

MISC 3 – The next generation of 3U CubeSats

Andrew E. Kalman, Adam W. Reif, Jerami M. Martin

Pumpkin, Inc.



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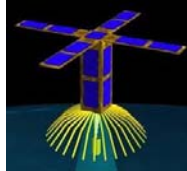
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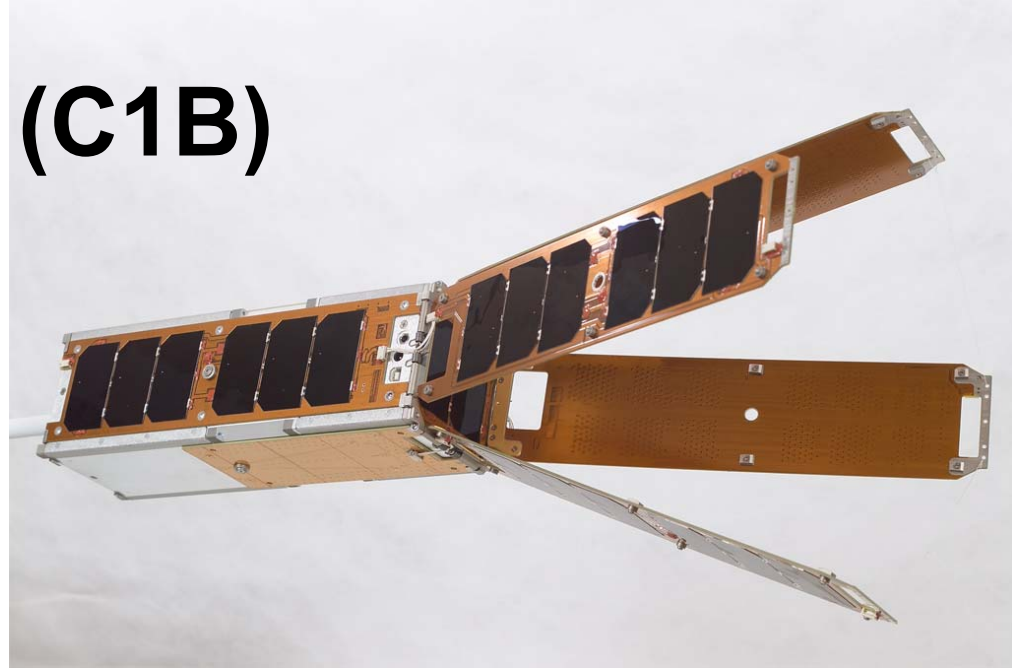
MISC 2 / Colony I (C1B)

- Timeline:
 - Design: Q4 2008
 - Delivery: Q1-Q3 2009
 - First flight: Q4 2010
 - Total: 14 units
- Two configurations:
 - Space dart (QbX1, QbX2)
 - Propeller (Aeneas)



• Capabilities

- 1500cc payload volume
(not including radio)
- 2° attitude knowledge & control
- MCU-based C&DH and payload processors
- 8-10W to payload



• Limitations

- Fixed bus & payload volumes
- No view of space for ADACS
- Radio & antennas not integrated
- Lack of symmetry on sides
- Volume & mass penalties due to ADACS in middle
- Limited configuration flexibility

MISC 3 Design Goals

- Power:
 - >15W to payload; improved heat paths; 40Wh battery
 - Variety of solar panel and solar array configurations
- Electronics
 - Support MCU-based customers with PPMs
 - Support Linux-based customers with PC/104 SBCs
- ADCS
 - <0.2° knowledge & control via MAI-400 or BCT XACT
 - Multiple configurations (e.g. nadir, anti-nadir, ram, anti-ram, etc.)
- Structure & Assembly
 - Unique addt'l hard points, cutouts and lengths → Pro chassis
 - Up to five sep switches; minimal harnesses
 - Support for multiple antenna configurations (esp. UHF & S-band)
 - GPS integration
- Comms & Propulsion
 - Accommodate new subsystems from various suppliers



