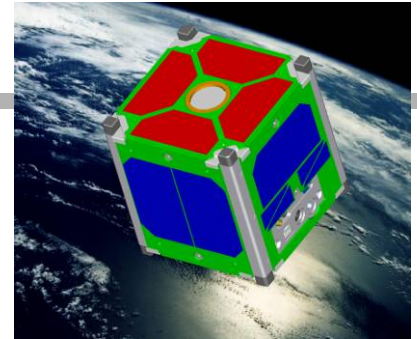


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## Naval Postgraduate School

NPS-Solar Cell Array Tester



### 2009 CubeSat Developers' Workshop

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MAJ Christopher Ortiona, USA

LCDR William Crane USN, LCDR Lawrence Dorn USN,  
LT Robert Jenkins USN, Paul Oppenheimer NRL,  
Capt. Matthew Schroer USMC, 2<sup>nd</sup>Lt Alexander Schulenburg GAF,  
Nathan Moshman



Principal Investigator: Dr. James Newman  
Co-investigator: Dr. Marcello Romano  
Professor Rudy Panholzer  
Mr. Dan Sakoda

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# NPS-SCAT Team



## STUDENTS

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

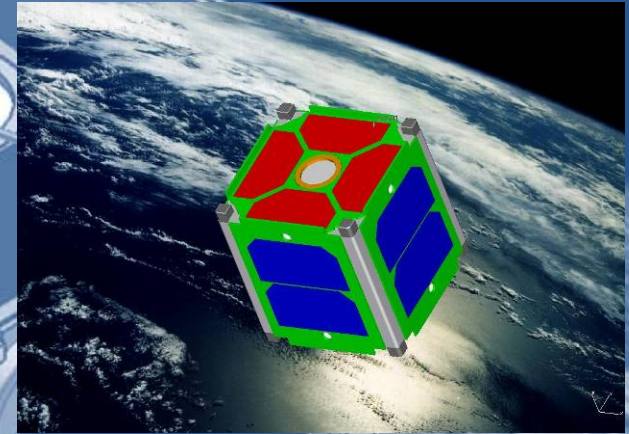




# NPS-SCAT

## 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



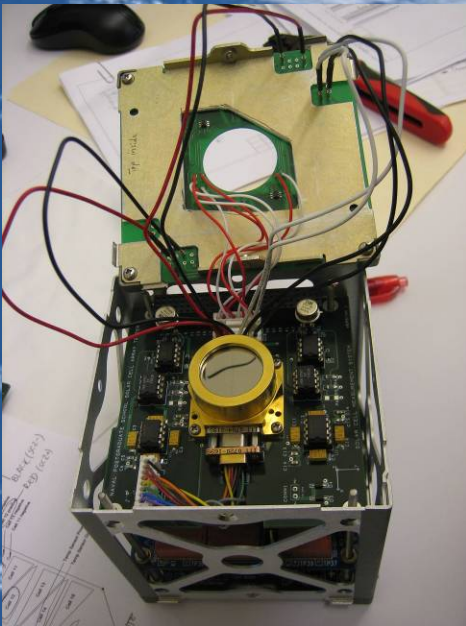
- NPS Space Systems Curricula (Engineering and Operations):
  - Traditional core (course works, labs, thesis research)
  - Exposure to real-world systems engineering trades
  - Hardware-in-the-loop education through building satellites
  - Environment where higher risk is acceptable





# 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

## Major Instrument or Equipment:

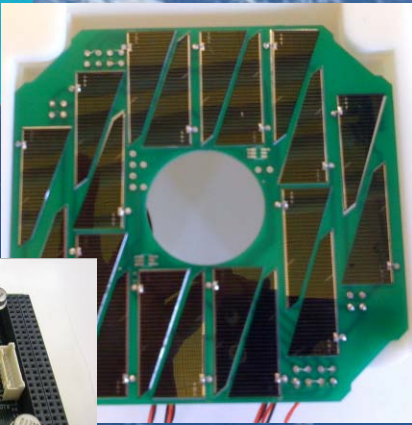
- NPS Solar Cell Measurement System CubeSat

