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Nano-Satellite Systems Inc.

Interplanetary CubeSat Launch Opportunities and Payload Accommodations

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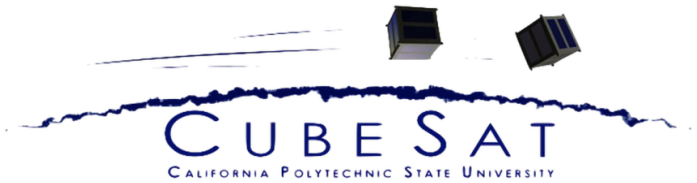

Partnered with
California Polytechnic State University (Cal Poly)
San Luis Obispo, CA

Tyvak CubeSat Launch Services

- **Principals Have Extensive Launch Integration Experience**
  - **Over a Decade Integrating CubeSats with Launch Vehicles**
    - **First launch in 2003**
  - **Successfully Completed 18 Launch Campaigns**
    - **121 CubeSat integrated, 72 P-PODs**
    - **10 Different launch vehicles and 9 ranges worldwide**
  - **7+ Launch Campaigns Ongoing**
    - **>40 CubeSats, >25 P-PODs**

NASA NPP with 3 P-PODs

U.S. Govt with 8 P-PODs

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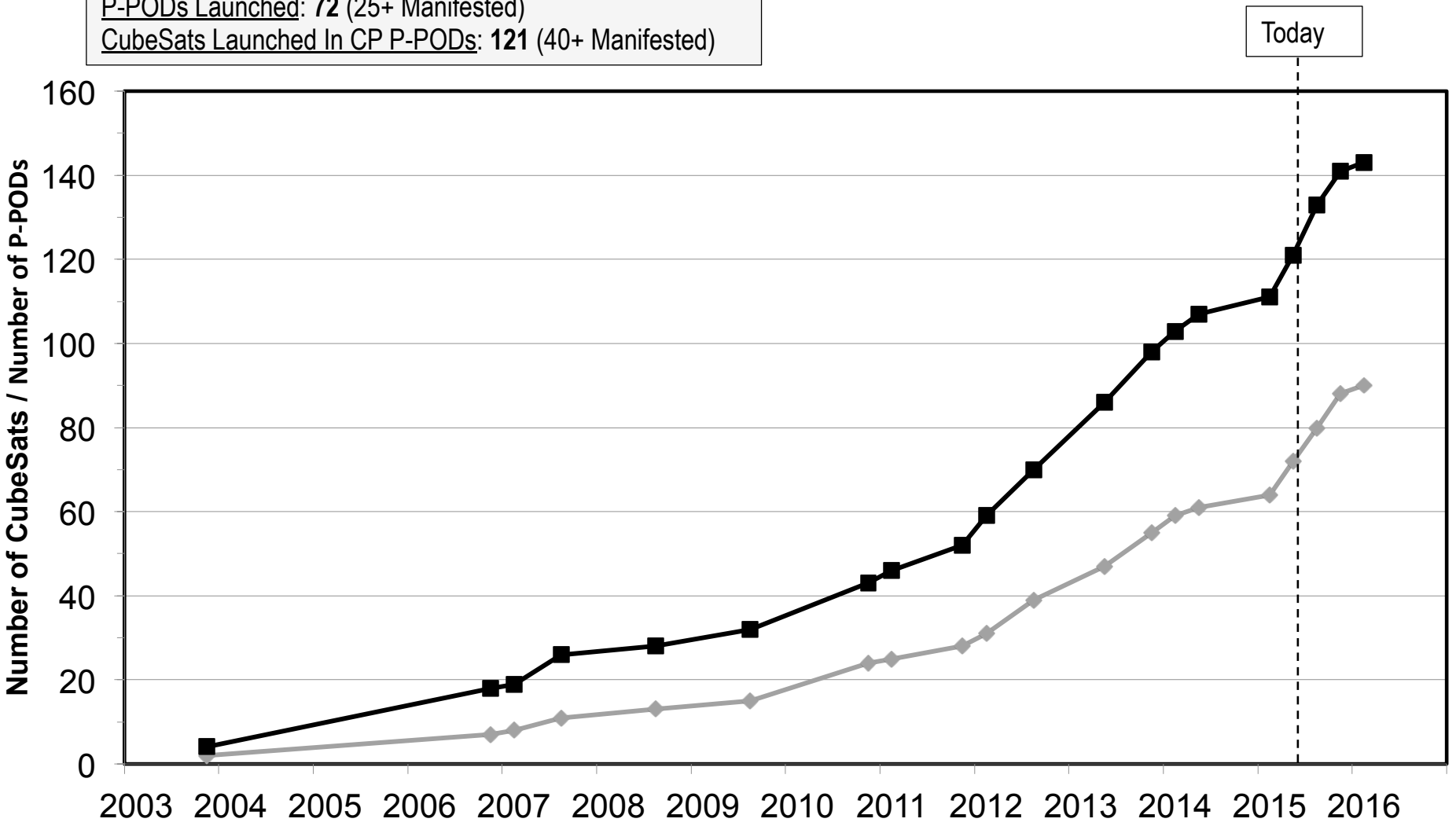
Extensive POD Flight History