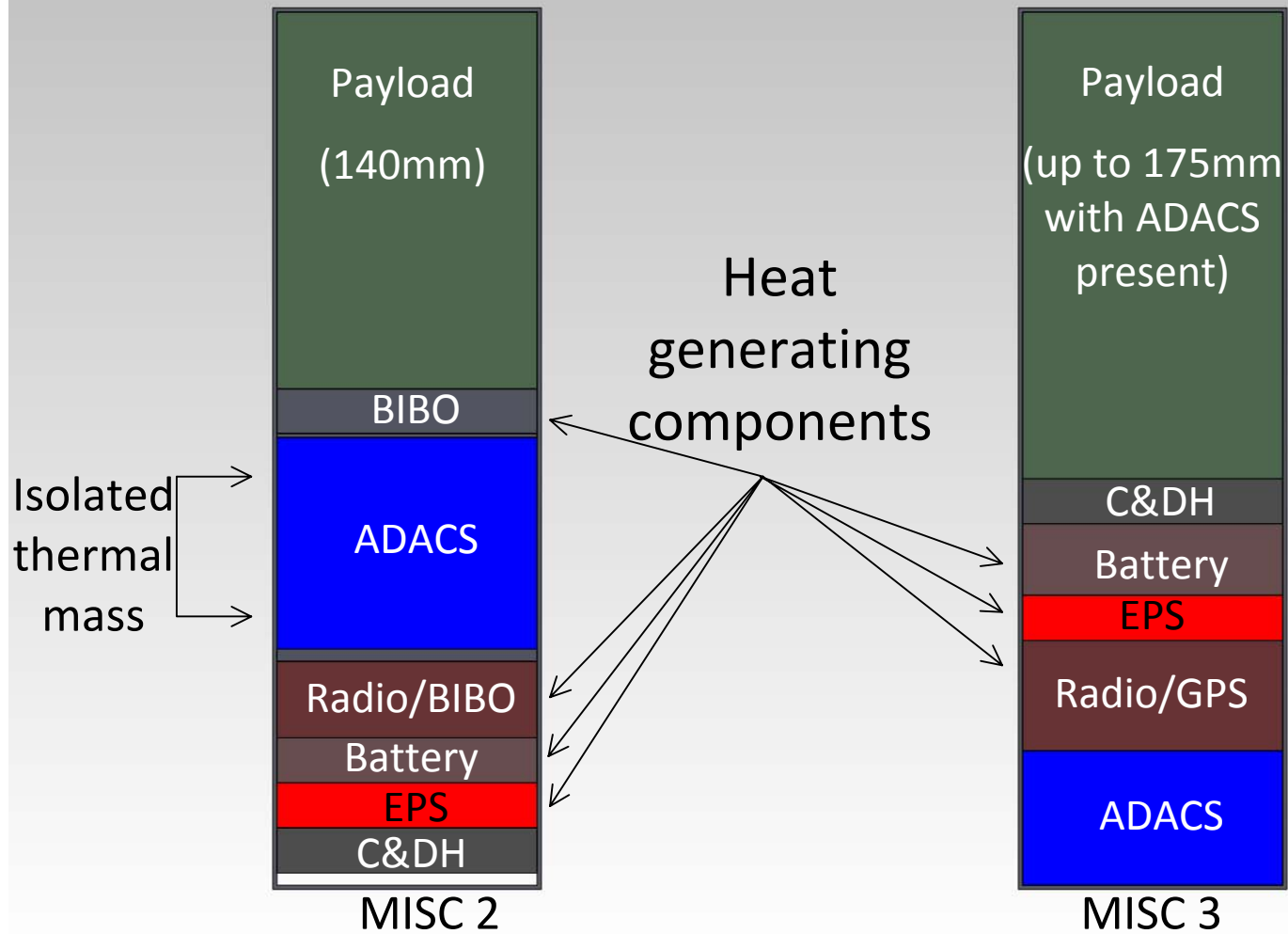
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MISC 2 vs MISC 3: Module Stacking



