National Aeronautics and Space Administration

NASA SmallSat LEARN Forum Briefing: BioSentinel

Presenter: Sergio R. Santa Maria

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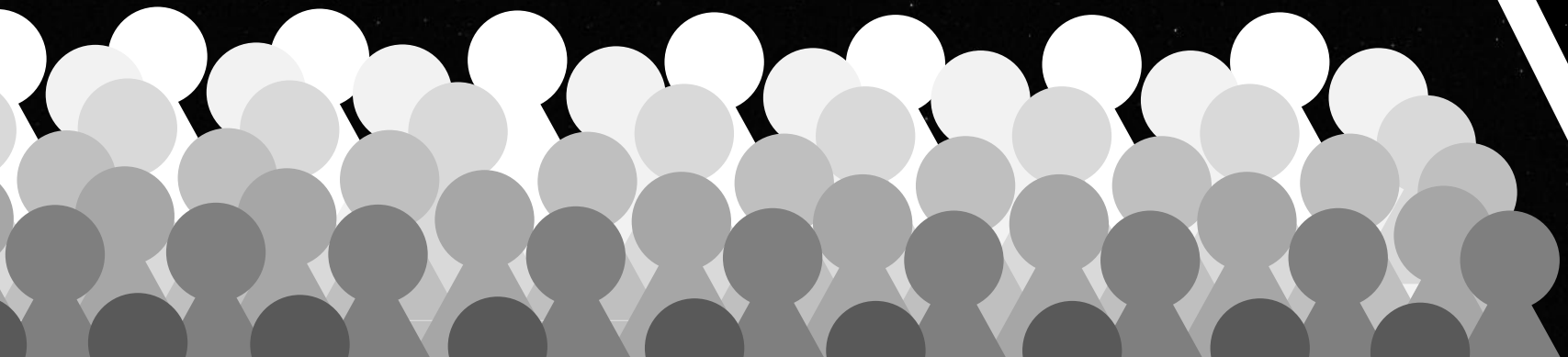
National Aeronautics and Space Administration Small Satellite Learning from Experience, Achievements and Resolution Navigation Forum



