

# CubeSat

Developers' Workshop

1st Annual

April 8th - 10th

**Cal Poly**  
San Luis Obispo

# CubeSats: From Launch to Deployment

Necessity for a standard.

- Creation of a standard to facilitate the design process of small satellites.
- Deployment system to support the standard.
  - Safe and reliable.
  - Efficient and cost effective.
  - Versatile.





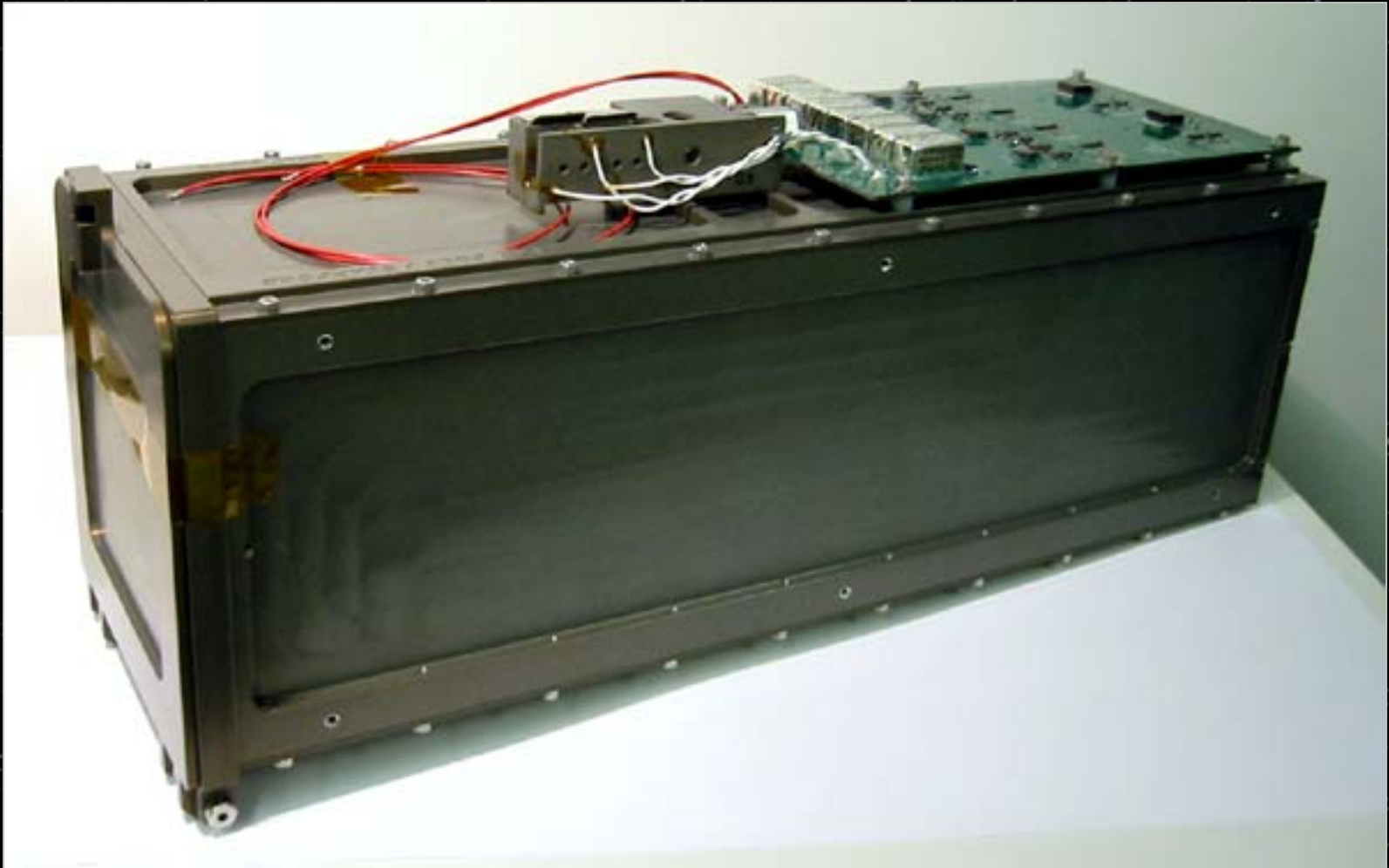
# CubeSats: From Launch to Deployment

## Poly Picosatellite Orbital Deployer.

- Basic P-POD Design.
  - Developed by Stanford and Cal Poly.
  - Hollow, spring-loaded design.
  - Holds 3 single sized CubeSats.
- P-POD Mk. I
  - Planetary Systems Line Cutter used for deployment.
  - On board power and timing circuits.
  - Accepts standard pyro pulse.

# CubeSats: From Launch to Deployment

## P-POD Mk. I



# CubeSats: From Launch to Deployment

## Flight Heritage.

- Eurokot Launch Vehicle.
