

Naval Postgraduate School

2007 Small Satellite Conference

#### CubeSat Launchers, ESPA-rings, and Education at the Naval Postgraduate School



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#### Naval Postgraduate School (NPS)

- NPS Monterey, CA (120 miles / 200 km south of San Francisco)
  - -~1700 students
  - Mid-career military officers and government employees
  - ~30 to 50 different countries send students to NPS
  - predominately MA degrees, increasing number of PhD degrees
  - Space Systems Academic Group
    - Space Systems Operations
    - Space Systems Engineering





- NPS payloads and satellites as part of space education
  - Shuttle mid-deck experiments
  - PANSAT (deployed on STS-95 Oct 1998 the "John Glenn flight")











• Education





Research and technology demonstrations



- Flight-qualified structure
- Working processor board & CFTP experiment
- Flight batteries built
- Flight ACS components on-hand
  - Magnetometer
  - GPS receiver
  - Torquer coils
  - Momentum wheel
  - MEMS rate sensor flight-build in progress
- Solar panel flight-build in-progress
- Ground station antenna build in-progress
- 19 Master's theses to date
- ~5+ Students actively participating during any given academic quarter
- Target completion: Jan. 2009



# Genesis of a CubeSat Launcher (NPSCuL)

- STP-1 Mission launched March 2007
  - One empty slot
  - NPSAT1 Mass Simulator







# Genesis of a CubeSat Launcher (NPSCuL)

- As NPSAT1 nears completion, NPS will evolve to the use of CubeSats in its educational program
- There "should" be ESPA carrier missions in the future
- There already exists a strong university CubeSat development community
- There appears to be a scarcity of U.S. launch opportunities for CubeSats
- It appears that an ESPA-compatible CubeSat Launcher could be of value
  - NPS will need to launch NPS CubeSats in the future
    - NPS is forming collaborations with other USG organizations and universities interested in flying CubeSats
    - This is also an educational outreach opportunity for NPS
  - A CubeSat launcher could ensure utilization of ESPA slots
    - Seek STP dedicated slot for the CubeSat Launcher for NPS CubeSats
    - Be mass and cg reconfigurable and ready to "fill in" for a payload not ready to launch due to development schedule issues or late problems in test or integration



- Utilize existing standards and processes
  - ESPA carrier interface
  - Cal Poly Cubesat organization
    - Broker for university satellites
    - Standards for Poly-Picosatellite Orbital Dispenser (P-POD)
  - STP launch process





- Programmatic Requirements
  - Cal Poly as broker for university CubeSats
  - NPS liaison to STP
  - Completion of survey form
    - Mission: description, objectives, schedule, etc.
    - Technical: mechanical, electrical, orbital, safety, etc.
  - ESPA-compatible payload flight request to STP
  - Earliest launch target: FY09 FY10









### Requirements

- Technical Requirements
  - Integrate multiple P-PODs
  - Maximize CubeSat volume
  - Be ESPA-compatible (mechanical / electrical)
  - Reconfigurable mass & distribution (functional mass simulator)
  - Meet all safety requirements
  - Ease of manufacturability
  - Implement certification & verification program
  - Allow experimenter access up to final P-POD assembly



Notional concept of launcher (8 P-PODs) within ESPA payload envelope



## **Objectives fulfilled**

- Provide a launcher capability to meet objectives of:
  - NPS Space Systems Education
    - Hands-on satellite development and operations
    - Shorter development cycle
  - Technology innovations for DOD
    - Encourage creative minds in higher education
    - Advance S&T for spacecraft technology (flight demonstrations)
  - Encouraging students to join the aerospace work force
    - Provide exposure to DOD / USG aerospace professionals by working on projects of mutual interest





### **NPS CubeSat Missions**



### Current NPS CubeSat projects:

- Solar cell measurement system
- 3-axis stabilized imager

#### Potential NPS CubeSat projects:

- Ship tracking
- Formation flying / docking
- Max. power tracking circuit
- Configurable, fault-tolerant processors (CFTP)
- Technology demonstrations
  - Attitude control
  - Energy storage devices