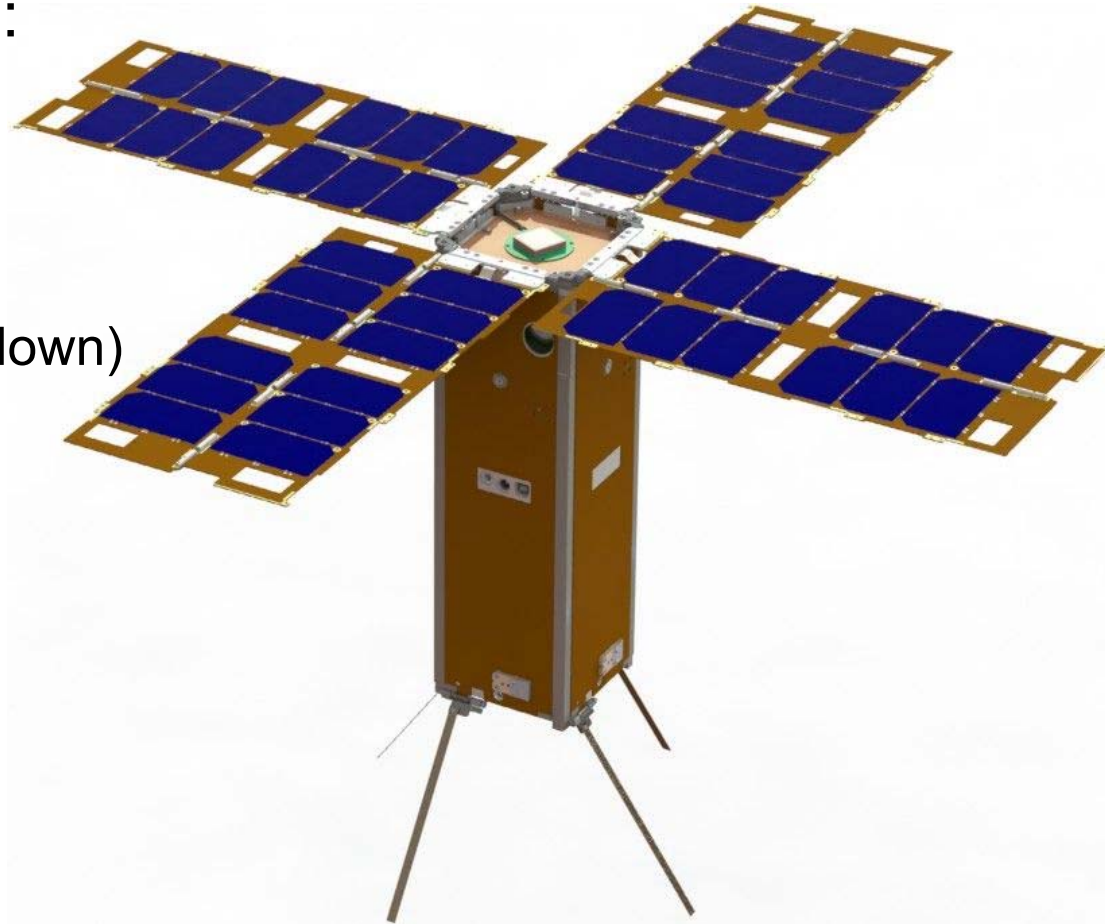
MISC 3 Bus

- ADCS, Radio, GPS, EPS, BATT, C&DH and panel I/F all tied together in a compact and thermally connected stack
- This stack can “slide” up and down relative to the total 3U length
- CSK electrical bus continues from end of stack (C&DH) into payload volume
- Either end can be used for sep switches, antennas, propulsion and/or solar panel hinges
- Other modules stacks (e.g., PC/104-based) can fit within this envelope, too