  - Launched from Plesetsk.
  - June 30, 2003
  - Coordinated by University of Toronto.
- 4 CubeSats on 2 P-PODs.
  - Quake Finder
  - P-POD mission successful!





# CubeSats: From Launch to Deployment

Lessons learned and improvements.

Issues addressed in redesign of P-POD to make it a more attractive secondary for future missions:

- Difficulty in Tracking.
- Door displacement during vibration.
- Deployment System.
- Telemetry Sensor.

# CubeSats: From Launch to Deployment

## Tracking CubeSats in the cluster.

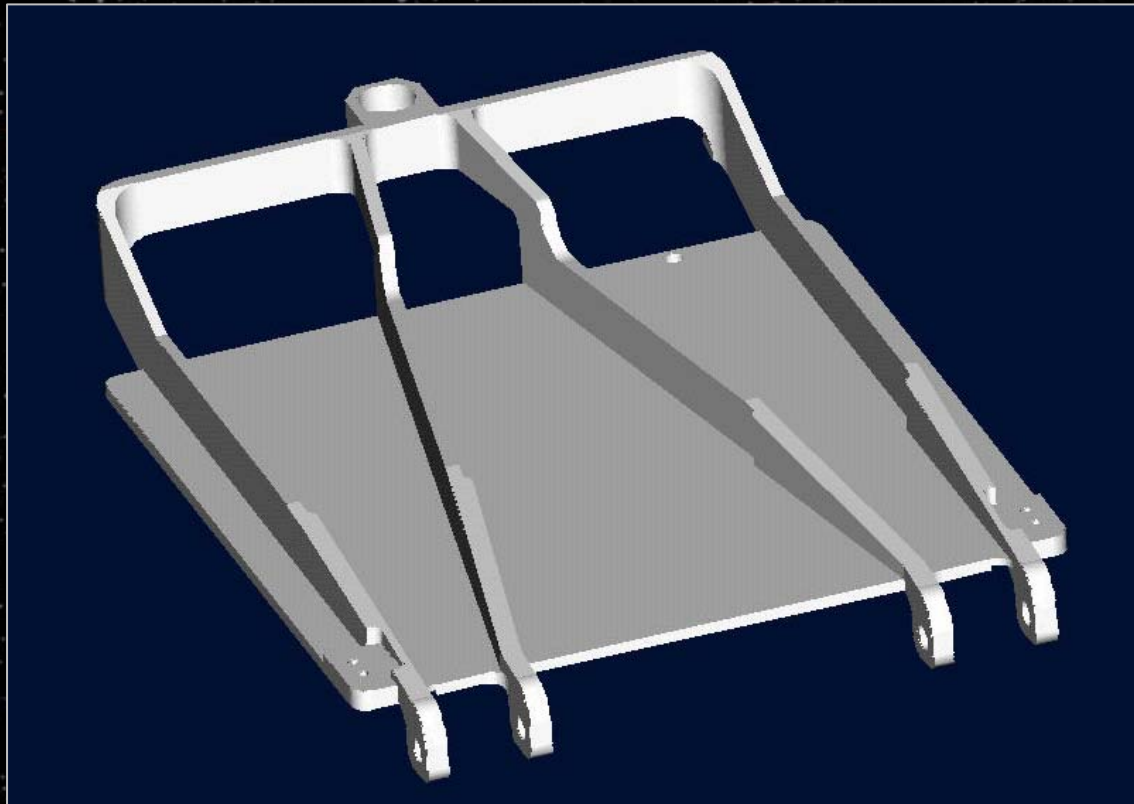
- Initially difficult to tell which CubeSat is which.
  - Need better beacons.
  - Ground Station's need to be better prepared and coordinated.
  - Considering radio fingerprinting for identification.



