

# Simulating Realistic Launch Conditions by Performing Shake Test Under Sustained G-load



**KENNETH MALLORY**

**TA LIN**

**JIN KANG**

**DREXEL UNIVERSITY**



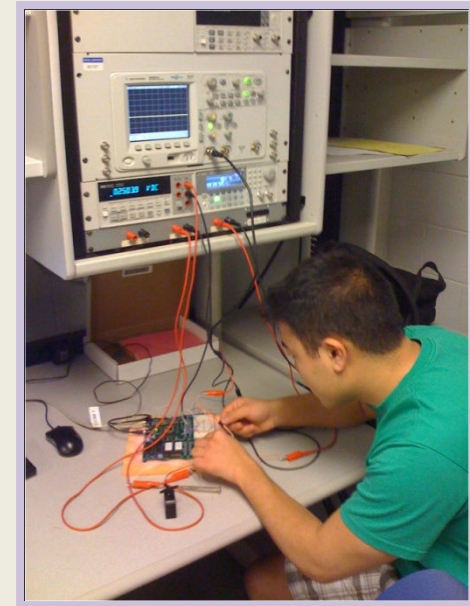
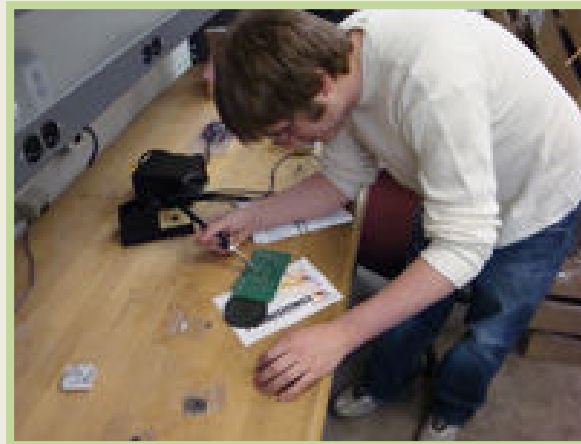
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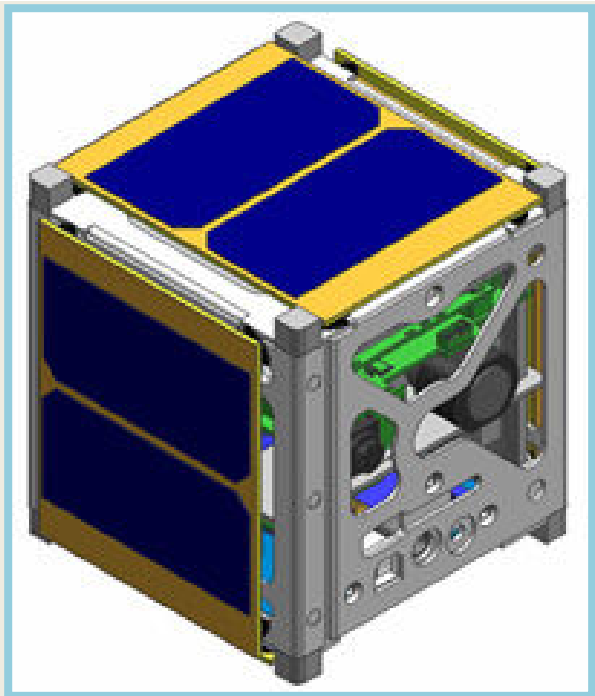
- Drexel Space Systems Lab
  - Part of Mechanical Engineering and Mechanics Dept.
  - Developing first satellite – 1U CubeSat
  - Has 24 undergraduate students working on CubeSat project



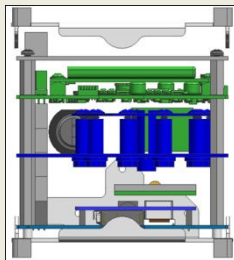
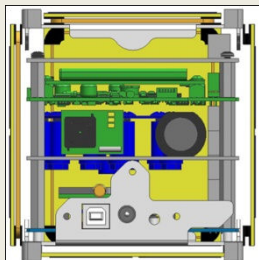
# Introduction – DragonSat-1



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DragonSat-1



- Specs
  - 1U CubeSat
  - 1.33 kg
  - 3-axis control
  - 1.5m Deployable boom
  - C328 Camera
- Missions
  - Pictures of Auroras
  - Boom Fluid Damper Experiment



# Combined G-load test



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- Shake test is done to simulate launch loads so that satellites will survive launch environment
- Idea is to better simulate launch environment
  - Vibration load applied to satellite
  - Sustained g-load applied to satellite in z-axis due to rocket acceleration
- Simulate both at same time → shake test inside centrifuge accelerator
  - ATFS-400™ "Phoenix" Sustained – G Centrifuge Motion Platform



