



Naval Postgraduate School

2009 CubeSat Developers Workshop

Utah State University



NPS CubeSat Launcher (NPSCuL) Program Update

Nicholas McGrail, Structural Analysis

LCDR (s) Christina Hicks, USN (Program Manager)

Shane Driscoll, (Integration & Testing)

Dr. Jim Newman (Professor, Space Systems)



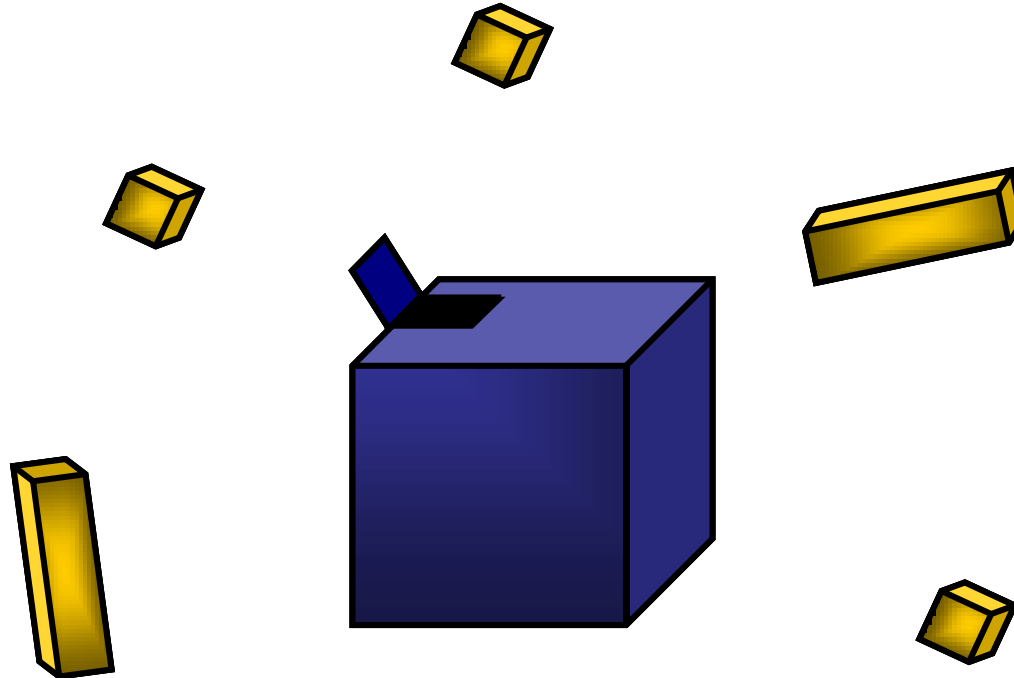
CALPOLY

Naval Postgraduate School
Space Systems Academic Group
Monterey, CA 93943

CUBESAT



What is “coach class” on a launch vehicle?



*NPS Cal
COACH-CLASS
TO ORBIT*



What is “coach class” on a launch vehicle?

The “airliners” of the US unmanned space program.