P-PODs Launched: **72** (25+ Manifested)
CubeSats Launched In CP P-PODs: **121** (40+ Manifested)



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CubeSat Launch Services – Launch Certifications

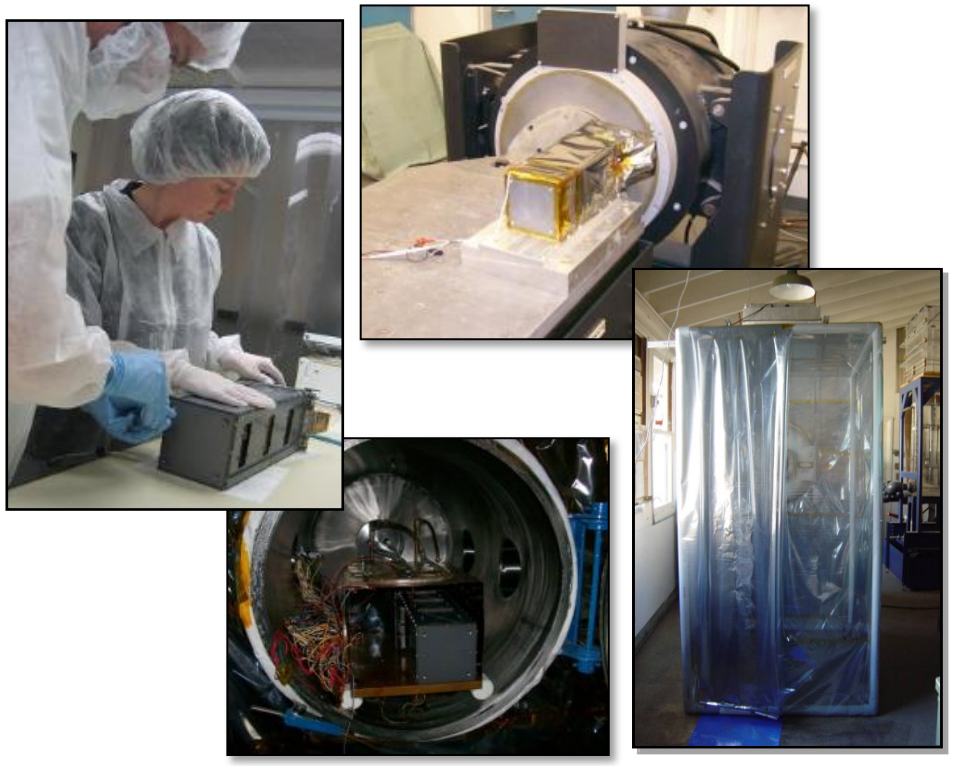
- **Launch Coordination and Regulatory Approvals**
  - Experienced in ITAR
    - International CubeSats on International LVs, International CubeSats on US LVs
  - Radio Frequency Licenses
    - IARU, FCC, NTIA, ITU
  - Range Safety AFSPCMAN 91-710
  - Flexible Launch Manifesting
  - CubeSat On-Orbit Operations