## 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



SS411 Sun Sensor



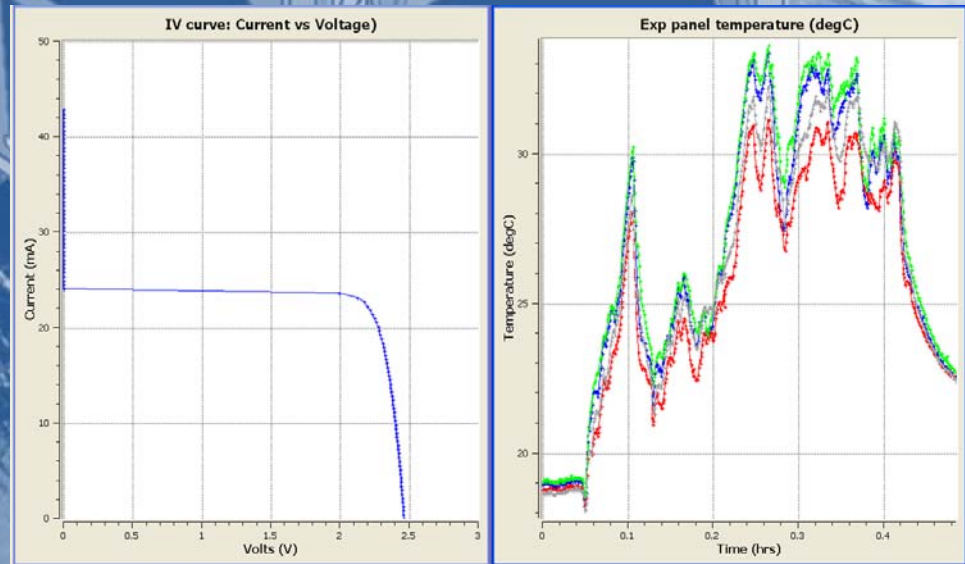
Experimental Solar  
Panel



SMS prototype circuit card

## Hardware Status:

- Current Technology Readiness Level: 7
- TRL after spaceflight: 9
- Prototype unit complete
- Flight Ready: Sept 2009



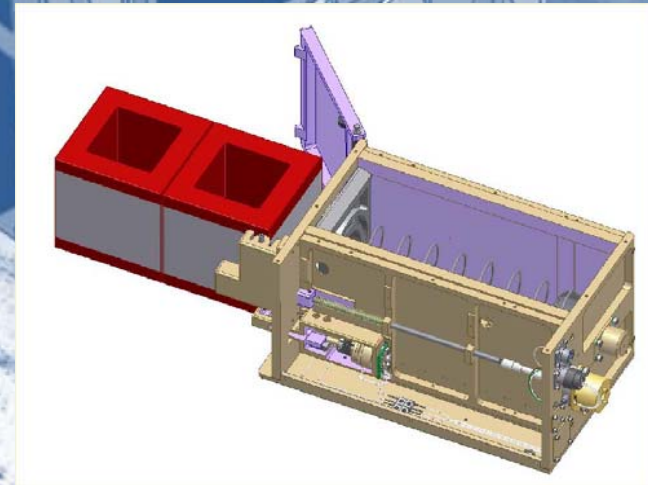
Solar cell IV curve and temperature plots