# CubeSats: From Launch to Deployment

## Door Redesign.

- Door flexing puts unnecessary load on CubeSats.
- Redesigned door is 200% stiffer.

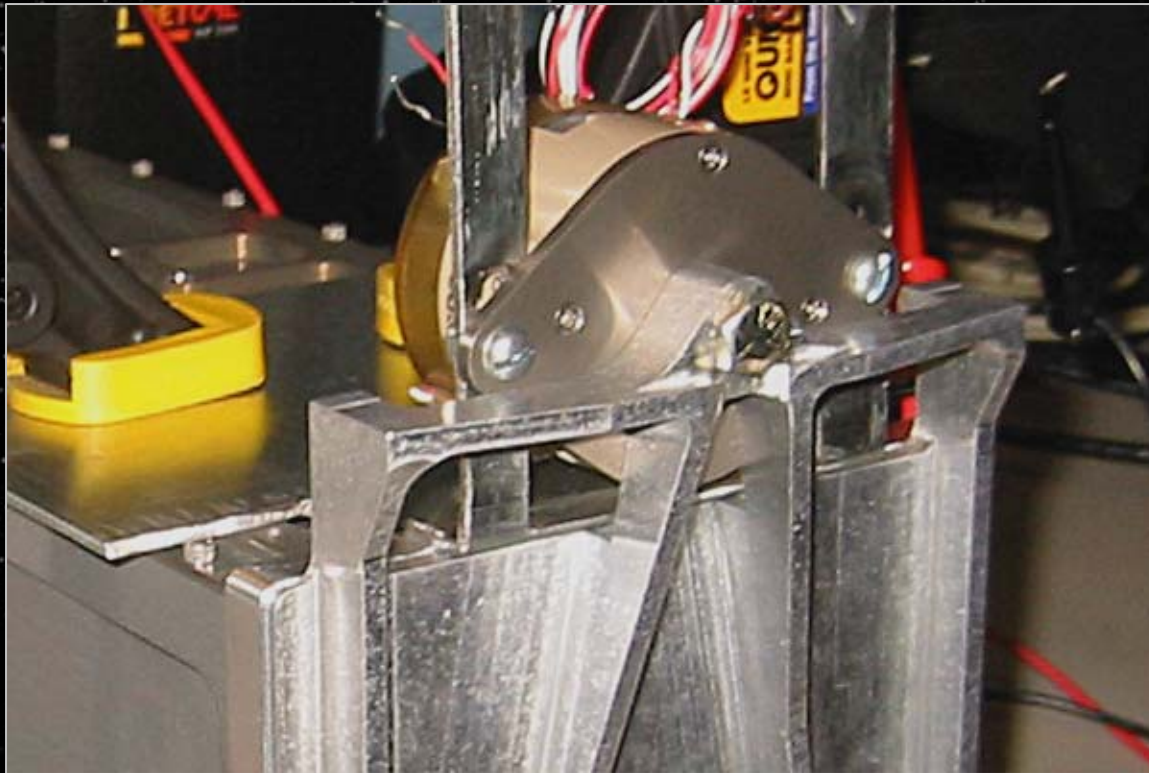




# CubeSats: From Launch to Deployment

## Starsys Release Mechanism.

- Fast and very reliable.
- No on-board electronics needed.



# CubeSats: From Launch to Deployment

## Telemetry Data.

- Confirmation of successful deployment.
- Signal is sent when door opens 90°.