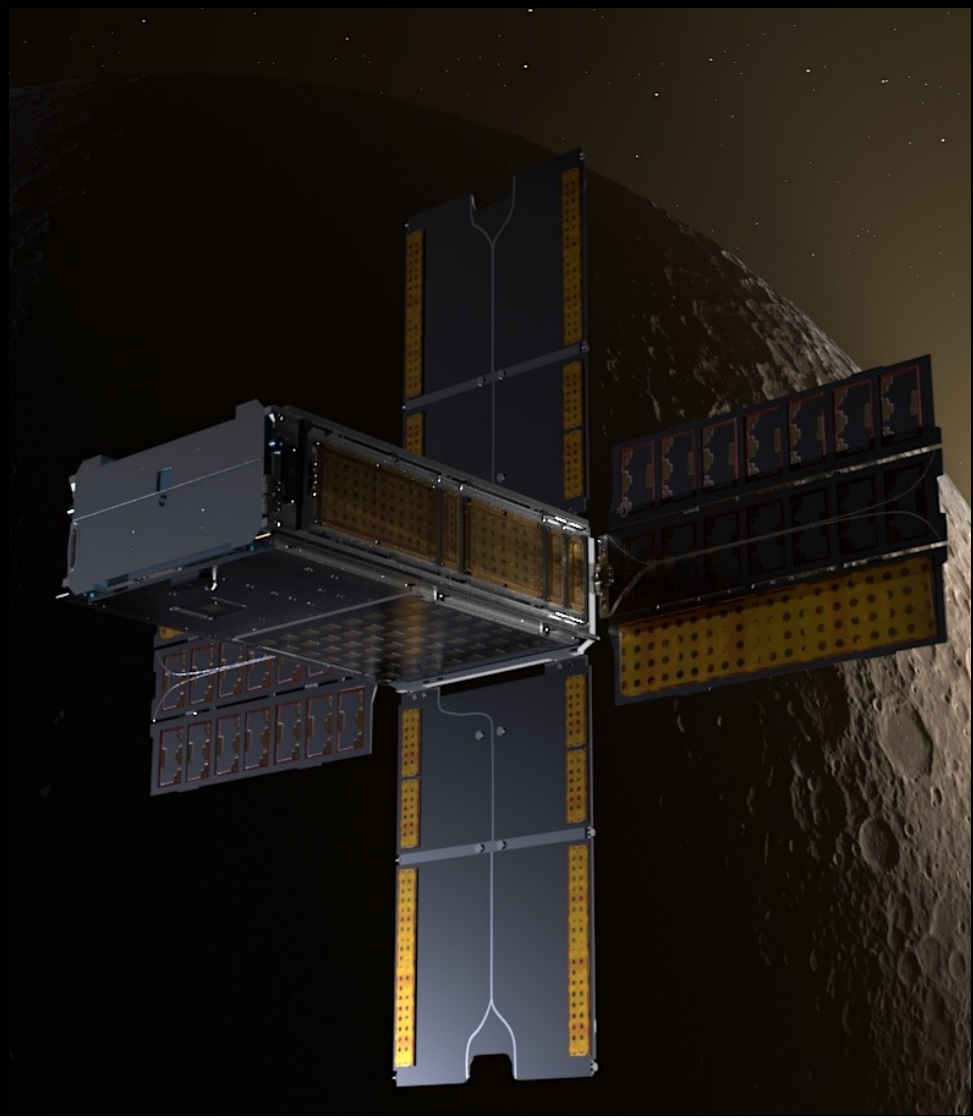
BioSentinel Overview

Mission Objectives

- Develop a deep space tool with autonomous life support technologies
- Study the space radiation environment beyond LEO and its effect on biology

Key Parameters

Form Factor	# Spacecrafts	Orbit	Launch Date
6U CubeSat	1	Heliocentric	Nov 16, 2022 (SLS Artemis I)
Mass	**Dispenser or Interface**	**Mission Duration**	**Current Phase/Activity**
~ 14 kg	OSA 6U dispenser	6 months	Science Phase