# NPS-SCAT Space Experiments Review Board

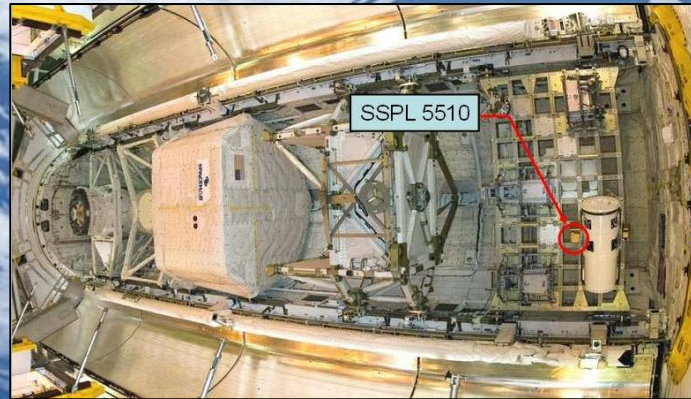
- OCT 2008 SERB
- Potential launch from Space Shuttle Picosat Launcher (SSPL) deployment in 2010
- The unique form factor of the SSPL, 5" x 5" x 10", requires a novel solution to launch a CubeSat and also the opportunity to fly risk mitigation experiments for other SERB approved payloads, in particular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





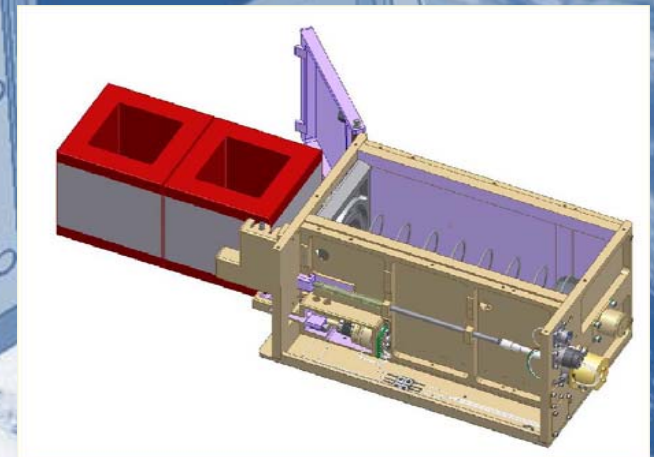


# NPS-SCAT ++ Evolution of a NanoSatellite



## Space Shuttle Payload Launcher (SSPL)

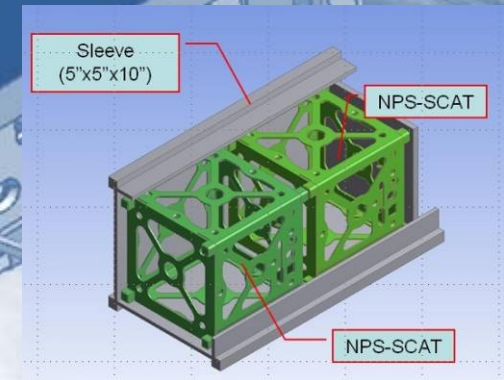
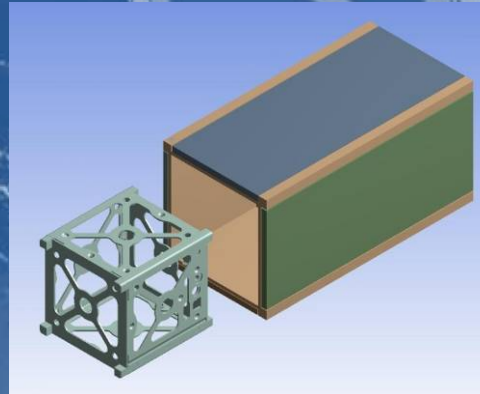
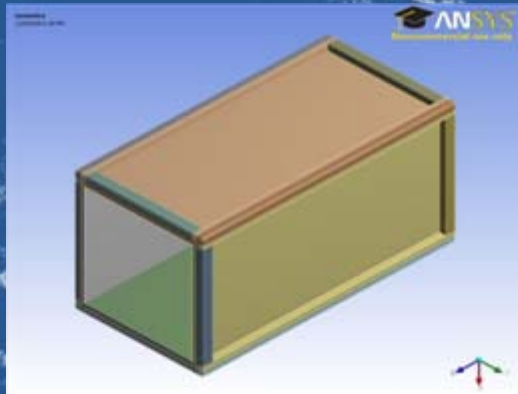
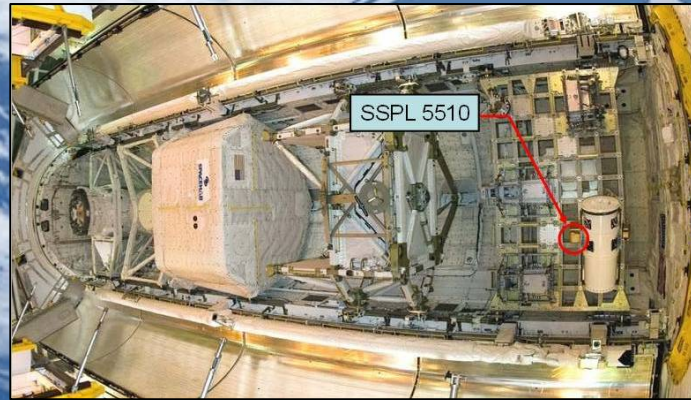
- Payload max size and mass: 5" x 5" x 10", 15.6 lb
- NOT a P-Pod Launcher
- Payload required to withstand 900lbs external force
- Payload integration into orbiter's bay