- **Approvals From U.S./International Government Agencies**
  - Successfully managed and assisted CubeSats in obtaining:
    - Export Control: Dept. of State, Commerce
    - CubeSat Frequency Allocations: IARU, FCC, NTIA, ITU
    - Orbital Debris Assessment Report (ODAR) and Re-Entry Analysis: NASA, AF, FCC
    - Earth Imaging: NOAA

Available Environmental Processing and Testing Facilities

Vibration Test Facilities

- 2 Vibration Tables
- Used for Qualification and Acceptance Testing of P-POD and CubeSat Hardware
- Random Vibration, Sine Vibe, and Sine Sweeps



Thermal Vacuum Facilities

- Housed in a Portable Cleanroom
- Temp Range: -60 to 80C
- High Vacuum
- Data Acquisition System
- Used for Qualification, Acceptance, and Thermal Bake Out of Flight Hardware

Clean Room Facilities

- Class 100,000 Nominal
  - Capable of Class 10,000 and cleaner
- 28 x 8 ft. of Floor Space
- Locked Storage for Flight Hardware

EMI/EMC Anechoic Chamber Facilities

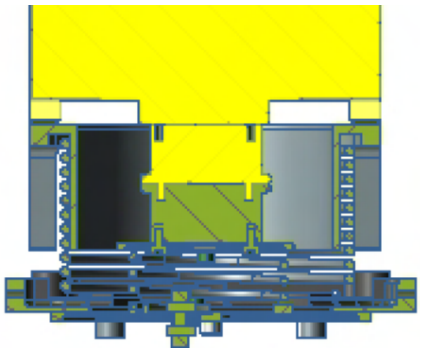
- Tests for attenuation and CubeSat RF antenna patterns

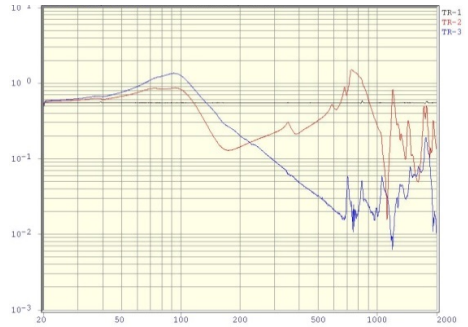
Supported CubeSat Testing at Other Facilities

- Commercial Test Facilities, NASA Ames, NASA WFF, NASA MSFC, SRI, NPS

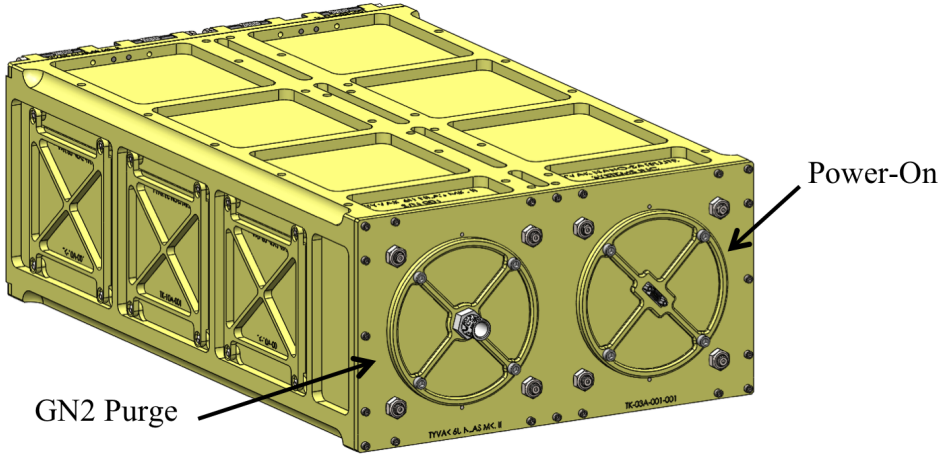
Possible Capabilities for Interplanetary CubeSats

