MISC 3 – The next generation of 3U CubeSats

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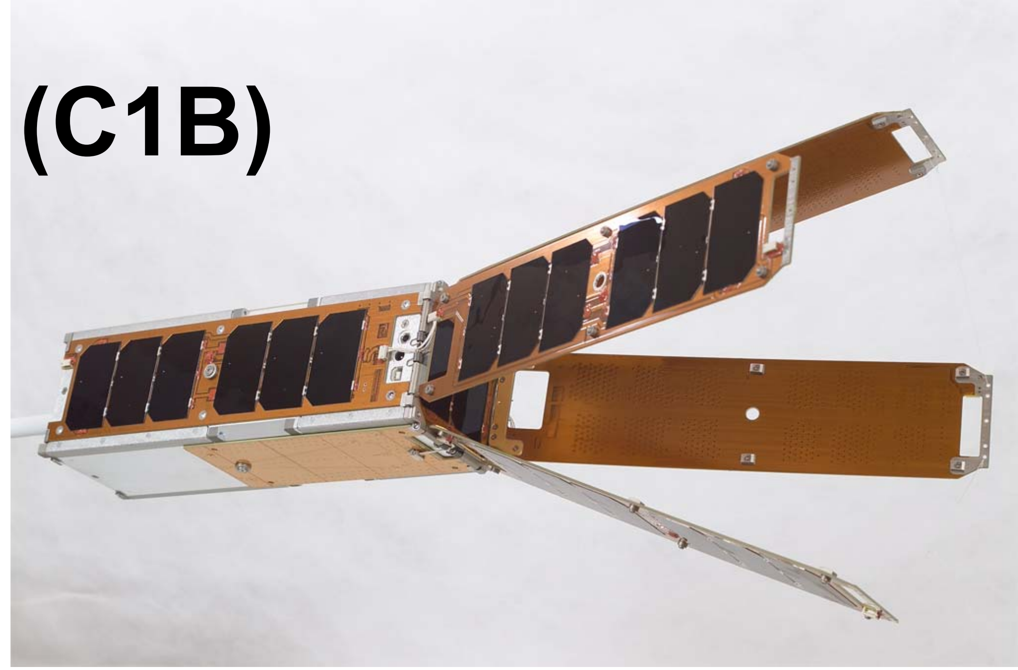
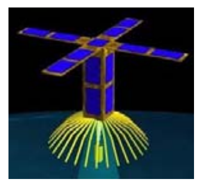
Pumpkin, Inc.

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)