# NPS-SCAT ++ Evolution of a NanoSatellite

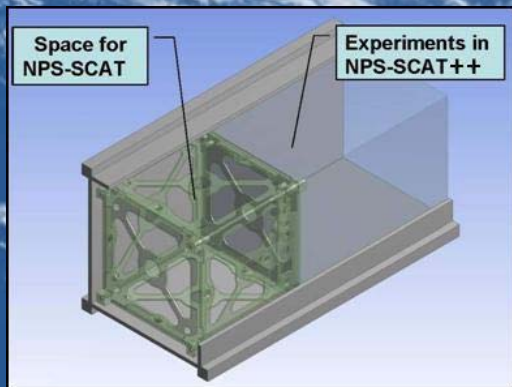




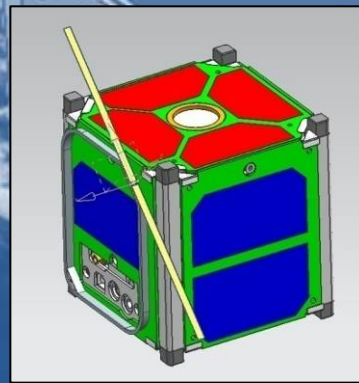


# NPS-SCAT ++ An Opportunity for Risk Mitigation

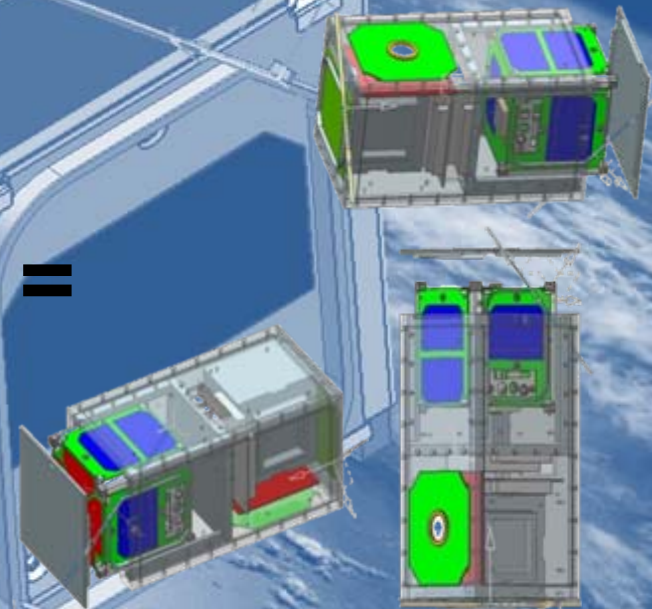
Leveraging existing and previously-developed CubeSat subsystems from NPS-SCAT CubeSat, provide a multifunctional nano-satellite capable of conducting experimental objectives in a LEO orbit:



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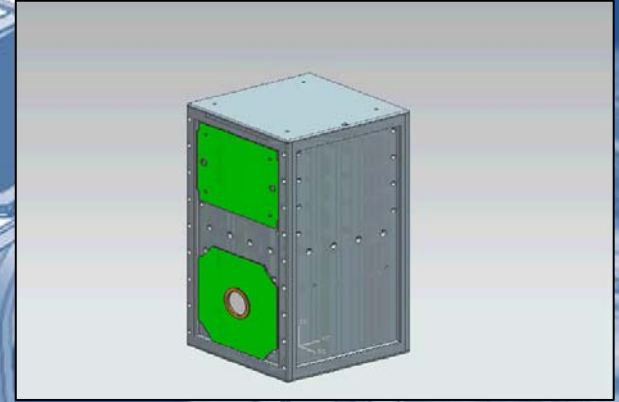
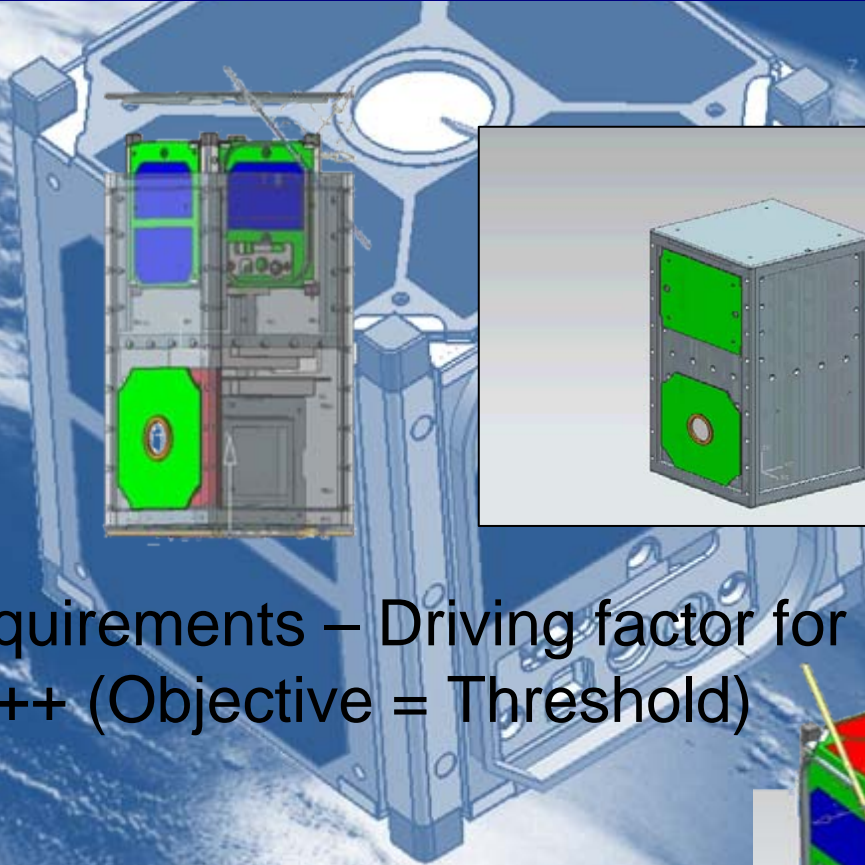
## Objectives:

- 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

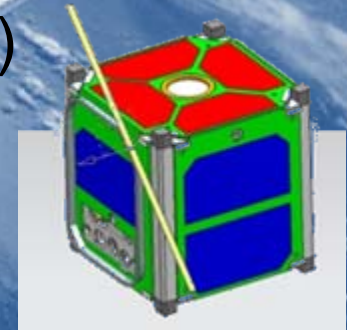




# NPS-SCAT ++ Concept of Primary Mission



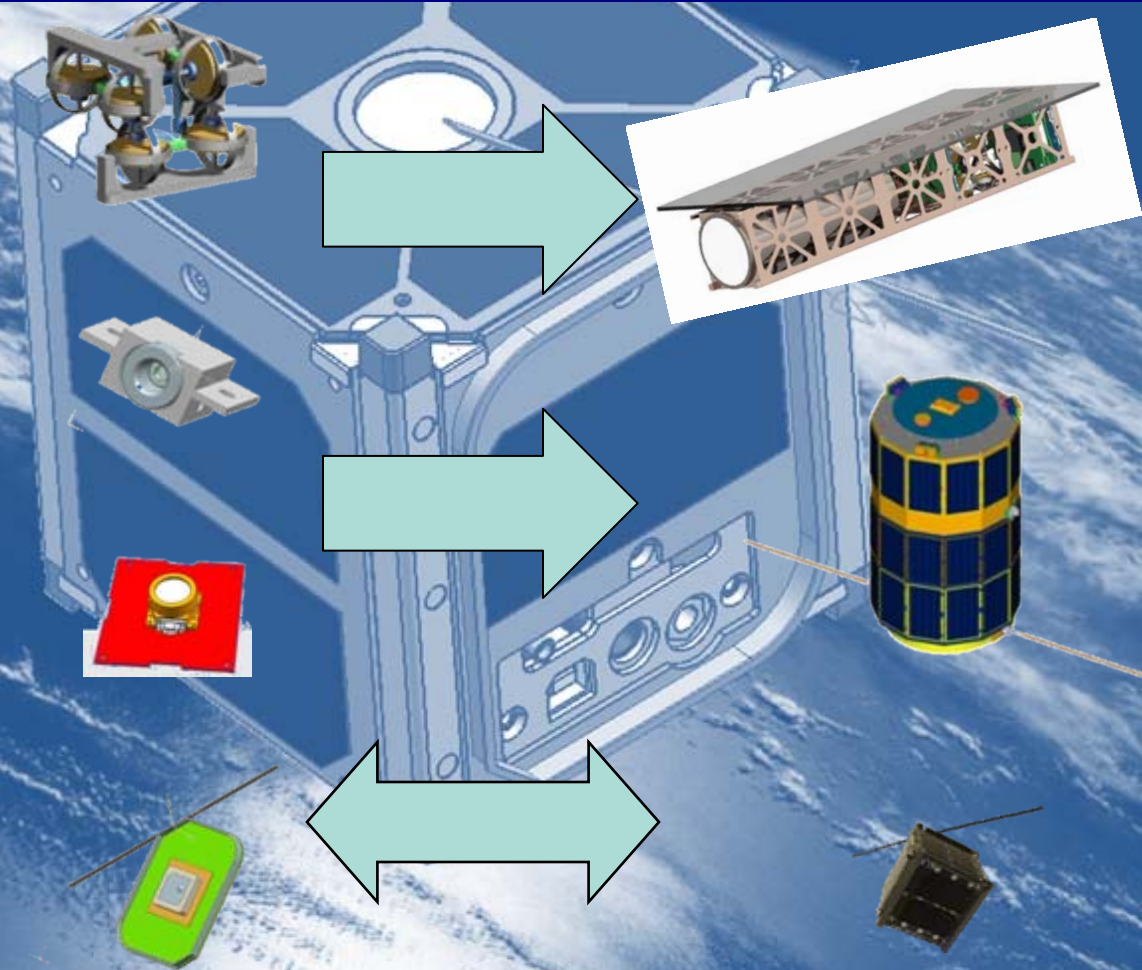
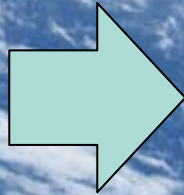
Top Down System Requirements – Driving factor for development of SCAT++ (Objective = Threshold)







## 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





**NPS-SCAT ++**

**QUESTIONS?**

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