DELTA



ATLAS



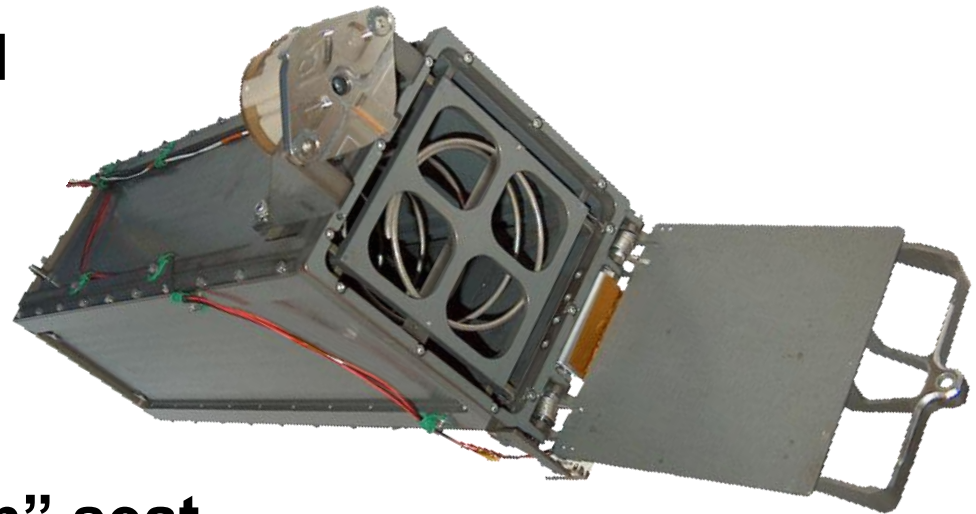


What is “coach class” on a launch vehicle?



The under-served customer

And



The “limited leg-room” seat

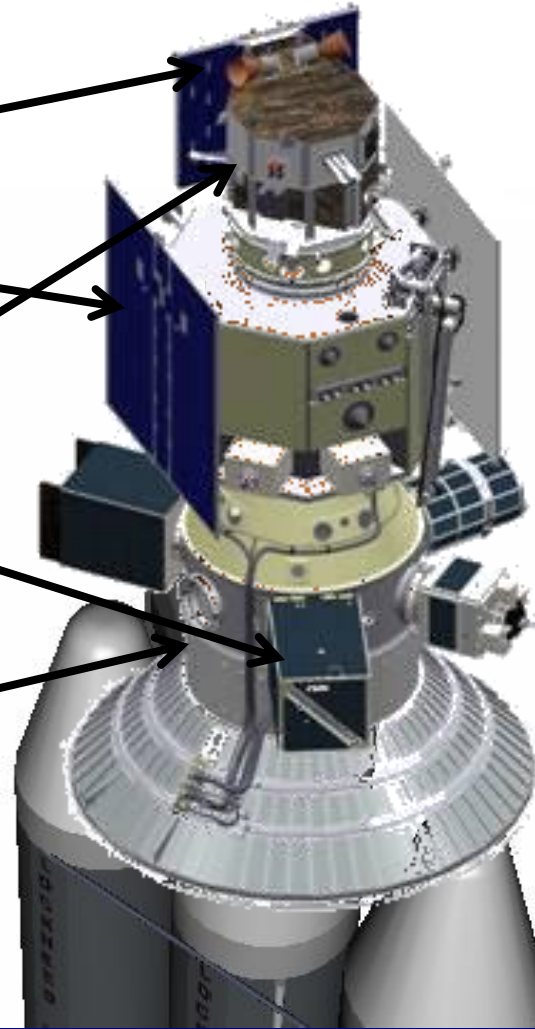


Seating Arrangement

“First Class”