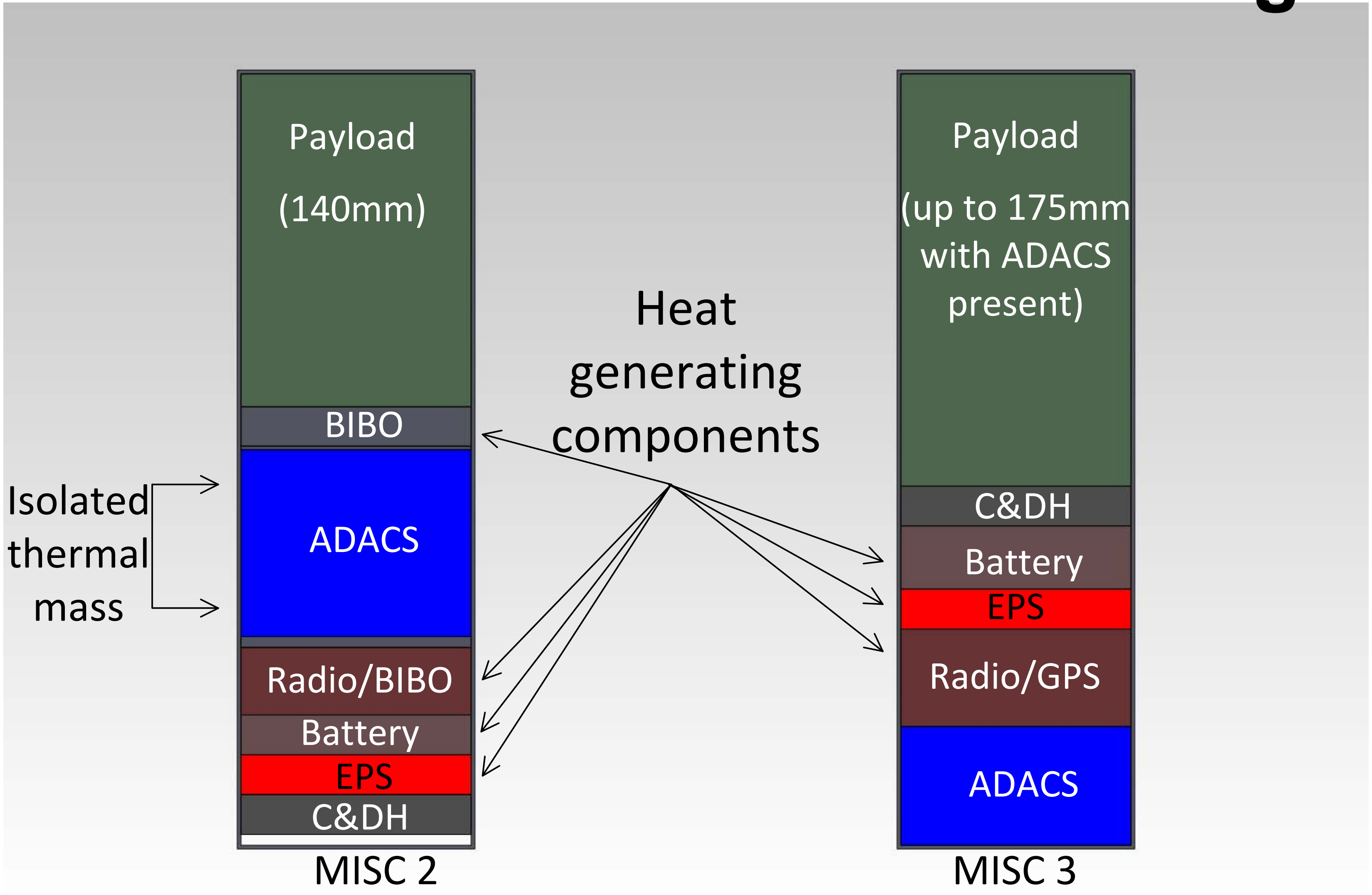


- Capabilities
  - 1500cc payload volume *(not including radio)*
  - 2° attitude knowledge & control
  - MCU-based C&DH and payload processors
  - 8-10W to payload
- Limitations
  - Fixed bus & payload volumes
  - No view of space for ADACS
  - Radio & antennas not integrated
  - Lack of symmetry on 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
  - <0.2º 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