# CubeSats: From Launch to Deployment

## P-POD Mk. II





# CubeSats: From Launch to Deployment

## P-POD Specifications.

**Mass:**

2.23 kg (empty)

5.23 kg (loaded)

**1<sup>st</sup> Natural Frequency:**

650 Hz – 700 Hz

**Exit Velocity:**

2 m/s

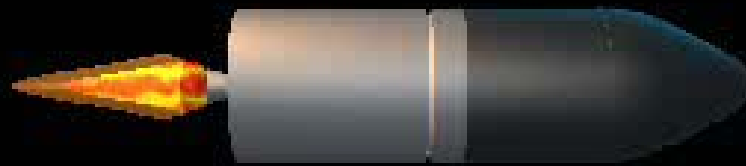
**Deployment Force:**

44.4 N



# CubeSats: From Launch to Deployment

DNEPR Video.



# CubeSats: From Launch to Deployment

## DNEPR Mission.

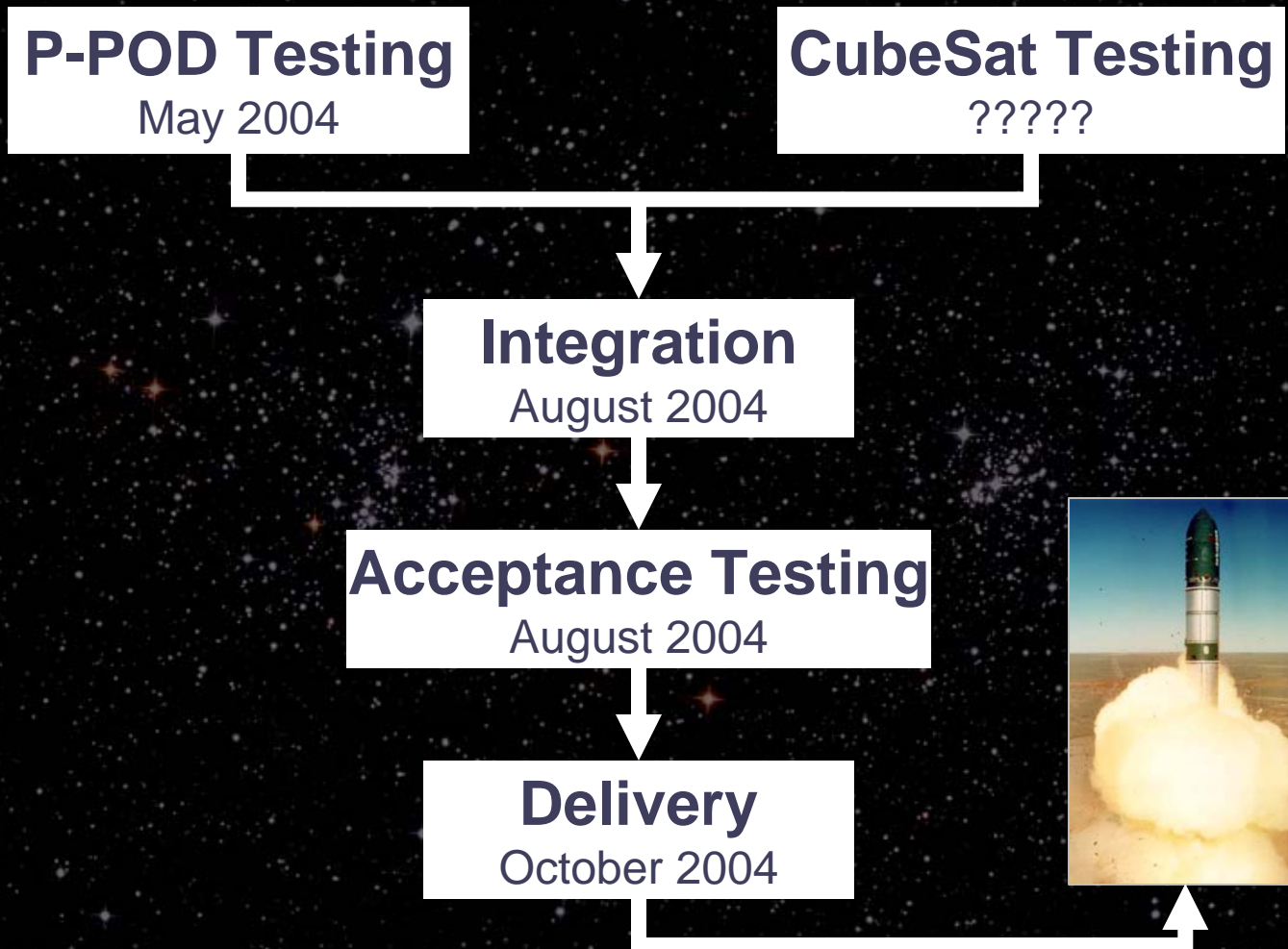
- October 2004
- 14 CubeSats
- 11 Universities
- 5 P-PODs
- \$40,000 per single sized CubeSat
- What will happen from now until then?