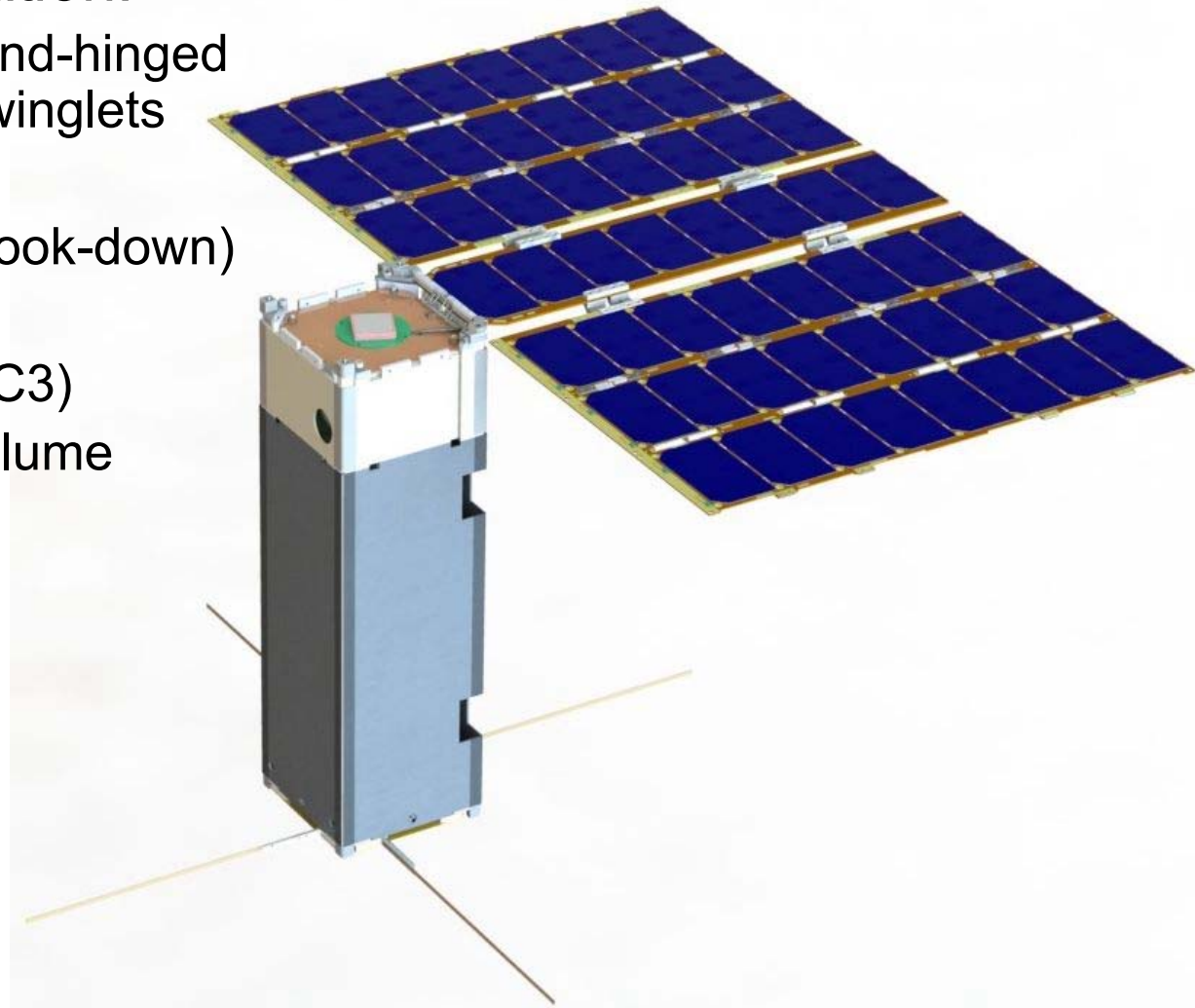
MISC 3: Propeller

- Example configuration:
 - 48W in-plane via quad end-hinged spars and winglets
 - 40Wh battery
 - Anti-nadir ADCS (look-down)
 - GPS
 - UHF up / down
 - 1550cc payload volume