MISC 2 vs MISC 3: Module Stacking

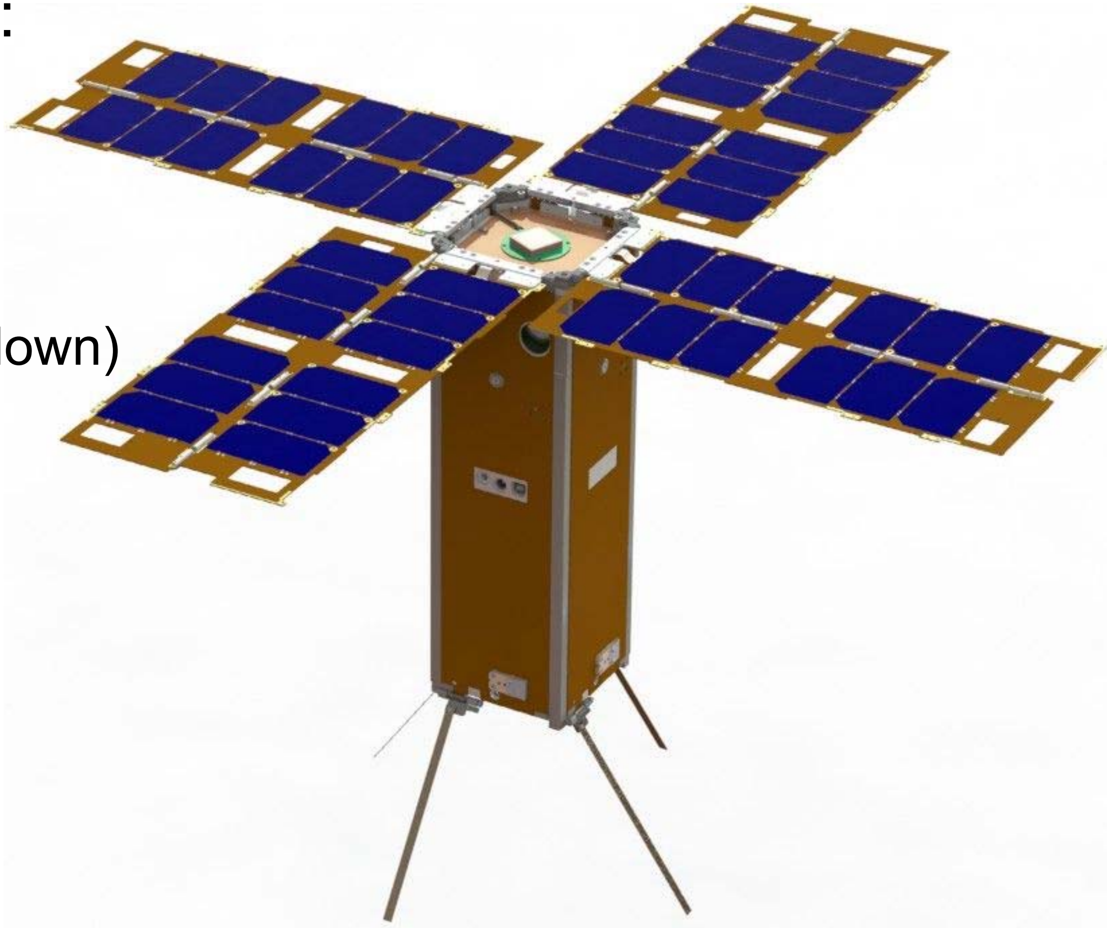


MISC 3 Bus

- 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

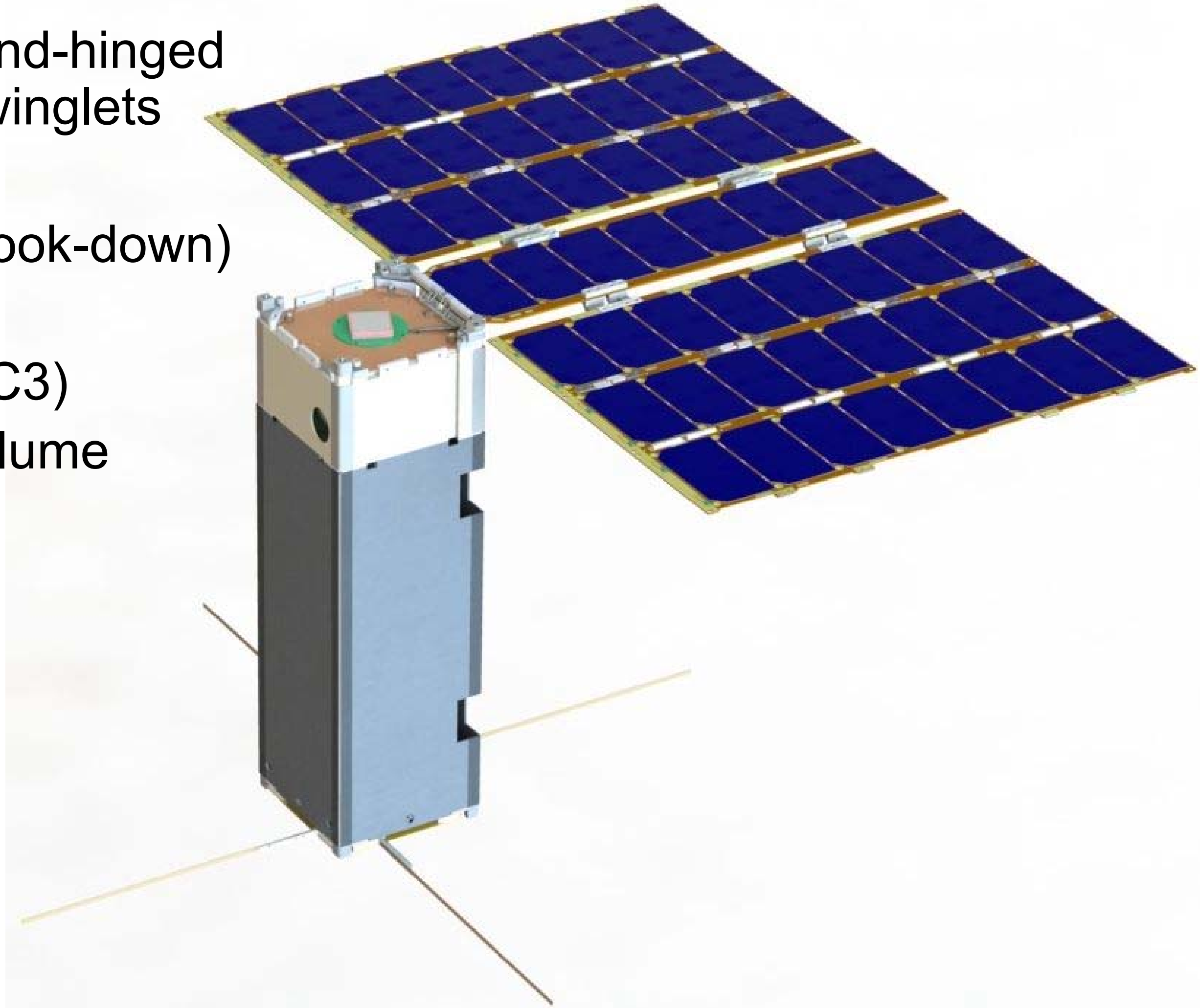
MISC 3: Propeller