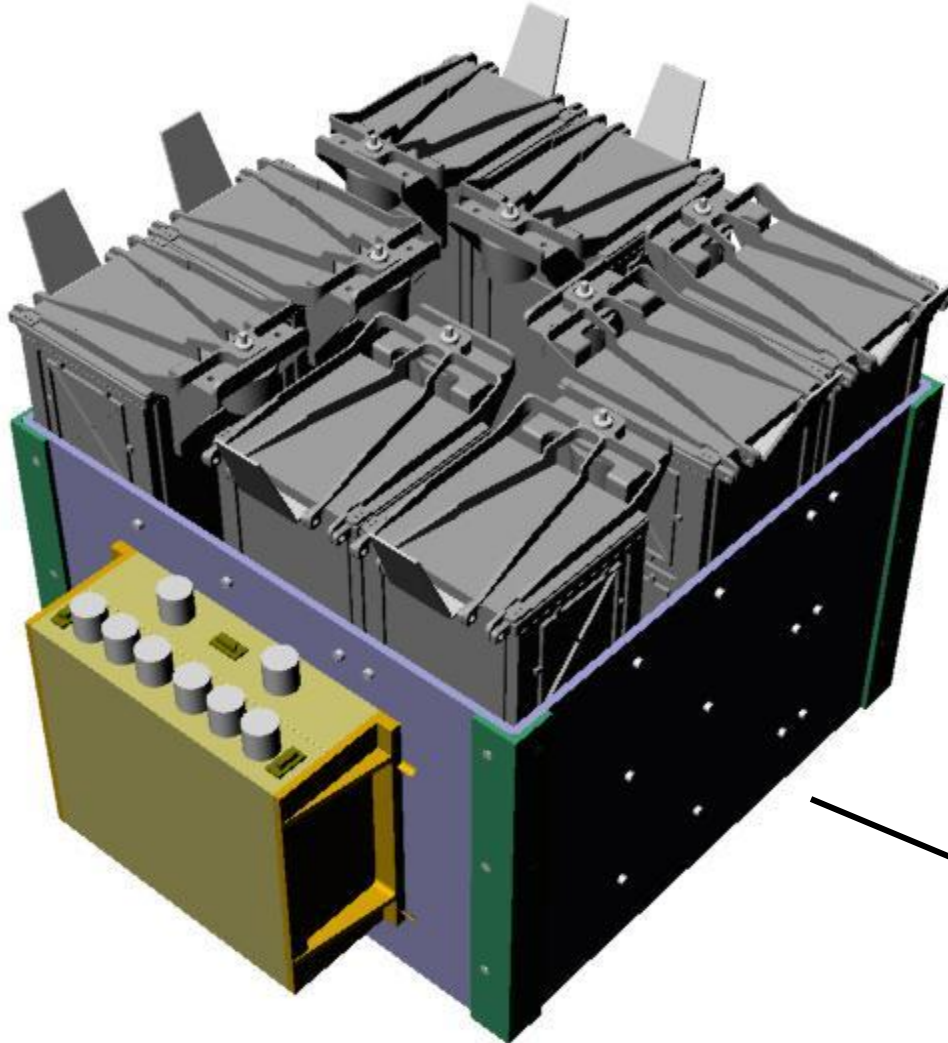
“Business Class”

“Coach Class”