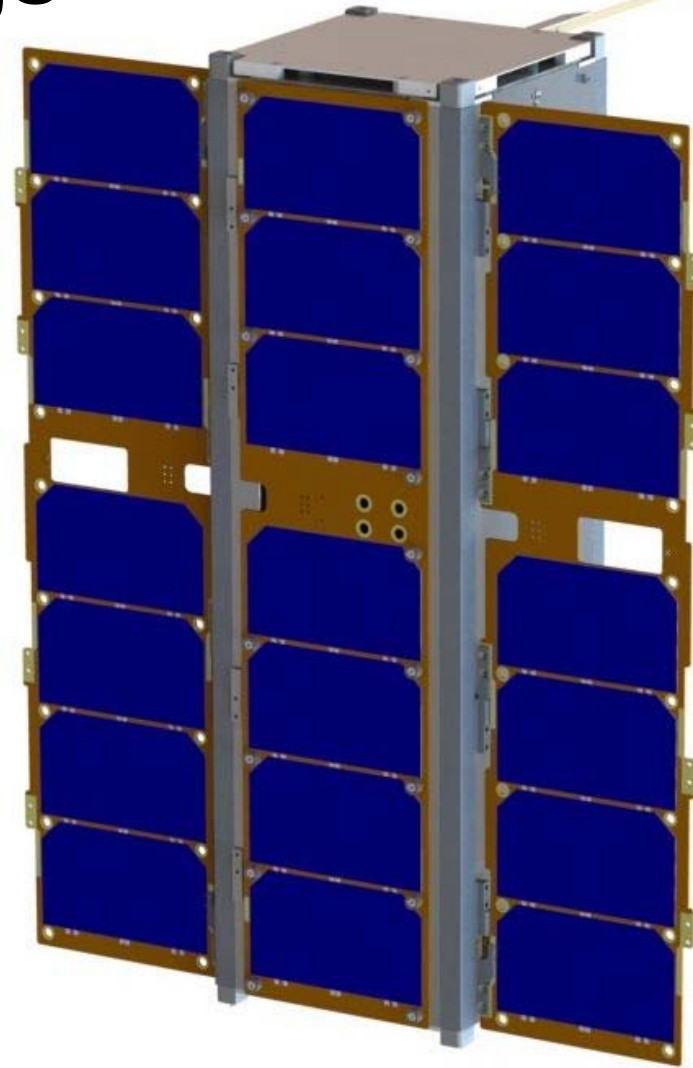
MISC 3: Turkey Tail

- Example configuration:
 - 56W in-plane via end-hinged spar and multiple winglets
 - 40Wh battery
 - Anti-nadir ADCS (look-down)
 - GPS
 - UHF up / down (MC3)
 - 1300cc payload volume