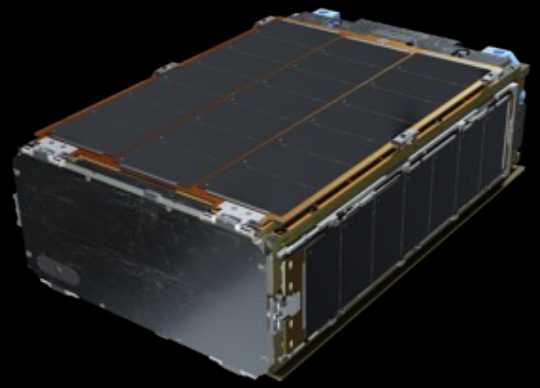
BioSentinel Team Composition

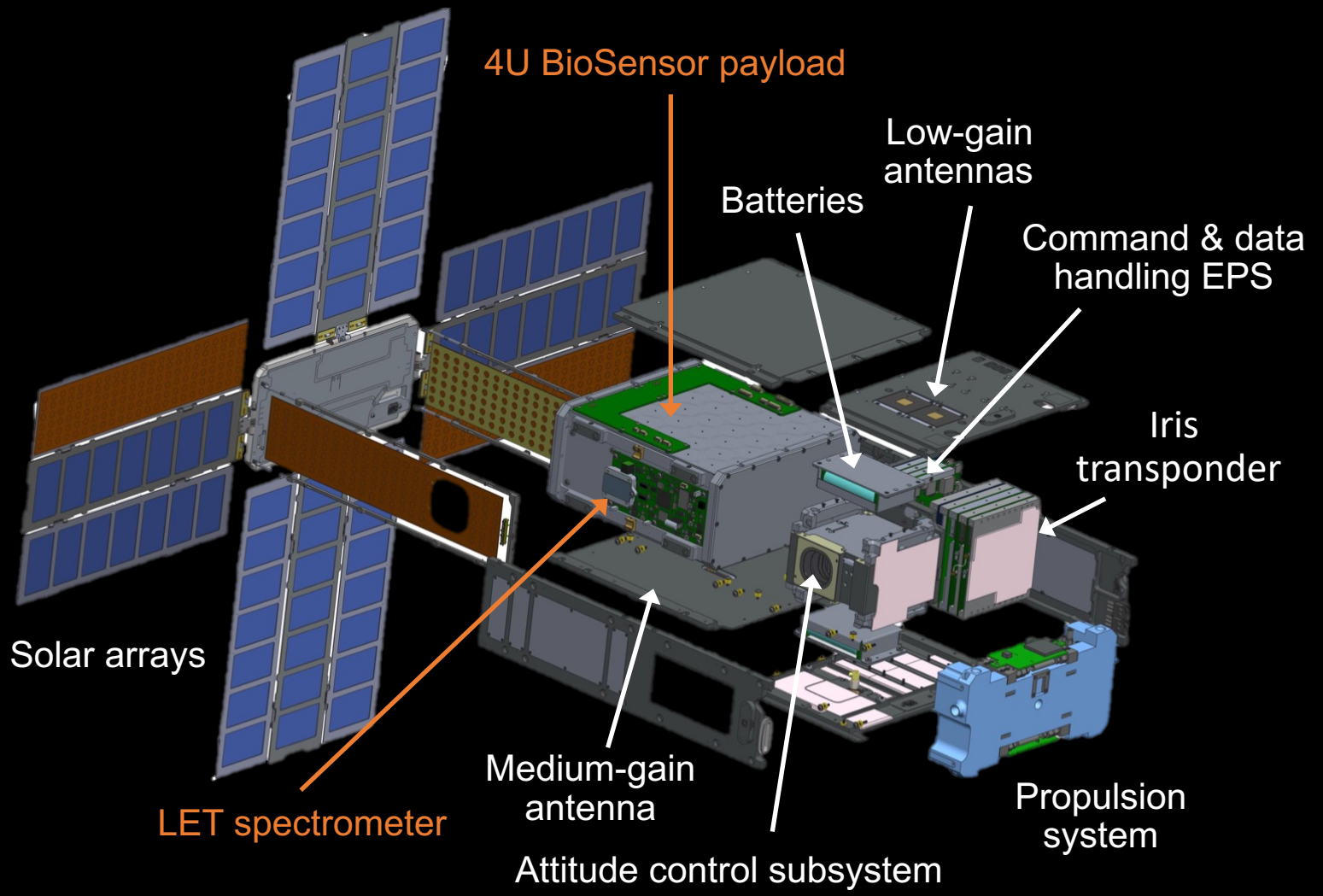
Management	Principal Investigator	Project Manager	Mission Systems Engineer	Mission Operations Lead
Team Member Name	Sergio Santa Maria	Matt Napoli	Jeff Homan	Marcie Smith
Organization	NASA ARC	NASA ARC	NASA ARC	NASA ARC

Payload & Bus	Instrument #1	Instrument #2	Spacecraft Bus	Spacecraft Bus
Title/Acronym	4U BioSensor payload	LET spectrometer	Iris v2 radio	Propulsion system
Organization	NASA ARC	NASA JSC	JPL	Georgia Tech

Data Systems	Mission Operations Center	Science Operations Center	Ground Station/Network	Data Repository
Title/Acronym	MMOC	BioSentinel SOC	Deep Space Network	*TBC*
Organization	NASA ARC	NASA ARC	NASA	NASA

