

SmallSat / Model-Based Mission Assurance Session Overview

Dr. Rebekah Austin

NASA GSFC

Acronyms



- AI: Artificial Intelligence
- FPGA: Field Programable Gate Area
- FPU: Floating Point Unit
- FSW: Flight Software
- GEO: Geosynchronous Orbit
- GSFC: Goddard Spaceflight Center
- HPSC: High Performance Space Computing
- LEO: Low Earth Orbit
- LET: Linear Energy Transfer
- MEO: Medium Earth Orbit
- NASA: National Aeronautics and Space Administration
- NEPP: NASA Electronics Parts and Packaging
- OBC: On-Board Computer
- RHA: Radiation Hardness Assurance
- SEAM: System Engineering and Assurance Modeling
- SEE: Single Event Effects
- SEL: Single Event Latchup
- SOA: State of the Art
- SoC: System on Chip
- TCM: Telemetry, tracking and Command control Module
- TID: Total Ionizing Dose
- TRL: Technology Readiness Level
- TTC: Telemetry, Tracking, and Command

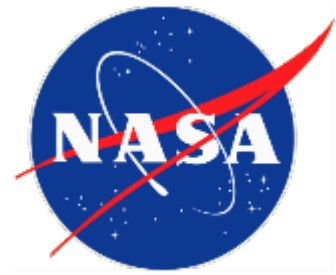
Session Overview



- SmallSat State of the Art Report Advanced Avionics Section Updates
 - Dr. Rebekah Austin, NASA GSFC

- Systematic CubeSat Radiation Hardening Assurance Using the SEAM Platforms
 - Dr. Art Witulski, Vanderbilt University

- Invited Talk: Building Ontologies for AI-Integrated Prognostic Health Management of Spacecraft Avionics
 - Dr. Michael Halvorson, Alabama CubeSat Initiative