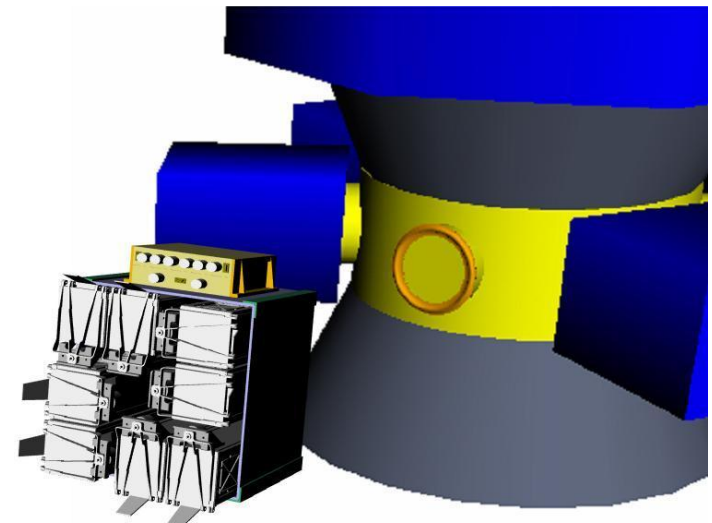
NPSCuL-Lite Design



8 P-PODS

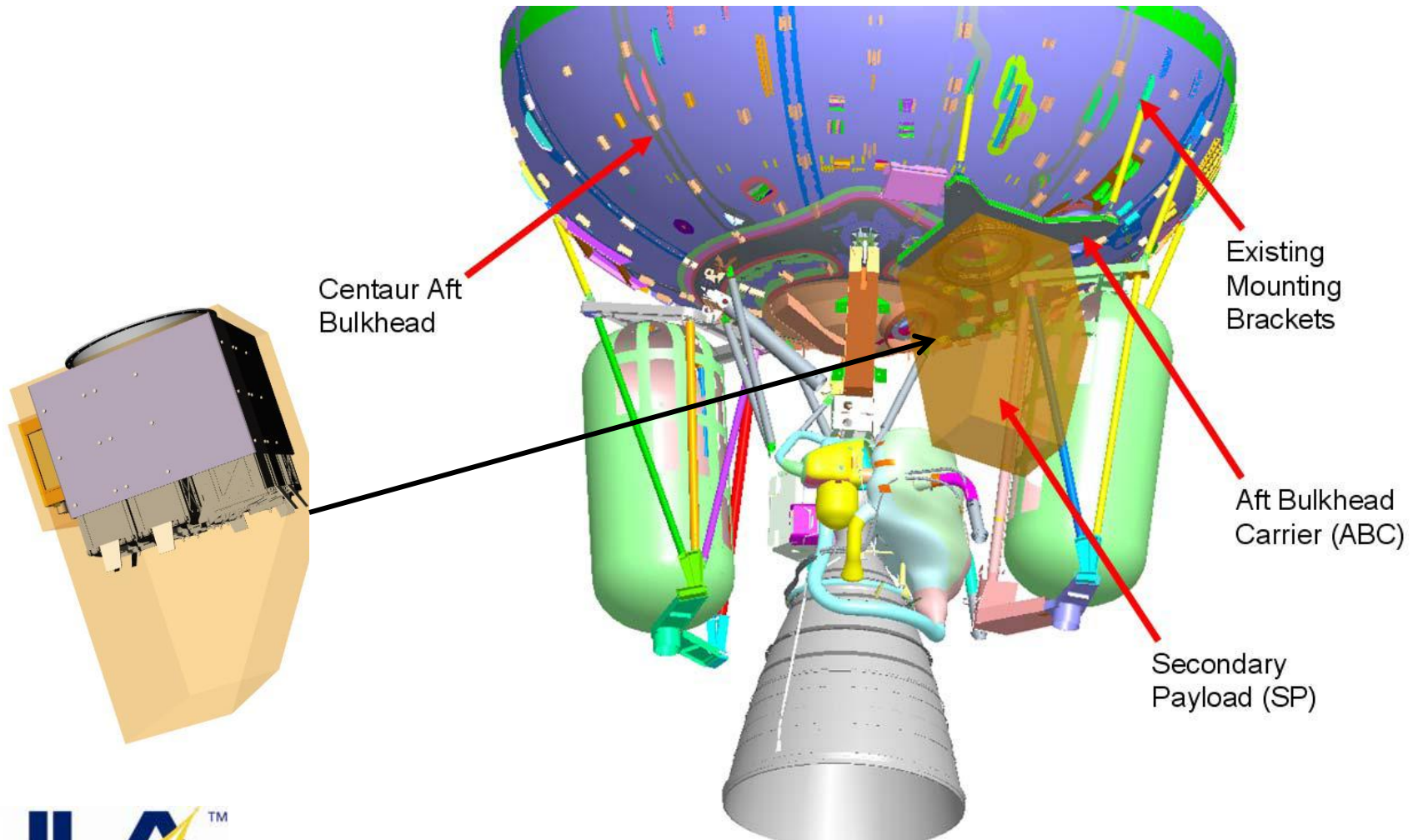
Up to 24U volume of
CubeSats

ESPA and ABC
Compatible





Atlas V ABC/SP Installation





Integration Process

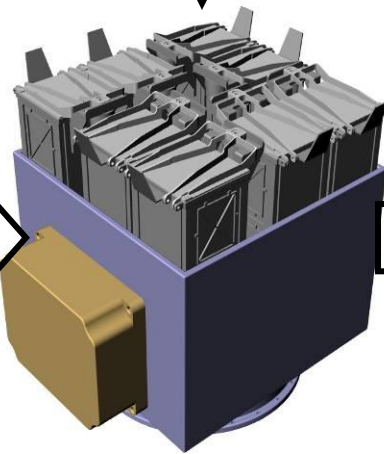
CubeSat Flight Experiments



University CubeSats integrated into P-PODS at Cal Poly

Finished P-PODs delivered to NPS for integration into NPSCuL

CubeSats from NPS and other USG partners



P-PODS and Sequencer integrated into NPSCuL

Finished NPSCuL delivered for integration onto ESPA/ABC

Space Test Program
(or other launch provider)