BioSentinel

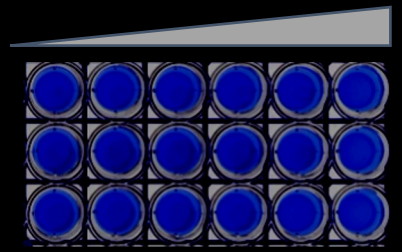


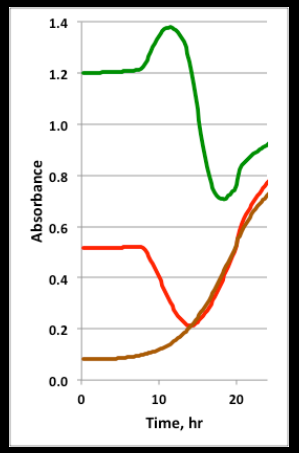


BioSentinel Key Components

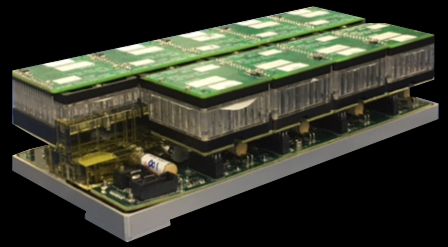
Subsystem	Description	Vendor	Subsystem	Description	Vendor
4U BioSensor			**LET spectrometer**		
Fluidics	18 PC cards & manifolds with integrated valves, pumps, bubble traps & desiccant chambers	NASA ARC	Radiation sensor	Timepix-based sensor (TID and LET particle characterization)	NASA JSC
Optics	3 LED lights & TAOS sensor per fluidic well (16 wells per card)		**Bus ADCS**		
Thermal	Dedicated thermal control per fluidic card		Reaction Wheels / Star Tracker / IMU	XACT 3-axis Attitude-Control System & Star Tracker	Blue Canyon Technologies
Sensors	Temperature, RH, pressure		Sun Sensors	5 sun sensors	SolarMEMS
Bus C&DH			**Bus Power**		
Processor	UT700 LEON 3	Space Dynamics	EPS	TI-MSP430 FRAM	NASA ARC
Data Storage	MRAM & Flash		Batteries	18650B Li-ion	Panasonic
Bus Comm			Solar Array	4 HaWK solar arrays	MMA Design
Radio	Iris v2 transponder	JPL	**Propulsion**		
Antenna	Medium & low gain		Thruster	7-nozzle 3D printed system	Lightsey Space Research

BioSentinel



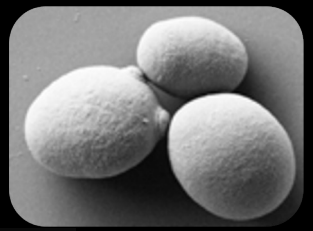


Fluidic manifold



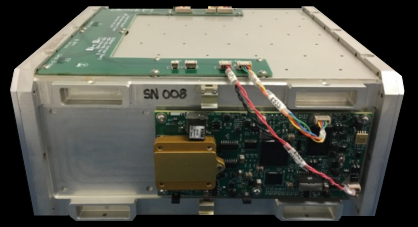
Optical detection system

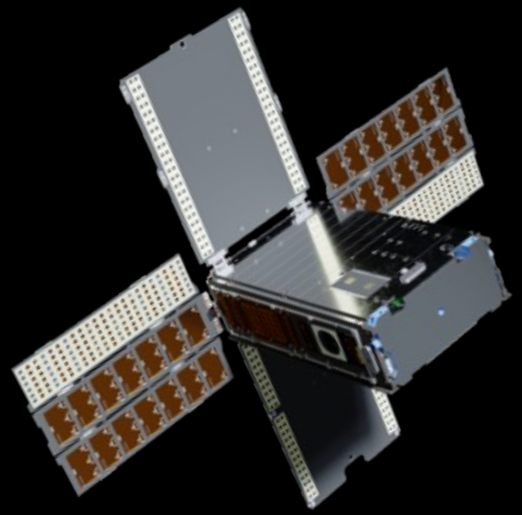
S. cerevisiae



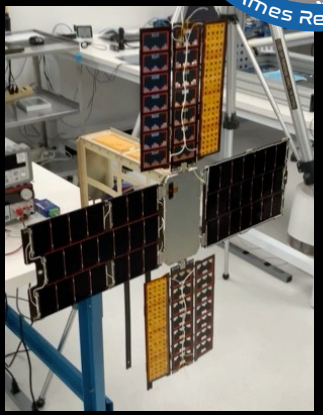
Microfluidic card (x18)