SmallSat State of the Art Report Advanced Avionics Section Updates

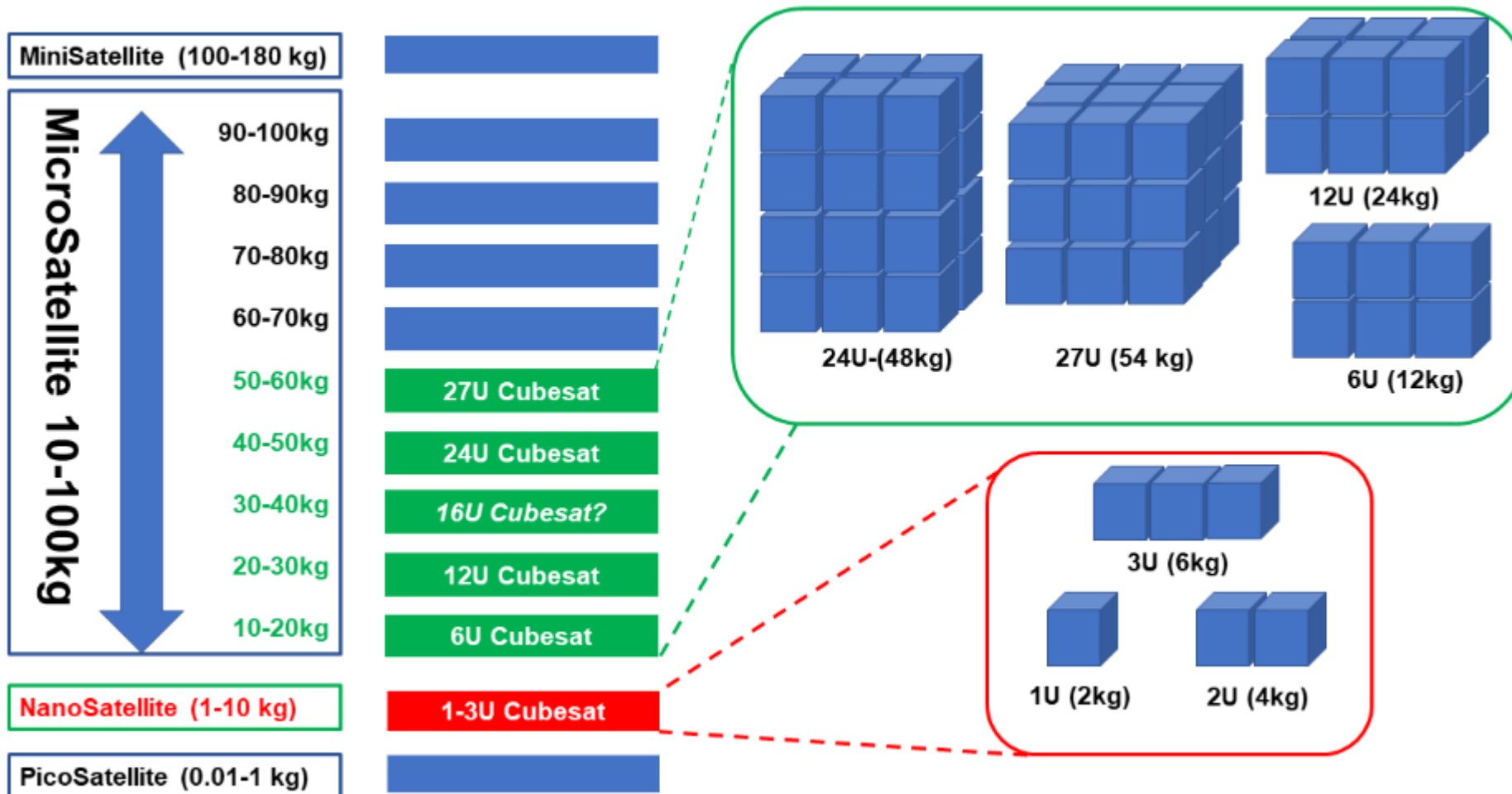
Dr. Rebekah Austin

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Sasha Weston, NASA Ames Millennium Engineering and Integration Co

What qualifies as a SmallSat?

- It's complicated, but it's all about mass



Nanosatellite sizes compared to CubeSat containerized sizes.
Credit: NASA.

SmallSat State of the Art (SOA) Report



- <https://www.nasa.gov/smallsat-institute/sst-soa/>
- NASA/TP—2024—10001462
- New in 2023
 - Revised Highly Integrated On-Board Computing Systems
 - Updated Radiation Section
- Planned for 2024
 - Update Memory Types Table
 - FPGA/SoC Table Addition

NASA/TP—2024—10001462



State-of-the-Art Small Spacecraft Technology

Small Spacecraft Systems Virtual Institute

Ames Research Center, Moffett Field, California

Advanced Avionics Industry Survey

(NASA/TP—2024–10001462)



- Table 8-1: Sample of Highly Integrated Onboard Computing Systems
 - Reached out to companies in past reports and who exhibited at SmallSat Conference 2023
 - 26 Companies, 61 Computers
 - Removed TRL level

Table 8-1: Sample of Highly Integrated Onboard Computing Systems							
Manufacturer	Product	Processor/ SoC/ FPGA	Radiation Hardness Assurance (RHA)	Board Dimension (cm)	Power Consumption (W)	Orbits Flown	Ref
AAC Clyde Space	Sirius OBC & TCM	32-bit LEON3FT (IEEE-1754 SPARC v8) fault-tolerant processor	TID 20 krad (system level)	9.589x9.017x1.720	1.3	LEO, lunar lander	(2)
Alén Space	OBC+TTC	ARM 32-bit Cortex-M7 with FPU	n/a	8.93x9.33x1.26	OBC_max: 5.865 TTC_max: 5.865	LEO, 2024	(3)
Aitech Systems Inc.	SP0-S	Power PC 1020, Alcatel RTAX	100 krad TID, SEL/LET 40 Mev-cm2/mg (without enclosure)	3U cPCI: 10.06x16x20.3	12	LEO, MEO, GEO, Lunar, Deep Space*	(4)

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Radiation Section Update (NASA/TP—2024–10001462)



- Radiation is mentioned
 - As a consideration in the systems engineering section
 - As a degradation concern in the solar cell section
 - Dose levels are given for different components (power systems, batteries, reaction wheels, start trackers, etc.)
 - Shielding technologies in the mechanical structures section
- Only detailed discussion of SEEs is in the Advanced Avionics section
 - Leverage past resources made for the CubeSat community by NEPP to infuse into SOA report



Planned Updates for 2024

- Inclusion of SpaceVPX and HPSC to upcoming technologies
- Inclusion of cybersecurity to upcoming technologies
- Update of memory types table including consideration for commercial solid-state drives
- Addition of FPGA/SoC/Processor table
- Inclusion of Artemis/Gateway standard electrical interfaces
- Evaluation of FSW sections

Feedback



- <https://www.nasa.gov/smallsat-institute/sst-soa/>
- NASA/TP—2024–10001462
- Feedback, products to include, reviewers
- Rebekah.a.Austin@nasa.gov

NASA/TP—2024–10001462



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