Integration & Launch





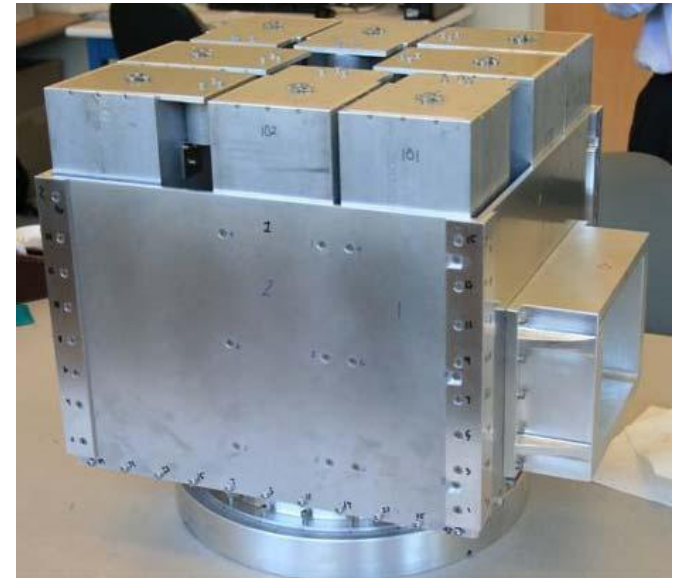
NPSCuL-LITE Test Program

Structure Qualification

- Launch environments +6dB using P-POD Mass Models (P2M2) to simulate loaded P-PODs
- Must accommodate minimum expected CubeSat mass (1 kg/U)
- NPS will perform all structural tests

Functional Developmental Testing

- On-board electronics fire the deployment systems in sequence
- Currently in development by a launch provider
- NPS to develop mission specific electrical harnesses





Testing Progress To Date

Qualification Testing

- Random Vibration Qualification Testing
- Test of NPSCuL-LITE with mass models of P-PODs and sequencer
- Mass model separation at 40s into 0dB Random Vibe

