2009

NPS-Solar Cell Array Tester

Malone, Chris

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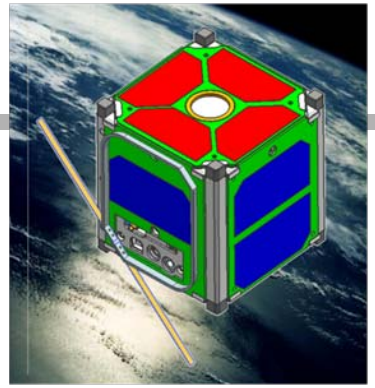

Naval Postgraduate School

NPS-Solar Cell Array Tester

2009 Small Satellite Conference

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Principal Investigator: Dr. James Newman
Co-investigator: Dr. Marcello Romano
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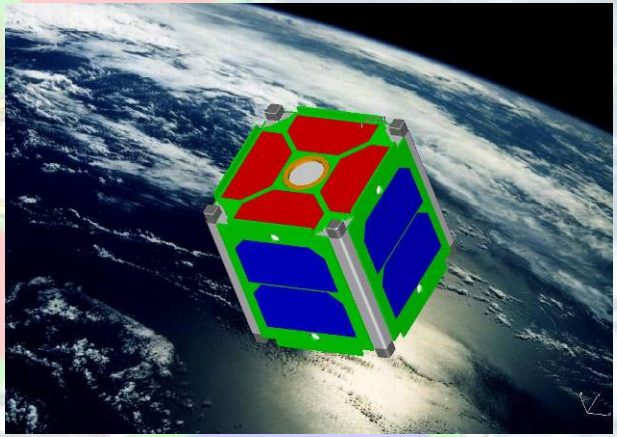
NPS-SCAT Team

STUDENTS

- LCDR Chris Malone
  - Project Manager
- MAJ Chris Ortiona
  - Systems Integration
- LCDR Lawrence Dorn
  - Power System
- Capt Matt Schroer
  - Communication System
- LT Rod Jenkins
  - Payload
- 2nd LT Alex Schulenburg
  - Structure
- Nathan Moshman
  - Software
- Marissa Brummit (Cal Poly)
  - Safety and Integration
- Paul Oppenheimer
  - CMG's
- LCDR William Crane
  - release mechanism

NPS-SCAT
Intro and Background

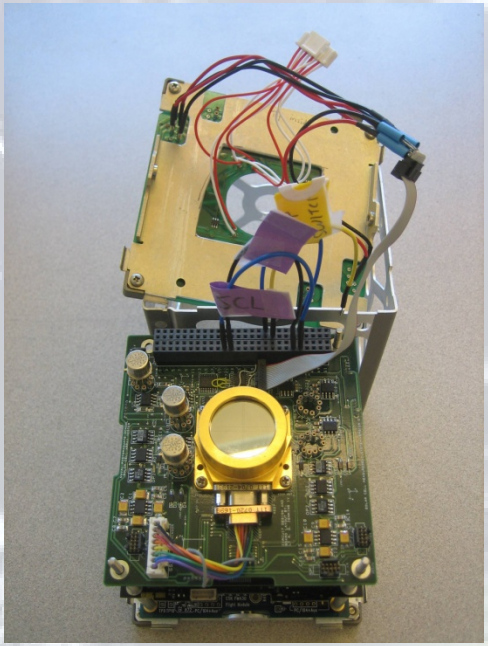
- Need to grow, equip, and maintain a cadre of military space professionals
- Need to develop CubeSat capabilities to continue to improve “hands-on” education opportunities at NPS
- Need for a dedicated, responsive platform to test new technologies and materials on orbit



- NPS Space Systems Curricula (Engineering and Operations):
  - Traditional core (course works, labs, thesis research)
  - Exposure to real-world systems engineering trades
  - Hardware-in-the-loop education through building satellites
  - Environment where higher risk is acceptable

NPS-SCAT
Experiment Concept

Objective: Provide an inexpensive space platform to perform focused research objectives of national interest. Start with a simple on-orbit solar cell tester while focusing on the education of NPS students with the development of an NPS CubeSat program.



NPS-SCAT prototype

Description: NPS-SCAT is a 1U CubeSat designed to test solar cells in the space environment. The solar cell measurement system (SMS) will calculate I-V curves (electric current of the solar cell as a function of the voltage). Using a variable voltage input, the SMS changes the current through the solar cell, thereby enabling a measurement of the cell at the full range of current and voltage. By comparing the data with pre-flight values, the performance of the cells in the space environment will be able to be determined. Measurements will continue throughout the lifetime of the experiment, providing the rate of degradation of the test cells.