- 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



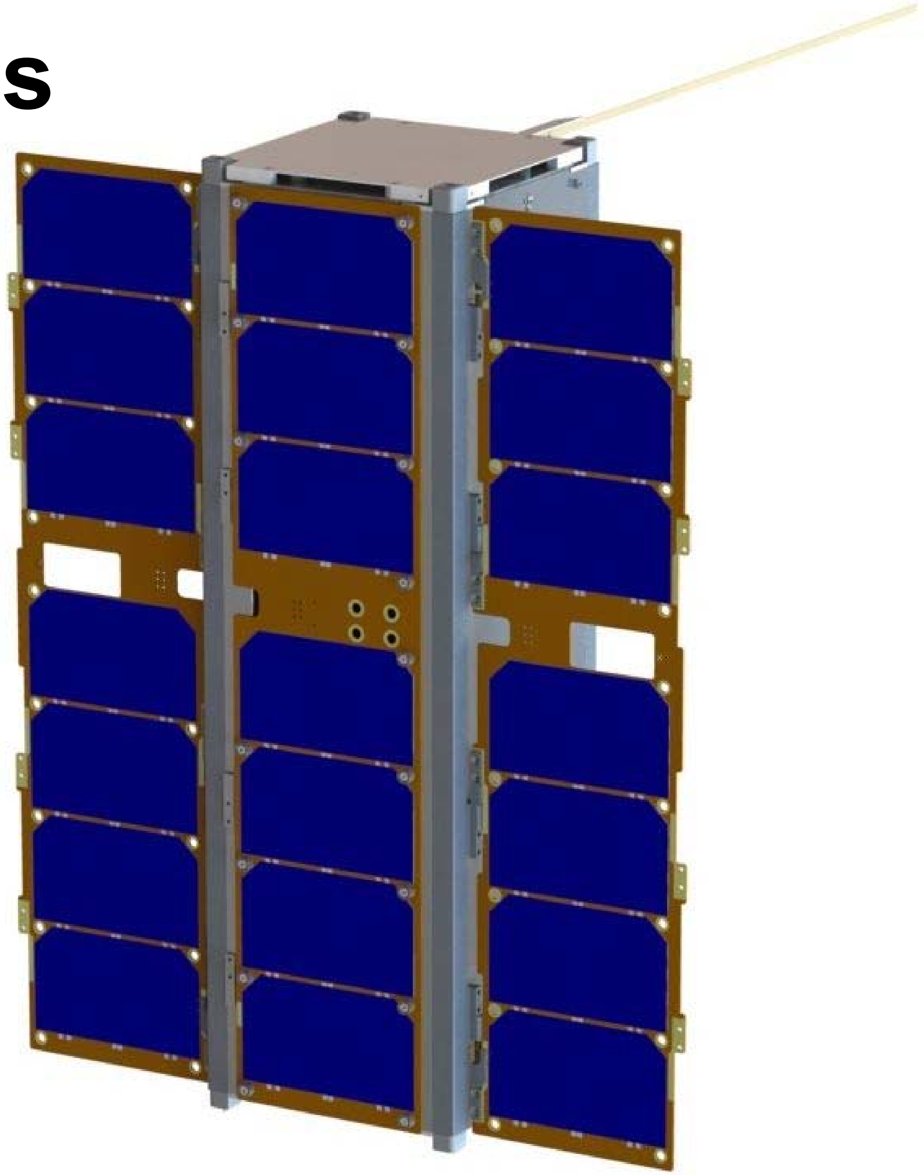
MISC 3: Turkey Tail

- 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



