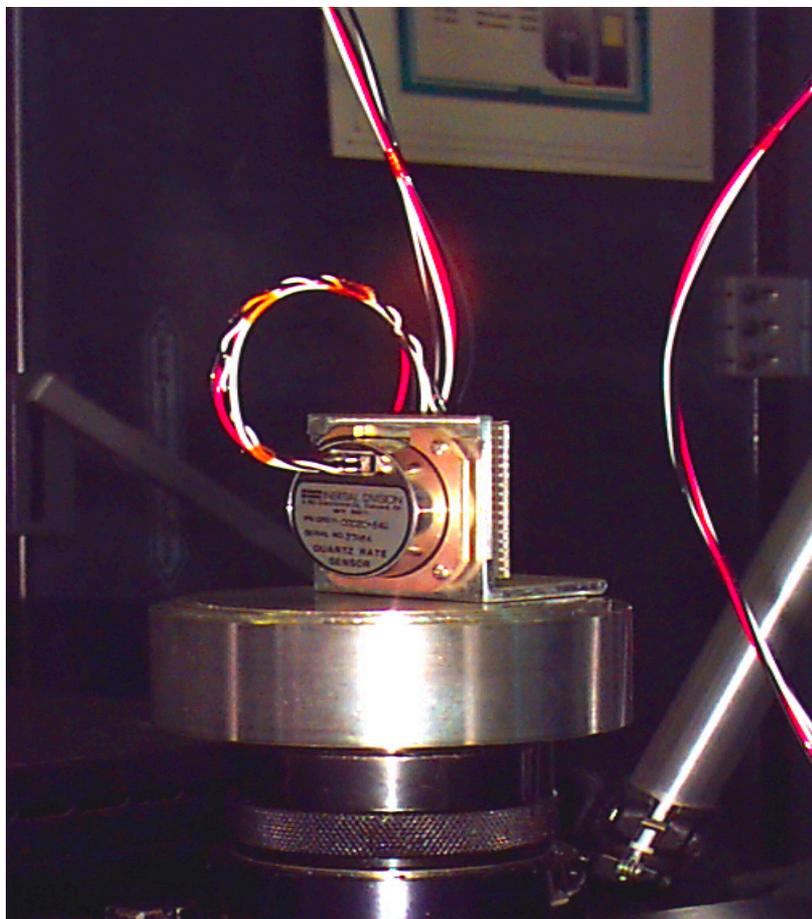


# NPSAT1 Experiments

- NRL Experiments (cont'd.)
  - Langmuir Probe
    - Augments CERTO data
    - In-situ measurements at orbit altitude
- NPS Configurable Fault-Tolerant Processor (CFTP)
  - Adaptable processor using FPGA
  - Non-volatile FERRO RAM for configuration memory
  - Add-on card within C&DH housing
  - Various applications (triple-modular-redundant computer, compression algorithms)



# NPSAT1 Experiments



- MEMS rate sensor
  - Use COTS rate sensor
    - $\pm 5^\circ/\text{sec}$  range
    - Three sensors for 3-axis rates
    - $\pm 5$  V at  $< 80$  mA each
  - Gain flight experience w/ MEMS devices
  - Use during acquisition (low sensitivity at orbital rates)
  - Use on a power-available basis



# NPSAT1 Experiments

- Solar Cell Measurement System (SMS)
  - Provide flight demonstration of advanced, triple-junction (ATJ) solar cells
  - Perform current-voltage (I-V) curve measurements
    - 2 experiment cells per cylinder side
    - Sun vector measurement
  - Perform 2 measurements per orbit



# NPSAT1 Experiments



PC/104 Camera

- COTS Visible Wavelength Imager (VISIM)
  - PC/104 interface card & CCD camera
  - PC/104 cpu board
  - Array: 652 x 492
  - Raw image: Bayer format
  - Custom optics for < 1 km resolution