# CubeSats: From Launch to Deployment

## Launch Flowchart.



# CubeSats: From Launch to Deployment

## Qualification Testing.

- P-POD Prototype.
  - Tested to NASA worst-case specs.
- Qualification
  - 125% of launch loads.
- Acceptance
  - 100% of launch loads.
  - Fully integrated P-POD.

# CubeSats: From Launch to Deployment

## Getting to Integration.

- Where? When? How Long?
  - Cal Poly CubeSat Lab
  - August 1<sup>st</sup> to 30<sup>th</sup>
  - Integration & Acceptance = 1 week
- Deliverables (1 month prior).
  - Charging Procedures
  - Diagnostic Procedures
  - Remove Before Flight (RBF) Procedures
  - Special Needs Requests



# CubeSats: From Launch to Deployment

## Integration...

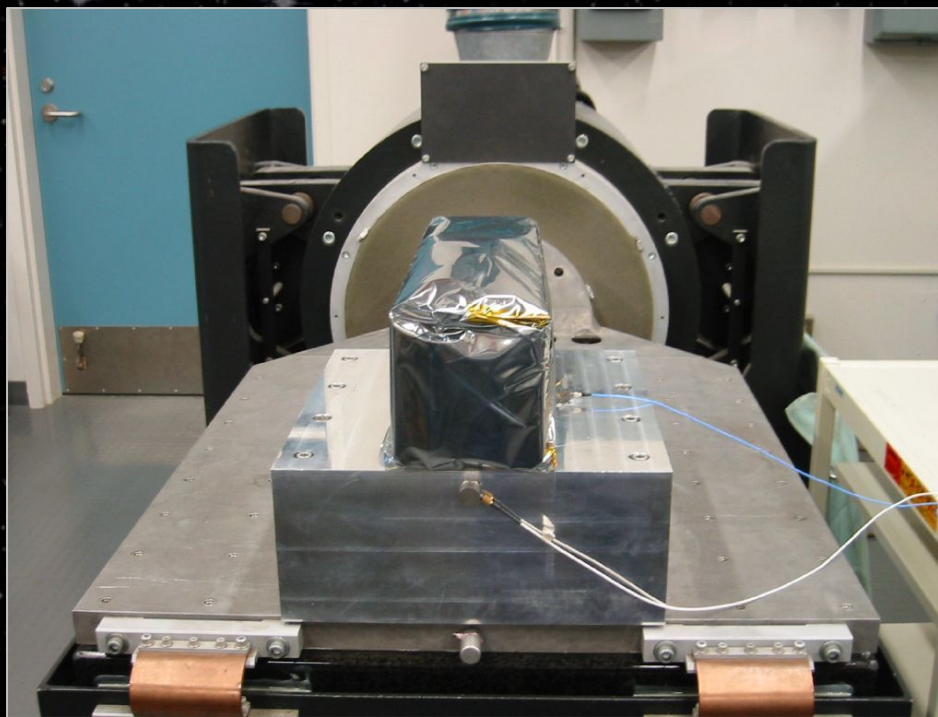
- Class 100,000 clean room.
- Shipping handled by developers.