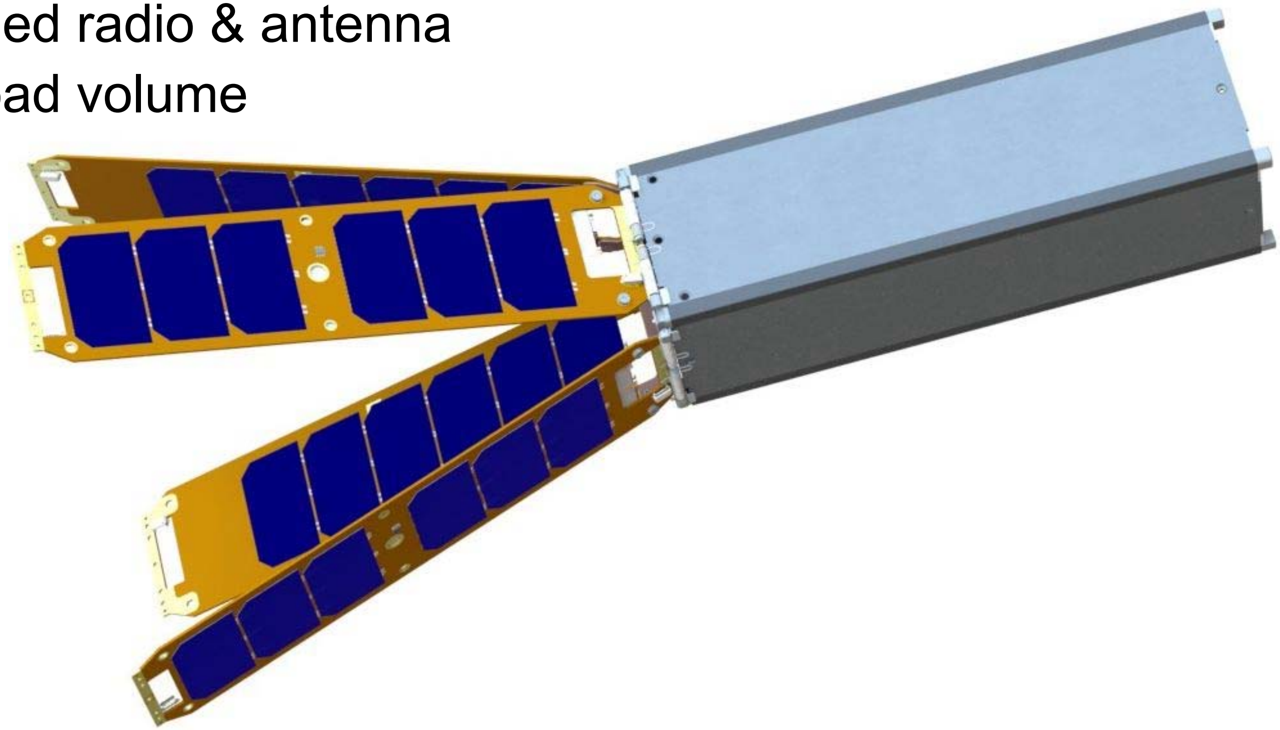
MISC 3: 3U w/Wings

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



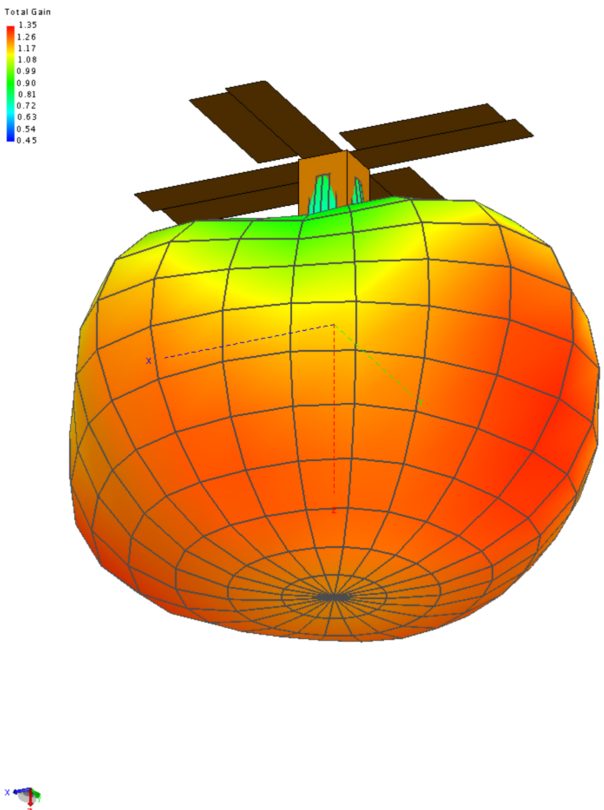
MISC 3: Space Dart

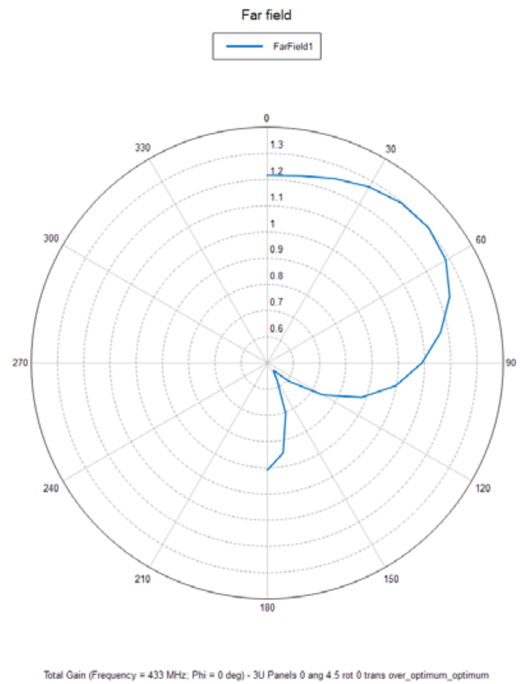
- Example configuration:
  - Aerodynamically stable with quad end-hinged panels
  - 40Wh battery
  - No ADCS
  - Optional GPS
  - Customer-specified radio & antenna
  - ca. 2300cc payload volume