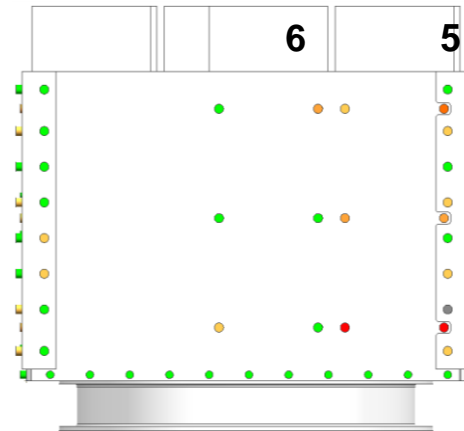
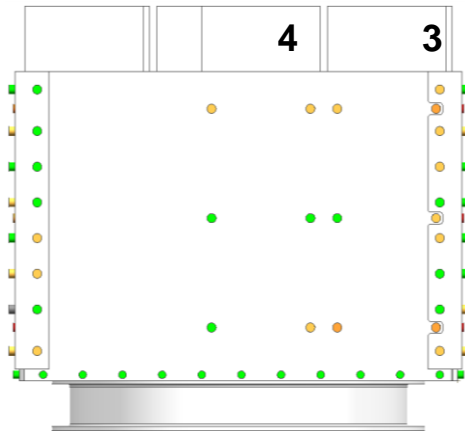
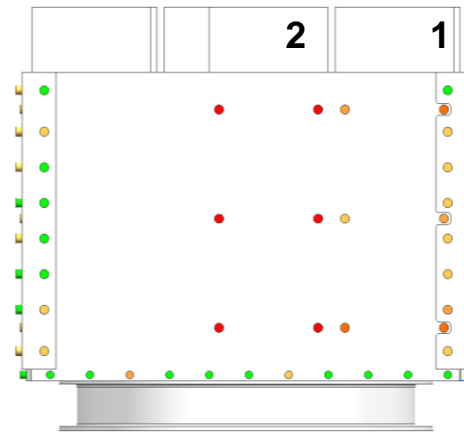
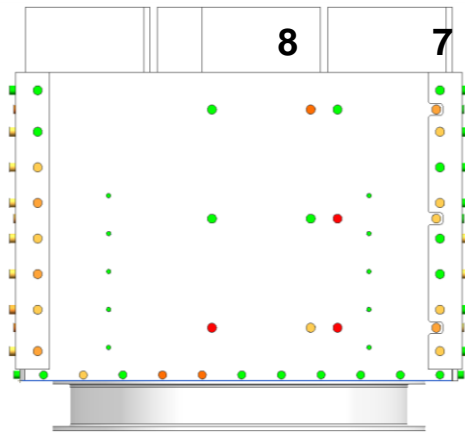
Post Testing Analysis

- Widespread loss of preload on both structure and mass models
- Witness marks indicate gapping between mass models and walls





Loss of Preload



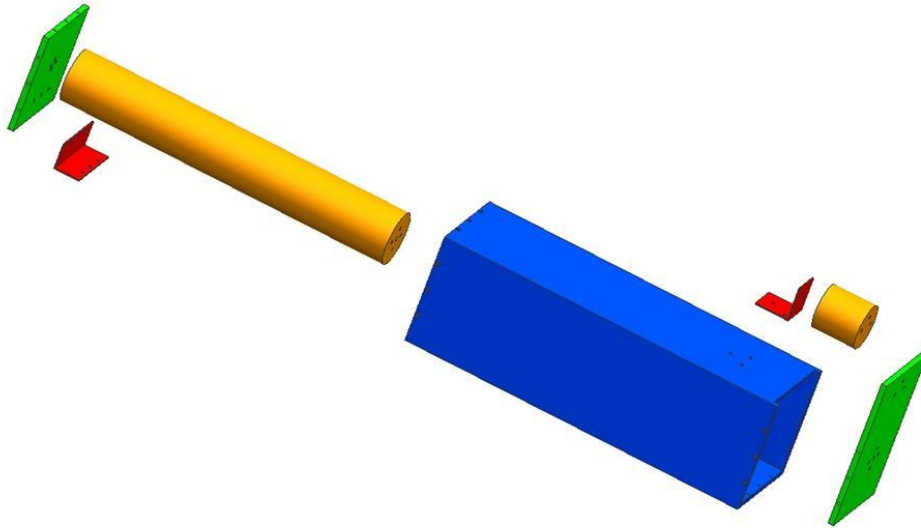
Color	Preload (in-lbs)
Green	>55 ¹
Yellow	45-55
Orange	35-45
Red-Orange	25-35
Red	<25

¹ Initial Preload



“In the Direction of Goodness”

Redesigned P-POD Mass Models (P2M2)