# CubeSats: From Launch to Deployment

...and Acceptance.

- Integrated P-POD with actual CubeSats and launch interface.
- 100% of launch loads.





# CubeSats: From Launch to Deployment

## Integration Schedule.

- Each developer assigned a week during August.
- Integration, testing and diagnostics.

TESTING SCHEDULE DETAIL												
					M	T	W	R	F	S	S	
					Integrate							
					T-Vac							
					Vibe							
					Diagnostics							
					Headroom							



# CubeSats: From Launch to Deployment

## DNEPR 2004 Schedule.

	NOV03	DEC03	JAN04	FEB04	MAR04	APR04	MAY04	JUN04	JUL04	AUG04	SEP04	OCT04
Design	█											
Manufacturing			█									
P-POD Qualification							█					
Integration & Acceptance										█		
Cal Poly Fit Check						█						
DNEPR Fit Check								█				
DNEPR Integration												█
Launch!												█

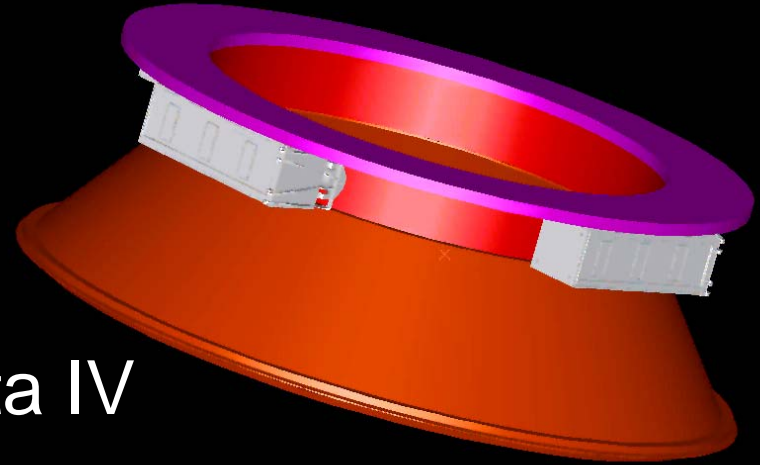
- Important Dates.

- April 8<sup>th</sup> – 10<sup>th</sup> ..... Cal Poly Workshop (Fit Check)
- June 20<sup>th</sup> – 30<sup>th</sup> ..... DNEPR Fit Check for P-POD
- August 1<sup>st</sup> ..... Delivery to Cal Poly
- October 10<sup>th</sup> ..... Nominal Delivery Date
- October 31<sup>st</sup> ..... Nominal Launch Date

# CubeSats: From Launch to Deployment

## Future Missions (US Launches).

- Space X – Falcon
  - Boeing – Atlas V
  - Lockheed – Delta II and Delta IV
  - Orbital Sciences Corp. – Pegasus
  - Other small launch vehicles.
- 
- Working with CSA to procure funding for future US CubeSat missions.