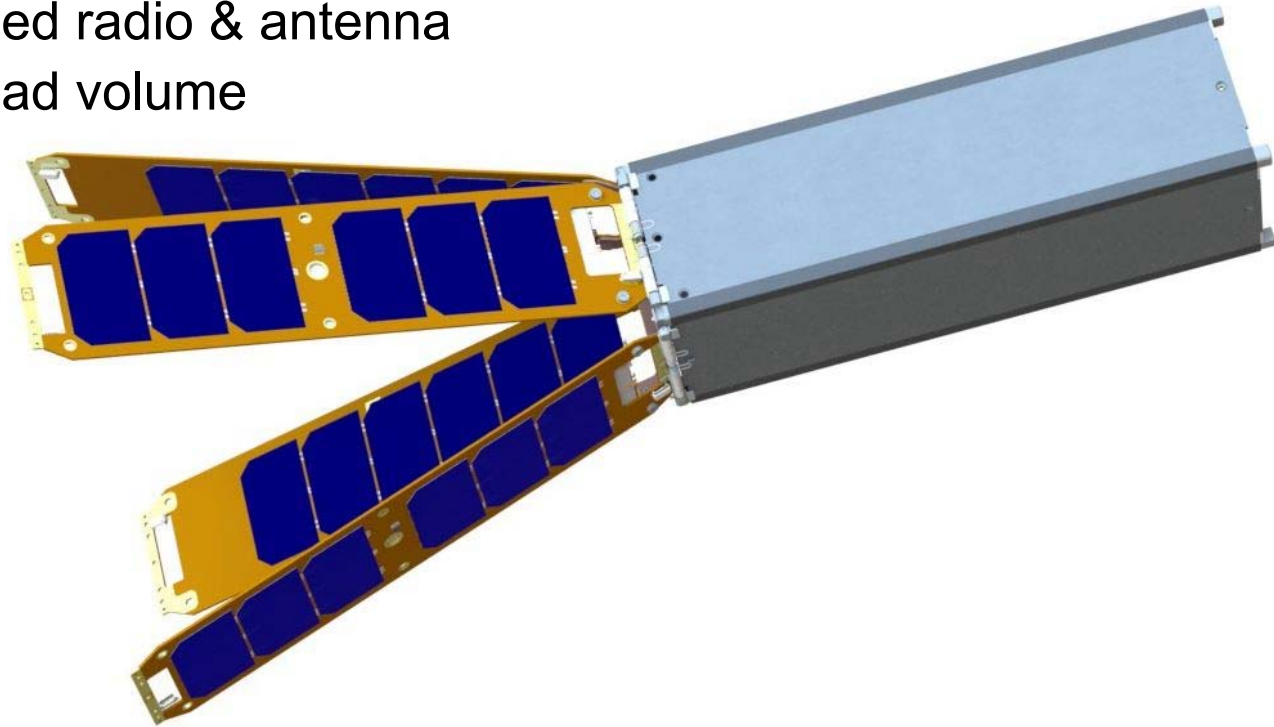
MISC 3: 3U w/Wings

- Example configuration:
 - 21W in-plane via fixed and long-edge deployable panels
 - 40Wh battery
 - ADCS (trailing view)
 - GPS
 - VHF up / down
 - 1550cc payload volume



MISC 3: Space Dart

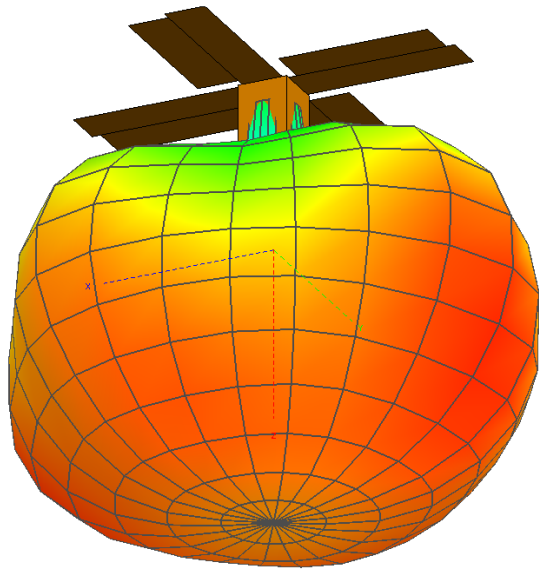
- Example configuration:
 - Aerodynamically stable with quad end-hinged panels
 - 40Wh battery
 - No ADCS
 - Optional GPS
 - Customer-specified radio & antenna
 - ca. 2300cc payload volume



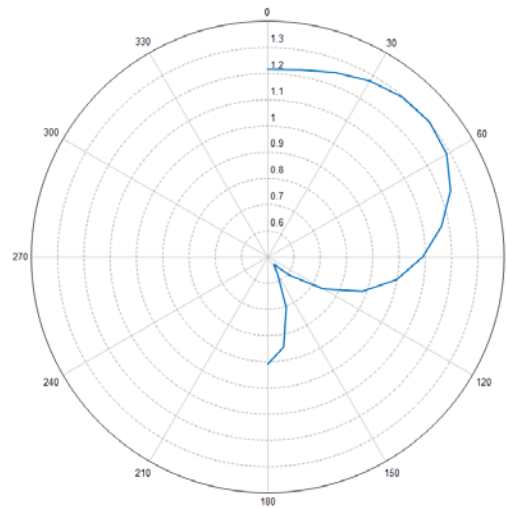
Antenna Tuning

- Configuration flexibility of MISC 3 enables us to optimize antenna placement on a per-user basis

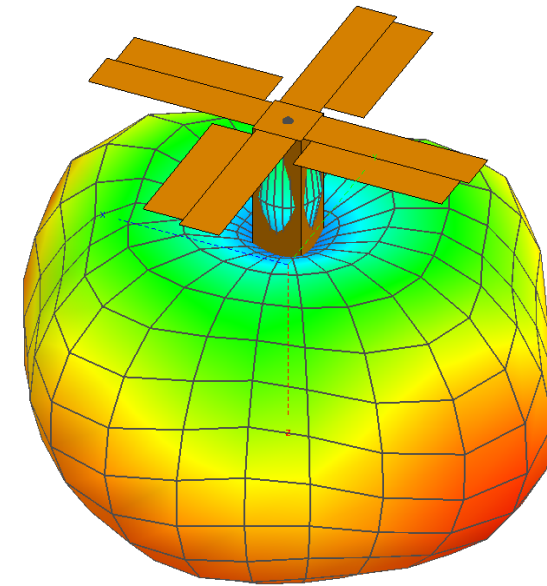
Total Gain
1.25
1.26
1.17
1.08
0.99
0.90
0.81
0.72
0.63
0.54
0.45