Old



New



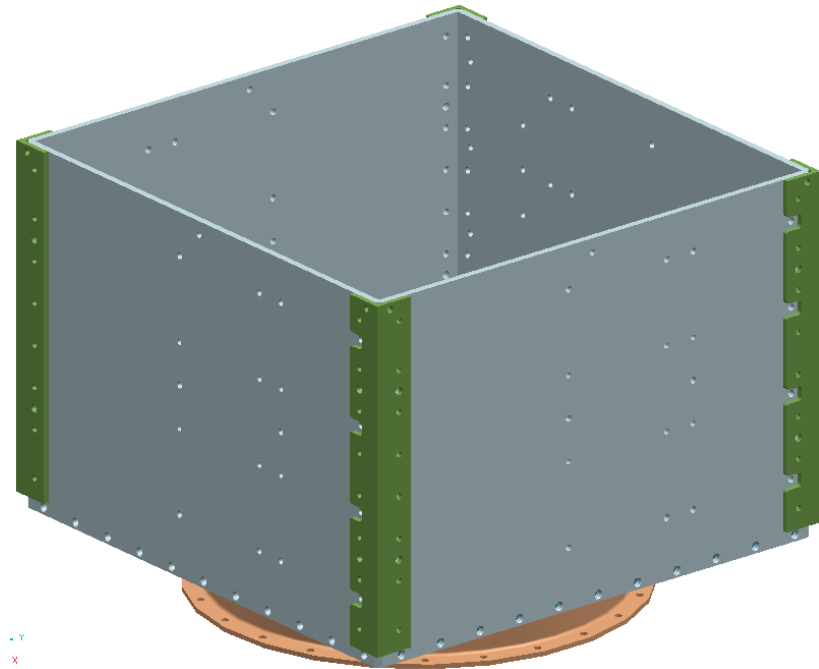
“In the Direction of Goodness”

Structural Design Modifications

- Eight (8) P-POD mounting holes
- Countersunk to socket head cap bolts
- Bolts upgraded to A286
- Holes for ground support equipment

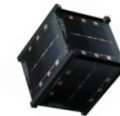
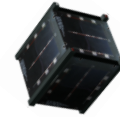
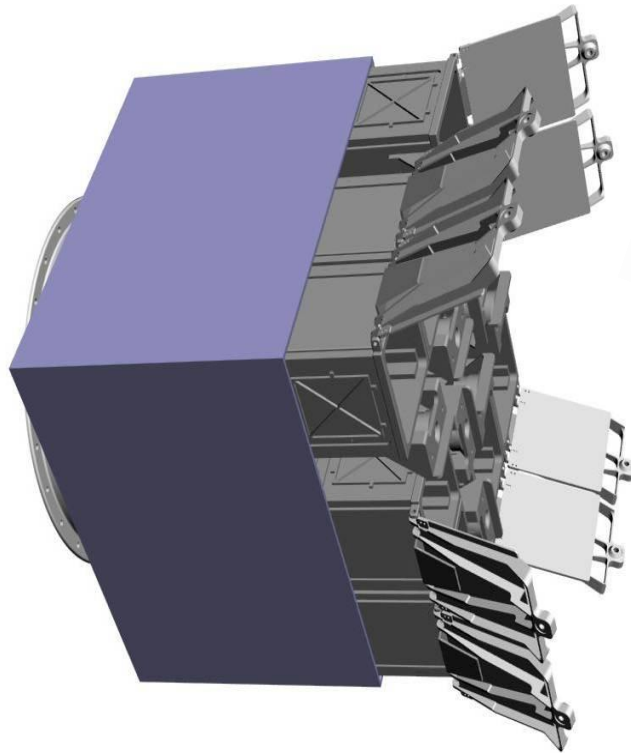
Upcoming

- NPSCuL assembly
- P2M2 integration
- Qualification testing (6 P2M2, 2 P-PODs)
- Build and acceptance test flight unit





Questions?



NPSCuL Coach Class to Orbit



NPSCuL Contacts

- **Principal Investigators:**

Dr. Jim Newman

Professor, Space Systems Academic Group, NPS

(831) 656-2487

jhnewman@nps.edu

Dr. Rudy Panholzer

Chairman, SSAG, NPS

(831) 656-2154

rpanholzer@nps.edu

Mr. Dan Sakoda

Research Associate, SSAG, NPS

dsakoda@nps.edu

- **Project Manager:**

LCDR(s) Christina Hicks

cmhicks@nps.edu