NPS-SCAT
Technology & Development

SMS Circuit AUG 08

SMS Circuit MAR 09

SMS Circuit JUL 09

Hardware Status:

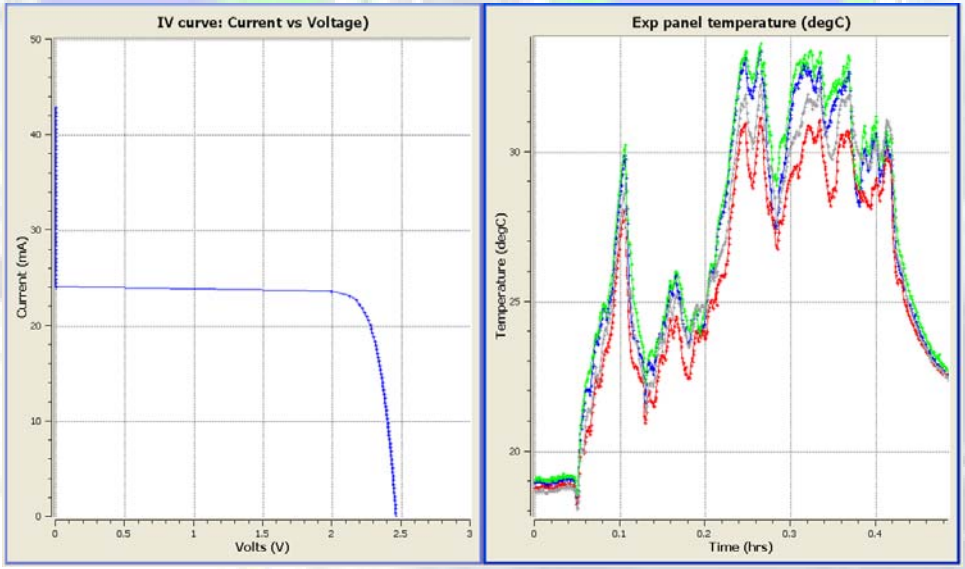
- Current Technology Readiness Level: 7
- TRL after spaceflight: 9
- Prototype unit complete

Major Instrument or Equipment:

- NPS Solar Cell Measurement System CubeSat

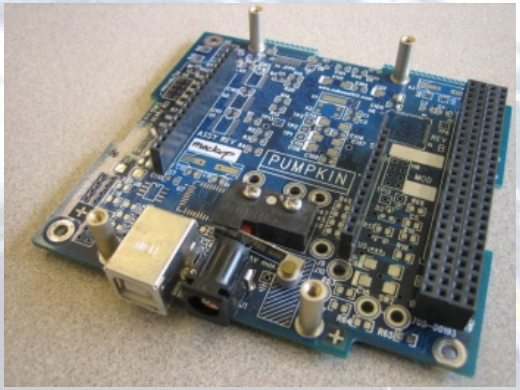
Instrument or Equipment Operation:

- COTS CubeSat equipment including structure, main processor board, comms, and power
- Custom solar cell measurement system payload
- Telemetry through NPS ground station in Monterey



Solar cell IV curve and temperature plots

NPS-SCAT
Bus System (COTS)



PUMPKIN FM-430

MICROHARD 2400

Subsystems:

- FM-430
- Microhard S-Band Radio 2420 vs 2400
- ClydeSpace 1U EPS

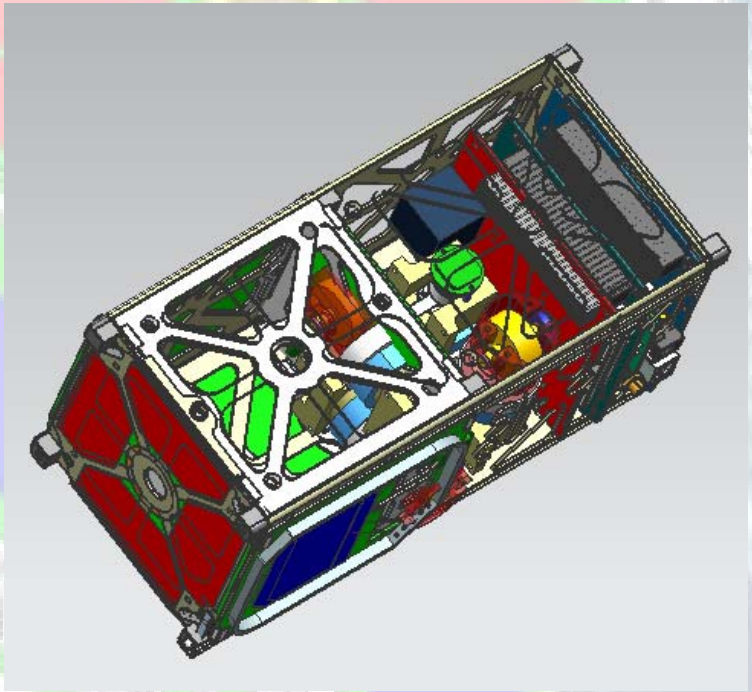
Primary Lessons Learned:

- Hardware Versus Specification Sheets
- Hardware Integration
- Procurement Timelines

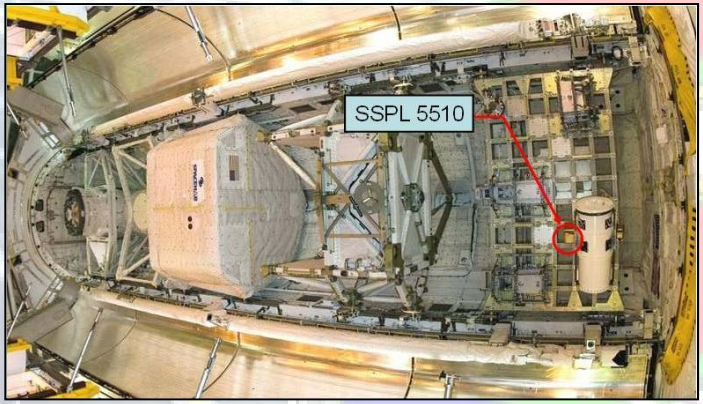
CLYDESPACE 1U EPS

NPS-SCAT
Space Experiments Review Board

- OCT 2008 SERB
- Potential launch from Space Shuttle Picosat Launcher (SSPL) deployment in 2010
- The unique form factor of the SSPL, 5” x 5” x 10”, requires a novel solution to launch a CubeSat and also the opportunity to fly risk mitigation experiments for other SERB approved payloads, in particular the control moment gyroscopes for the TINYSCOPE program
- 2U CubeSat as backup

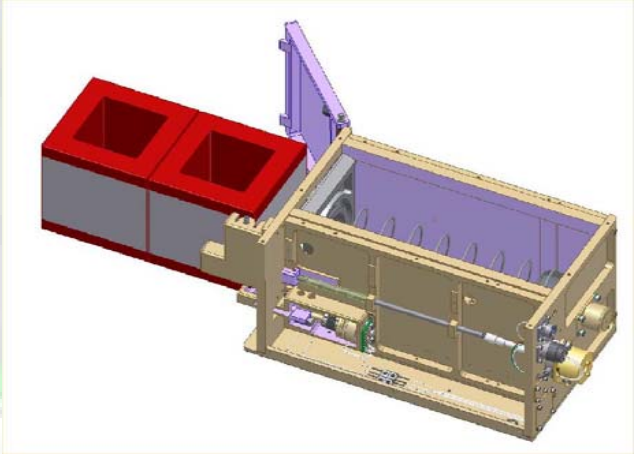


NPS-SCAT ++
Evolution of a NanoSatellite

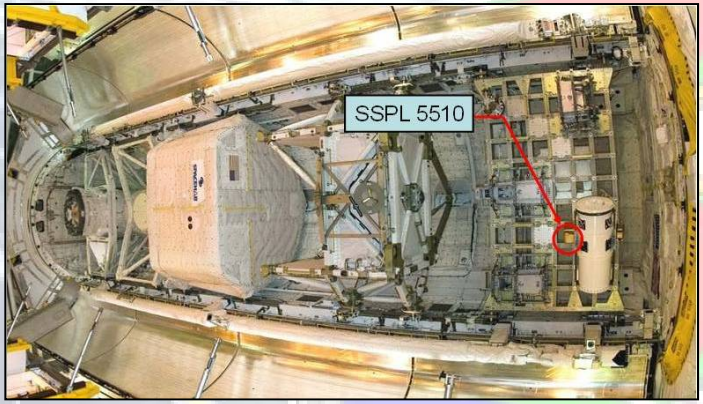


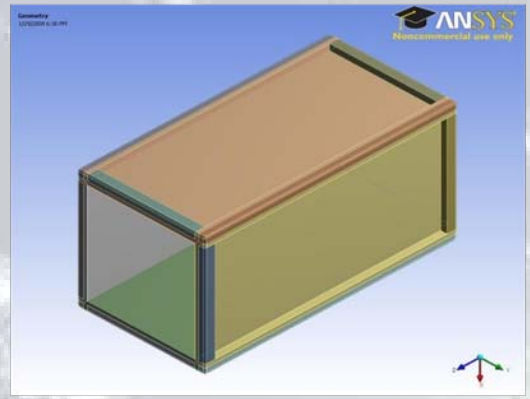
Space Shuttle Payload Launcher (SSPL)