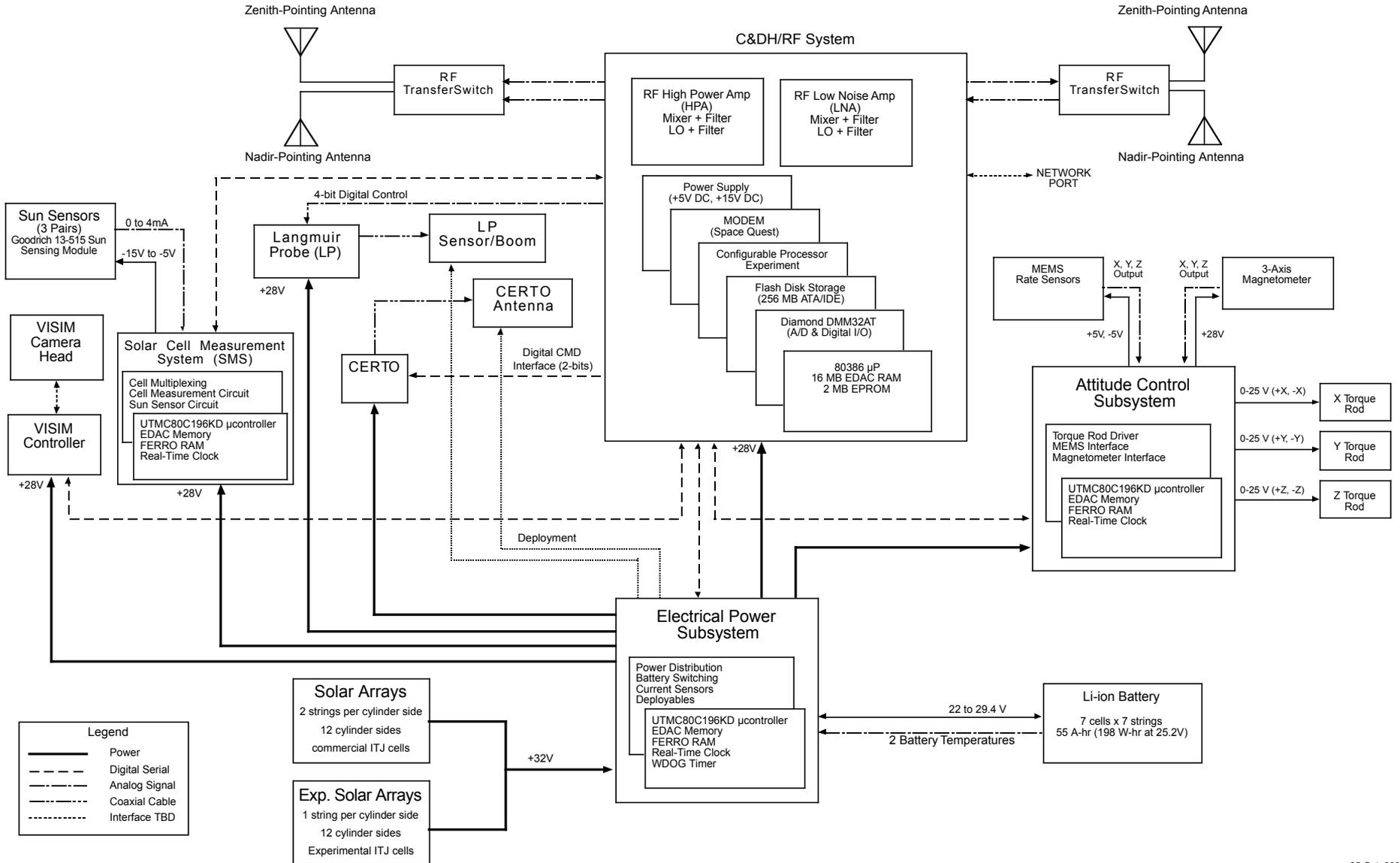


# NPSAT1 Experiments

- COTS Visible Wavelength Imager (VISIM) (cont'd.)
  - Generate data for officer students in space curricula
  - Research on-orbit processing of data (compression algorithms, etc.)
  - Educational outreach
    - Have k-12 schools ‘task’ satellite for images
    - Distribute images via Internet (World Wide Web)
    - ‘Spark’ interest in engineering / science



# System Block Diagram





# NPSAT1 Schedule

Earliest launch: Oct. 2006  
 NPSAT1 earliest delivery: Jan. 2006  
 System-level testing complete: July 2005  
 Spacecraft integration: April 2005

Activity Name	Start Date	Finish Date	2002			2003				2004				2005				2006					
			Q 2	Q 3	Q 4	Q 1	Q 2	Q 3	Q 4	Q 1	Q 2	Q 3	Q 4	Q 1	Q 2	Q 3	Q 4	Q 1	Q 2	Q 3	Q 4		
NPSAT1 CDR	5/2/02		▼																				
CDR Delta	12/5/02				▼																		
FY04 Mid-Year Review	5/24/04									▼													
Flight Readiness Review	1/5/06																			▼			
Hardware Delivery Date	1/9/06																			▼			
Launch Date	10/1/06																				◆		
Post-Flight Data Report	4/3/06	4/14/06																		◇			
Design/Development	4/13/02	3/15/05	◇	—																			◇
Spacecraft Integration	3/7/05	4/29/05												◇	◇								
Integrated Functional Test	5/27/05	7/21/05													◇	◇							
System-Level Environment Test	7/28/05	9/21/05														◇	◇						
			2nd	3rd	4th	1st	2nd	3rd	4th	1st	2nd	3rd	4th	1st	2nd	3rd	4th	1st	2nd	3rd	4th		



# NPSAT1 Web Site

For more information . . .

<http://www.sp.nps.navy.mil/npsat1>

Thesis topics:

<http://www.sp.nps.navy.mil/npsat1/education/educationpage.htm>