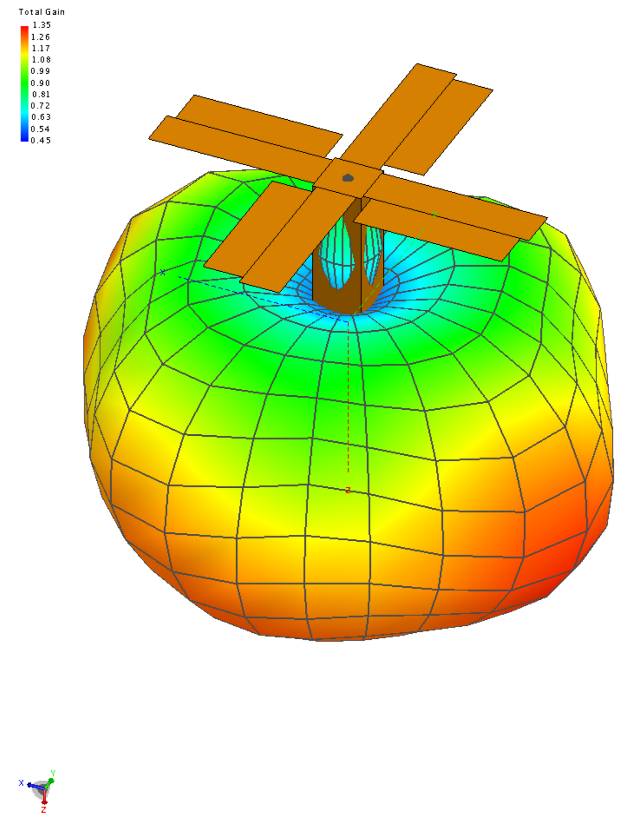


Antenna Tuning

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

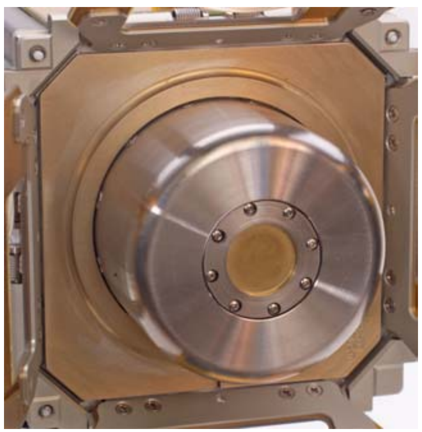


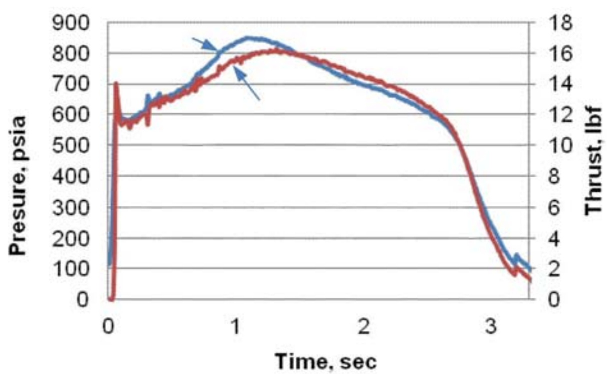




Propulsion

- 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

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

Q&A Session

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

Notice

This presentation is available online at:

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

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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