4U payload





6U spacecraft



BioSentinel Risks & Mitigations

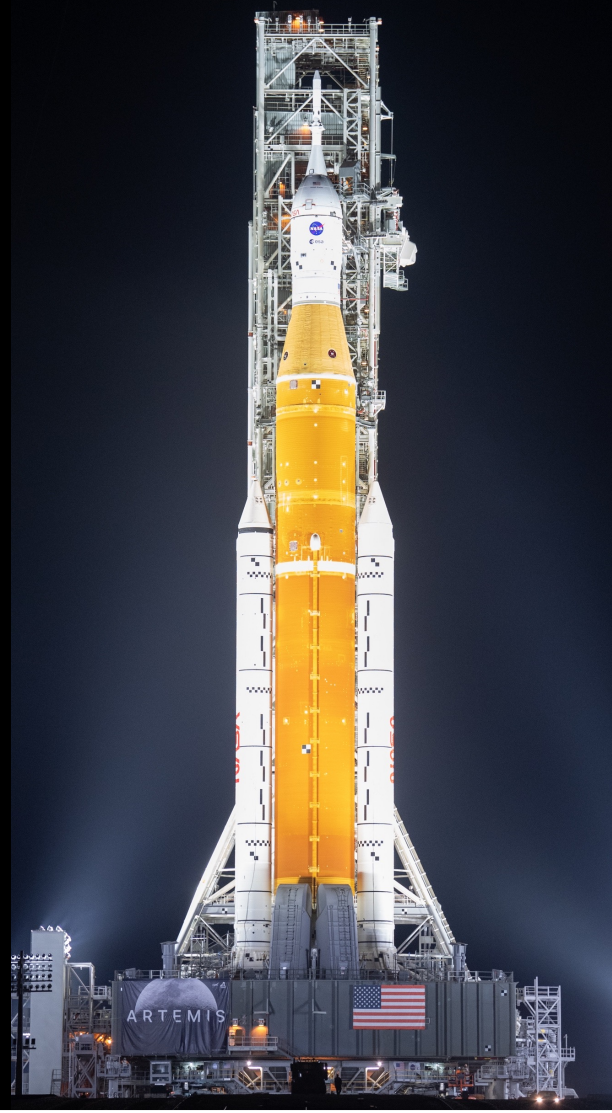
Top 3 Risks (current or retired)

	Risk Description	Mitigation Approach
1	Long-term pre-launch integration time for biology	Turn spacecraft over as late as possible
2	DSN antenna oversubscription	Use non-DSN antennas (*e.g.*, ESA)
3	Solar array fails to deploy	Additional deployment commands

BioSentinel Issues

Top Issue: launch delays

- Issue: Artemis I launch had multiple launch delays independent of secondary payloads
- How the project managed the issue? Long-term testing (reagents, biology, etc.)
  Environmental monitoring requests once at KSC
  Constant communication with NASA HQ
- Results: Loss of personnel
  Constant replanning (*e.g.*, moving trajectories)
  Additional battery recharging
  Effects of long-term storage inside BioSensor enclosure
- Recommendations: Constant communication between project, NASA, and SLS
  Plan for such complex mission (*e.g.*, personnel, battery charging)
  Improve environmental monitoring if biology involved



BioSentinel Lessons Learned

Top 3 Lessons Learned

	What Happened?	What did we learn from it?	Proposed Mitigation Strategies	Recommended Actions
1	Lower (than expected) yeast viability on ISS unit	Long duration effects inside sealed enclosure decreases viability of biology	Late integration	Modify design for future missions to include late load and integration options; add more desiccant inside payload enclosure
2	Unknown launch date	Loss of personnel & constant changes in trajectory	Analyze risks associated with unique mission conditions	Document for later project personnel on why specific decisions were made
3	Late payload EVT not ideal	EVT provided many lessons learned that could not be implemented for this mission	Work around issues without design changes	Conduct early EVT (scaled down EVT) to feed potential design changes

Thank you!

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Backup Material

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