Far field
— FarField1



Total Gain
1.25
1.26
1.17
1.08
0.99
0.90
0.81
0.72
0.63
0.54
0.45



Total Gain (Frequency = 433 MHz; Phi = 0 deg) - 3U Panels 0 ang 4.5 rot 0 trans over_optimum_optimum



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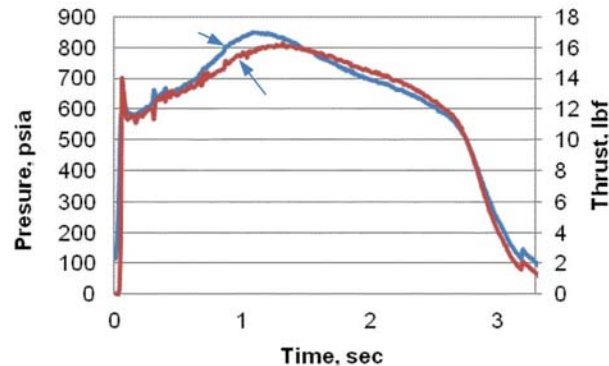
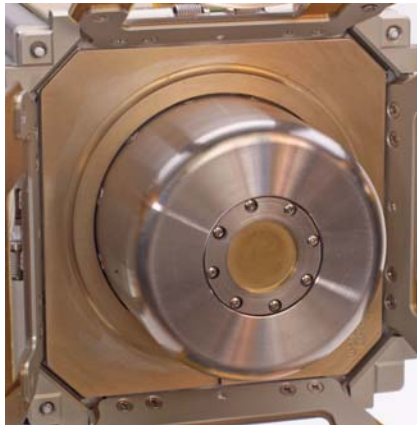
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Propulsion

- MISC 3 layout permits integration of propulsive modules on either end of structure or anywhere in-between.
- End locations can take advantage of P-POD's "hockey puck" extra volume
- (UHF) antennas and thrusters can coexist on same end



Delta-V / deorbit motor, CAPS unit and data courtesy of DSSP



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Conclusion

- MISC 3 has all of the features that made MISC 2 so user-friendly, including:
 - Open architecture
 - Highly modular
 - Rapid delivery (<90 days from receipt of order)
 - Pumpkin quality & affordability
- MISC 3 adds:
 - Basic user customization included in price
 - >20W to the payload, and enough power to run Linux SBCs
 - CubeSat Kit Pro chassis structure
 - More accurate ADACS
 - Bigger / better battery
 - Integrated basic UHF comms, or optional higher-performance comms
 - Easy GPS integration
 - Multiple ADACS, radio, antenna, propulsion and other subsystem choices
 - Multitude of different configurations possible to suit mission requirements



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Q&A Session

Thank you for attending this Pumpkin presentation at the 2013 CubeSat Developers' Summer Workshop!



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Notice

This presentation is available online at:

www.pumpkininc.com/content/doc/press/20130811_Pumpkin_CSDWLU_2013.pdf



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Appendix

• Speaker information

- Dr. Kalman is Pumpkin's president and chief technology architect. He entered the embedded programming world in the mid-1980's. After co-founding Euphonix, Inc – the pioneering Silicon Valley high-tech pro-audio company – he founded Pumpkin, Inc. to explore the feasibility of applying high-level programming paradigms to severely memory-constrained embedded architectures. He is the creator of the Salvo RTOS and the CubeSat Kit. He holds several United States patents. He is a consulting professor in the Department of Aeronautics & Astronautics at Stanford University and directs the department's Space Systems Development Laboratory (SSDL). Contact Andrew at aek@pumpkininc.com.

• Acknowledgements

- Pumpkin's Salvo, CubeSat Kit and MISC customers, whose real-world experience with our products helps us continually improve and innovate.

• CubeSat Kit information

- More information on Pumpkin's CubeSat Kit can be found at <http://www.cubesatkit.com/>. Patented and Patents pending.

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