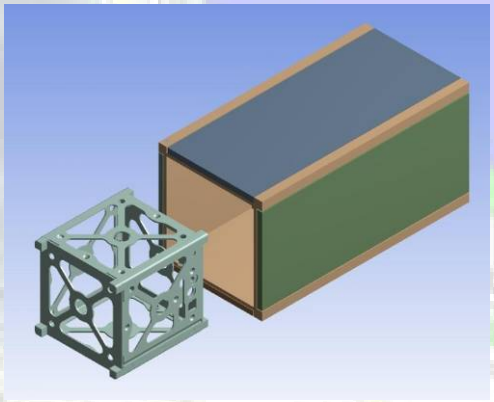
- Payload max size and mass: 5” x 5” x 10”, 15.6 lb
- NOT a P-POD Launcher
- Payload required to withstand 900lbs external force
- Payload integration into orbiter’s bay

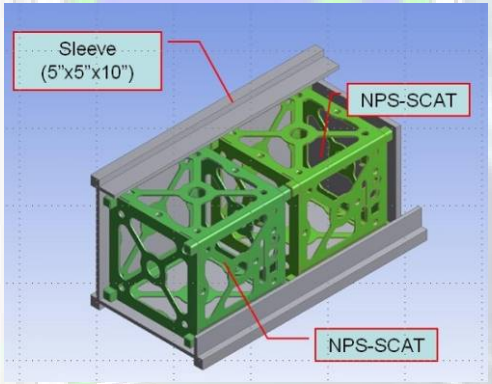


NPS-SCAT ++
Evolution of a NanoSatellite



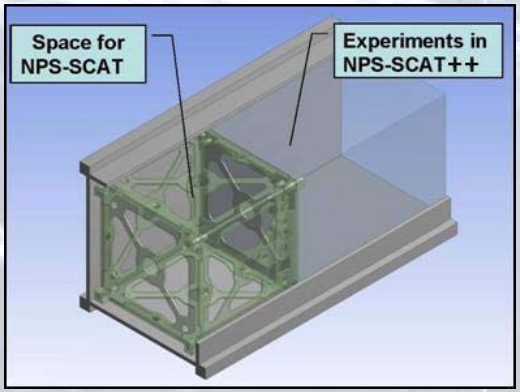






NPS-SCAT ++
An Opportunity for Risk Mitigation

Leveraging existing and previously-developed CubeSat subsystems from NPS-SCAT CubeSat, provide a multifunctional nano-satellite capable of conducting experimental objectives in a LEO orbit:



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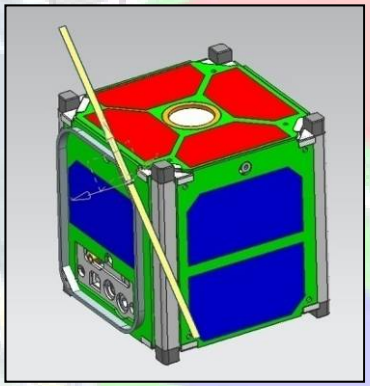