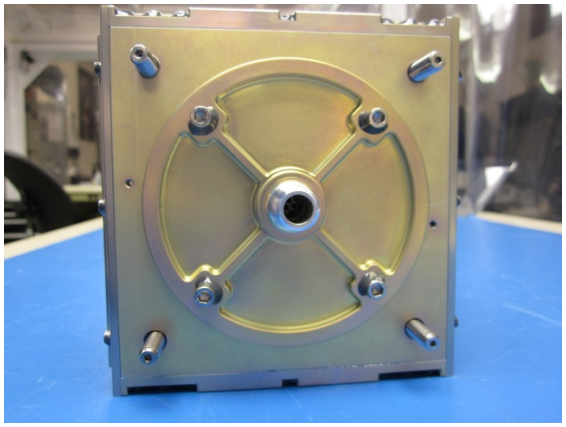
- **Additional Capabilities for Sensitive CubeSats/Payloads**
  - Dependent on LV availability
  - Planetary Protection Processing
  - Nitrogen Purge
  - Trickle Charging and Diagnostics
  - Vibration Isolation





- **Looking for feedback from community**





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Current Launch Opportunities

Date	Mission	Destination	Location	Capacity
2015	U.S. Govt	LEO	Atlas V	24U
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Q1 2016	Commercial	LEO	Indian	12U
Q1 2016	Commercial	LEO	Russian	12U
Q1 2016	U.S. Govt	Mars	Atlas V	12U
H1 2016	Commercial	LEO	Russian	9U
H1 2016	Commercial	LEO	Indian	12U
H2 2016	Commercial	LEO/Escape	Atlas V	24U+
H2 2016	Commercial	LEO	Indian	12U
H2 2016	Commercial	LEO	Russian	24U+
H1 2017	Commercial	GEO	US	24U+

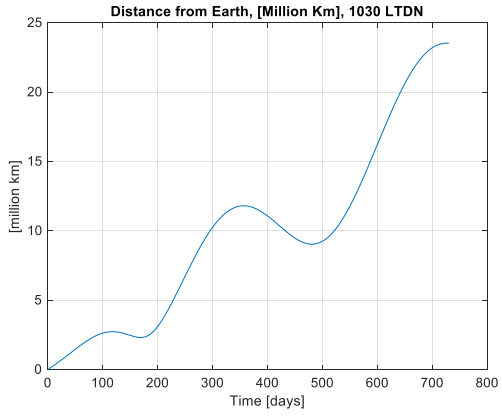
Current Launch Opportunities - GEO

- **GEO Launch Opportunity**
  - **Primary Spacecraft: SS/Loral Satellite Bus**
  - **Maximum Mass: 60kg**
  - **Maximum Volume: 1m x 0.5m x 0.4m**
  - **CubeSat Form Factors: 1U to 27U+**
  - **Launch: Early Q1 2017**
  - **Delivery for Integration: ~Sept. 2016**
  - **Cost: ~$100,000 USD per kg (negotiable)**
  - **Contract Signing: June/July 2015**

Current Launch Opportunities - Interplanetary

- 1st Commercial Interplanetary Launch Opportunity!
- Very Quick Turnaround Needed
- Launch Details
  - Launch Vehicle: ULA Atlas V
  - CubeSat Form Factors: 1U to 12U
  - Capacity Available: 108U
  - Launch: Q3 2016
  - Delivery for Integration: June/July 2016
  - Cost: ~$700,000 USD per 3U to Elliptical or Escape Orbit
  - Contract Signing: ASAP

- Orbit Option #1
  - LEO SSO 620km
- Orbit Option #2
  - Highly Elliptical
  - Perigee: ~620km
  - Apogee: Between Lunar and 1,000,000km
  - Phasing possible for lunar flyby
  - 10-40 day orbit period
  - ~40 m/s at perigee to go escape
- Orbit Option #3
  - Earth Escape Orbit
  - C3 of ~0.1



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Conclusions

- Looking for feedback from Interplanetary CubeSat community on additional requirements and needs
- Current interplanetary launch opportunity in Q3 2016, need to act fast if interest/funding is available
- Collaboration with science teams creates new opportunities

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