# CubeSats: From Launch to Deployment

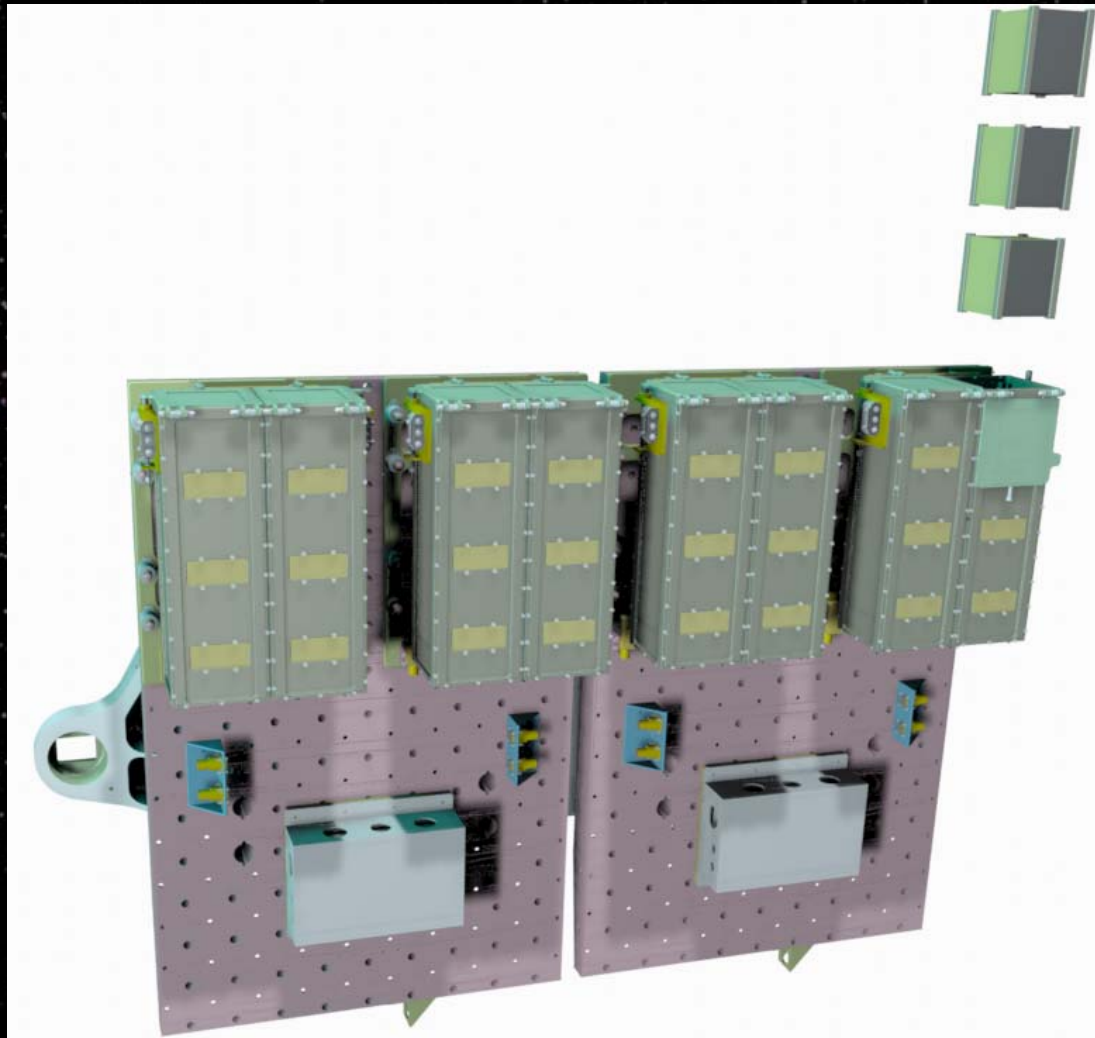
Shuttle.