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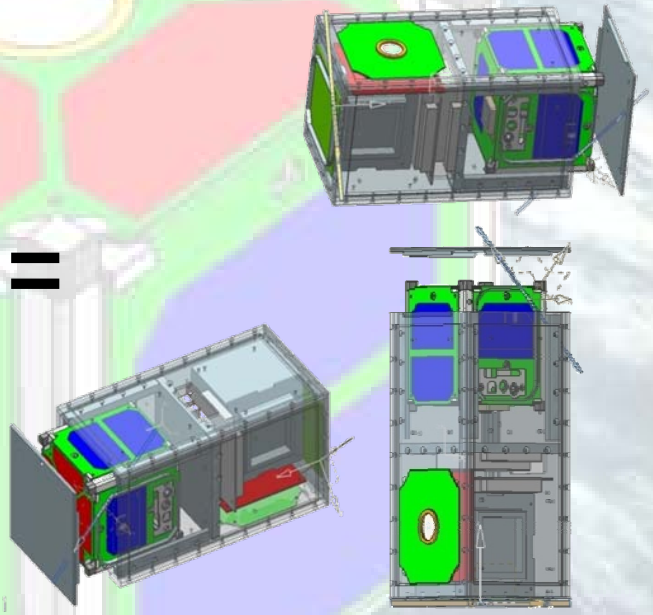
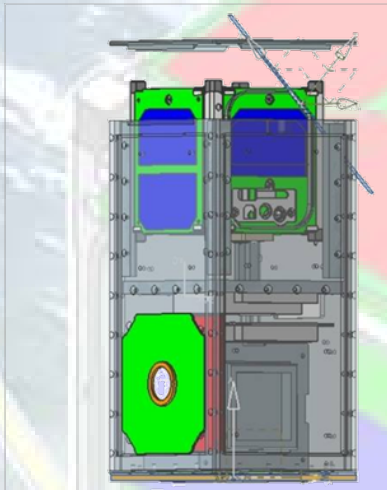
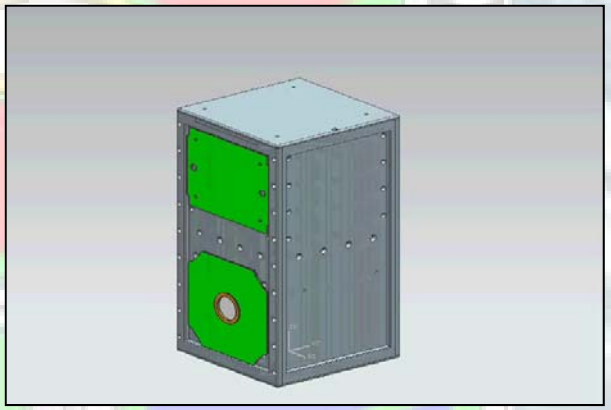


Objectives:

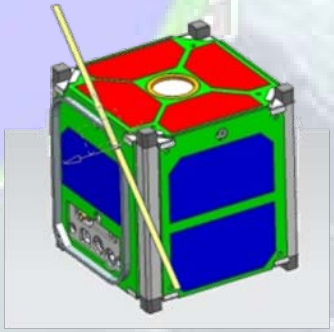
- Hold NPS-SCAT during launch
- Eject NPS-SCAT upon command after its own deployment from the SSPL
- Perform a redundant solar cell test experiment
- Build the CubeSat maximizing use of COTS (Commercial Off The Shelf) components
- Risk mitigation opportunities for other NPS, SERB-approved experiments

NPS-SCAT ++
Concept of Primary Mission

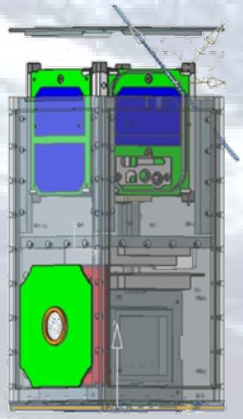


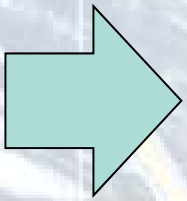


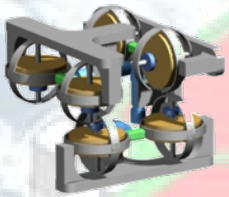
Top Down System Requirements – Driving factor for development of SCAT++ (Objective = Threshold)

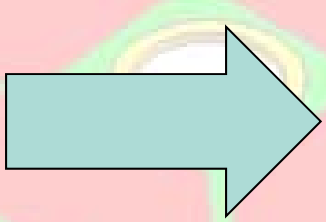


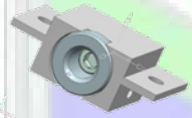
NPS-SCAT ++ : Payloads / Experiments on Board
Synergy with Programs

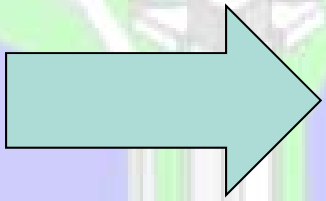


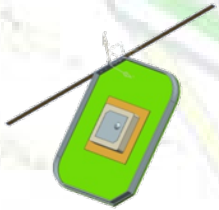


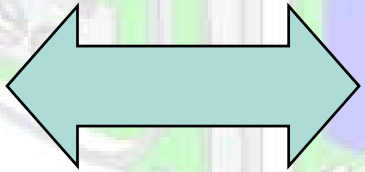












Bottom up System Requirements – SCAT++ subsystems' capabilities to sustain / operate subsequent payloads

- Collect and downlink IV curve on designated solar cells utilizing custom Sun Sensor
- Release NPS-SCAT CubeSat through Innovative Release Mechanism
- Command, monitor, and downlink attitude control through high agility CMGs
- Transmit, in the clear, data through CubeSat Class Beacon

QUESTIONS?