# Benefits of Combined G-load Test



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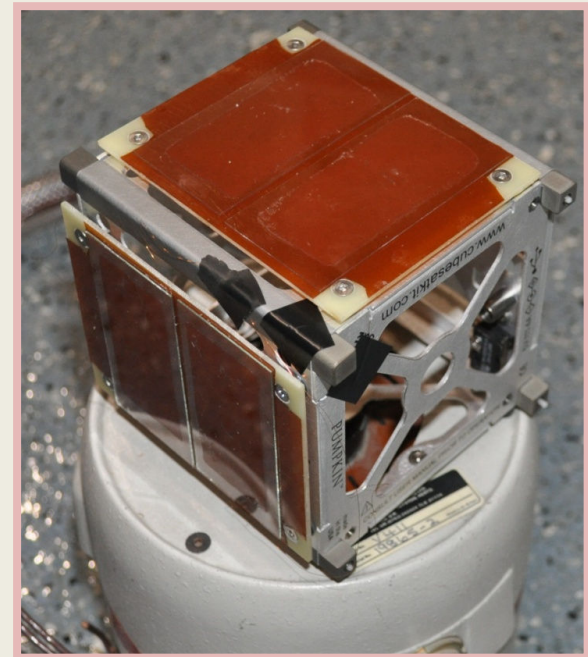
- Limitations of current shake test
  - Does not account for sustained-acceleration
  - Must test to much higher level for safety margin
  - Cannot simulate simultaneous two-axes loading
    - ✦ E.g.) vibration in y-axis, combined with sustained g-load in z-axis
- Expected benefits of combined g-load test
  - Better simulate launch environment such that more realistic load characteristic of satellite can be analyzed
  - May lead to reduction in required margin → less strain on satellite

# Test Setup

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ATFS-400™ "Phoenix"



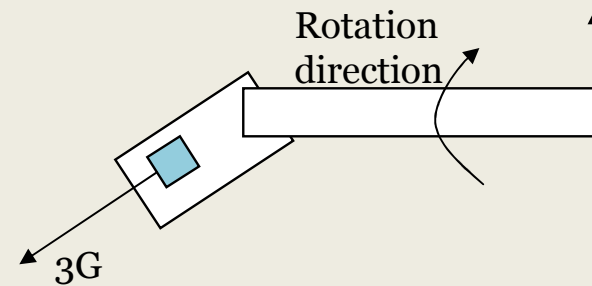
DragonSat-1 Test Model

# Test Setup

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Shaker and Test model  
approximate location in  
gondola



Sustained g-load of up to 9g can be  
applied while performing shake test

Credit: Nastar



- Initial testing to Demonstrated NASA GEVS Qualification profile at G loads of up to 9G

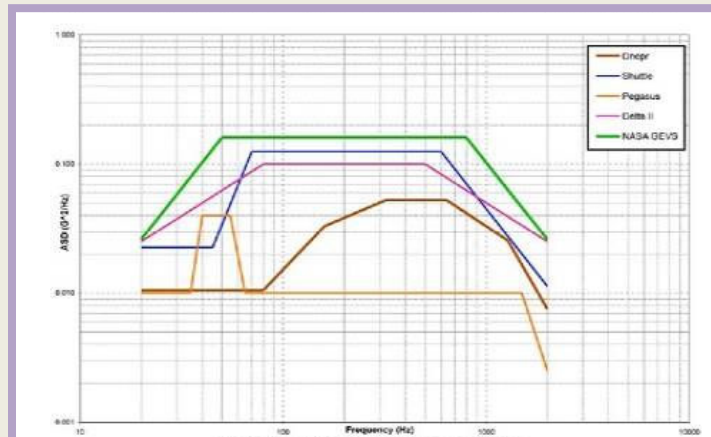


Figure 10 - NASA GEVS Qualification Profile

Table 6 - NASA GEVS Qualification Profile

Frequency, Hz	ASD Level (G <sup>2</sup> /Hz)
20	0.026
20 - 50	+6 dB/oct
50 - 800	0.16
800 - 2000	-6 dB/oct
2000	0.026
Overall	14.1 G <sub>rms</sub>



Data result obtained from NASTAR



# Preliminary Results



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- Test setup with mock payload (small mass) has been successfully tested
  - Obtained preliminary data as shown
  - Confirmed feasibility of combined loading test
- Actual flight hardware vibration testing will be performed on similar setup
  - Further testing delayed due to technical difficulties
  - Obtained data be compared to traditional vibration test
  - Will perform multiple axes vibration relative to acceleration
  - DragonSat-1 to be tested with NASA GEVS profile



# Conclusion



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- Combined g-load testing can have benefits
  - Better simulation of realistic conditions
  - Can lead to reduction in required shake level
- CubeSat platform ideal for collection of data and implementation of new test method
  - Hard to fit larger shaker table inside gondola → small shake payload
- Actual space hardware/satellite will be tested
  - Detailed test result will be available soon
  - Can potentially catalyze new test paradigm