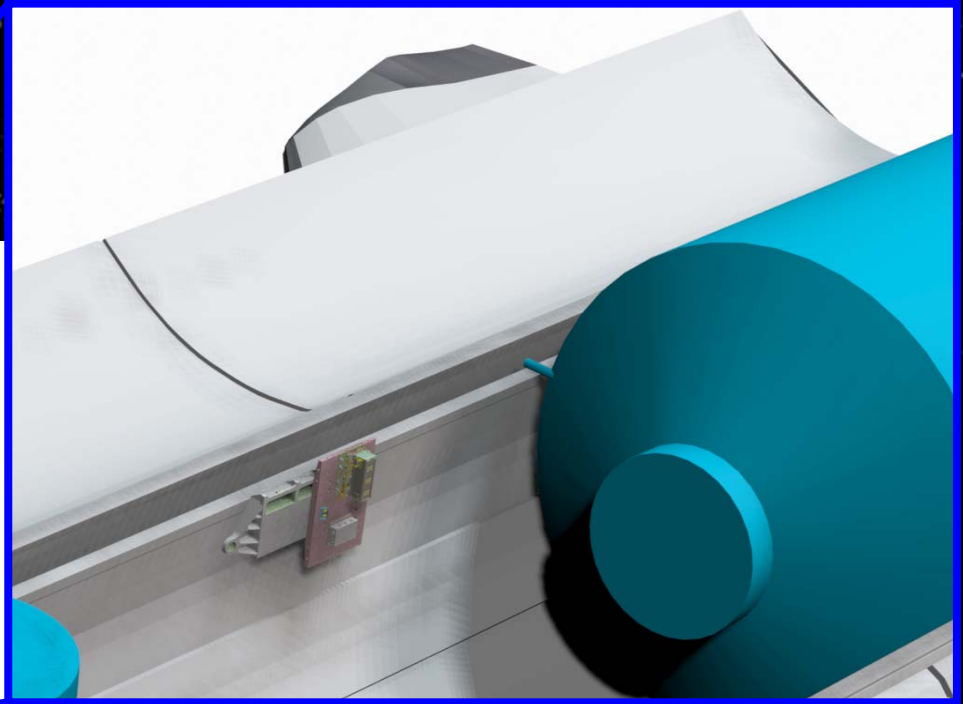
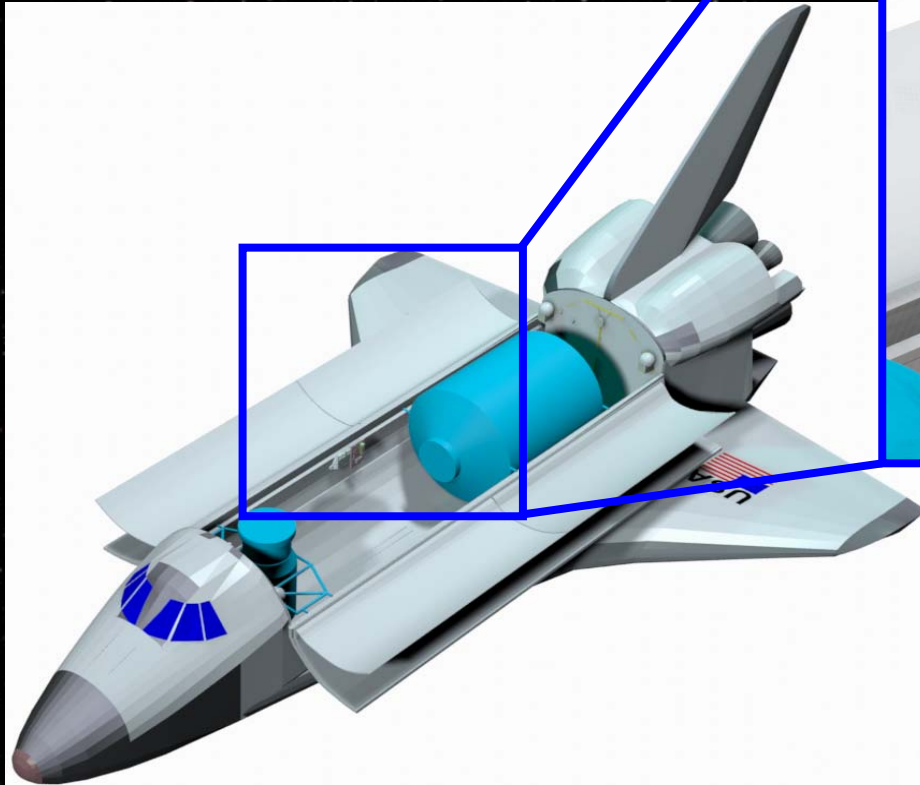
# CubeSats: From Launch to Deployment

## Shuttle Capabilities.



# CubeSats: From Launch to Deployment

Where'd they go?!



# CubeSats: From Launch to Deployment

Future Missions (DNEPR).

## ***DNEPR 2005***

- What you need to know:
  - Launch in Fall 2005.
  - \$40,000 per single CubeSat.
  - Need 12 – 15 CubeSats.
  - MOU signed in Summer 2004.
  - Contact us if interested.

