In-Situ Characterisation of Material Degradation in Space

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Background

Debris characterisation is critical for understanding the orbital debris population. A 3U CubeSat is proposed to observe the reflectance spectra of three spacecraft materials to assist in ground-based identification of materials and orbital age [1,2].

An open-source spectra library [2] will be populated to stimulate technology development in debris mitigation and removal technologies.

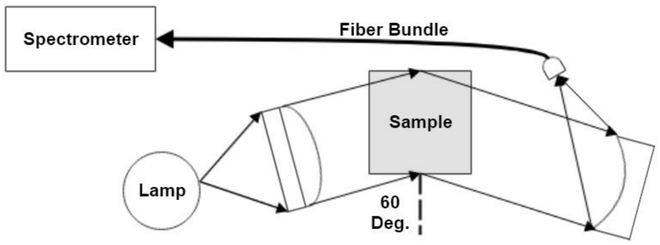
This targets the Responsible Consumption and Production; and the Industries, Innovation, and Infrastructure UN Sustainable Development goals.

Primary Mission Objectives

1. Record VIS-NIR reflectance spectra of common spacecraft materials and add data to a public-access materials library.
2. Augment existing material reflectance models with temporal data and compare new model predictions with known long-exposure results.

Primary Payload

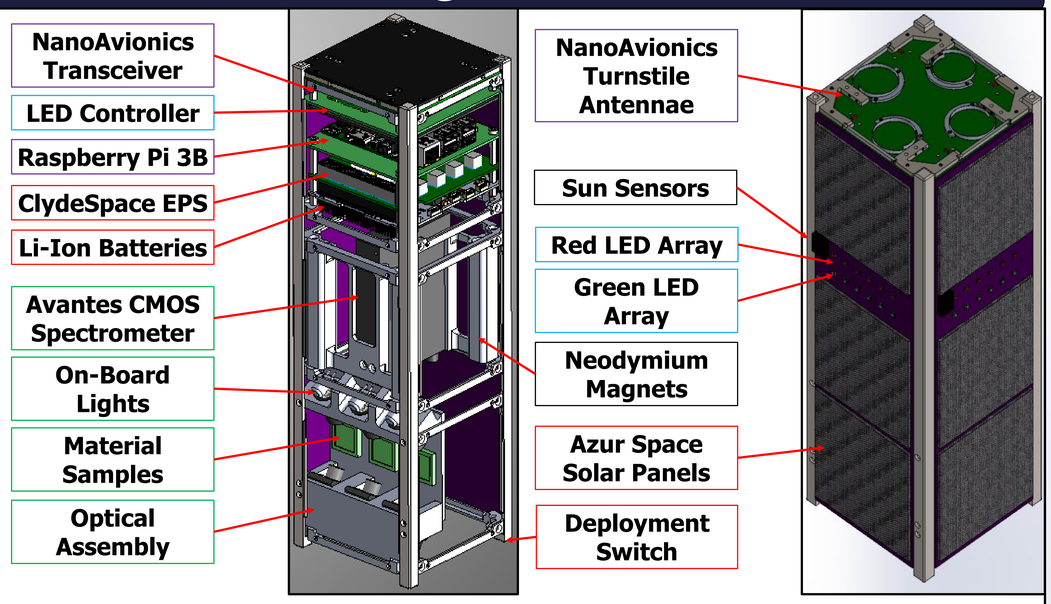
Reflectance spectra of triple-junction solar panels, bare aluminum, and white paint will be recorded periodically as they degrade from exposure in space.



- On-board lighting allows operating in eclipse
- Recessed sample stage removes need for external probes and reduces TID effects on instrumentation
- Reflectance geometry maximizes sample exposure while shielding probes and providing sufficient signal

Satellite Bus Design

- **Structure:** Aluminum 7076-T6 Type III Hard Anodized
- **Mass:** 3.9 kg
- **Volume:** 34 cm x 10 cm x 10 cm
- **Vibration:** f_0 > 90 Hz
- **Power:** 10 W max. avg.
- **DoD%:** 70% @ max. avg.
- **OS:** Linux
- **Language:** C++
- **RF Band:** 437 MHz
- **Protocol:** AX25
- **Link Margin:** 15.6 dBm uplink, 0.9 dBm downlink
- **Data Req.:** Avg. 2000 kB/day (~3 mins.)
- **Cost Est:** $55,000 CAD (hardware)



CoSMOSat successfully completed launch vibration tests at CSA-DFL but still needs thermal-vacuum bake-out to meet CubeSat launch requirements. Critical components such as the raspberry pi OBC will be replaced with space-qualified boards in final design.

Ground Segment

RF Ground Station & Telescope: Royal Military College of Canada 44°14'2" N, 76°28'3" W

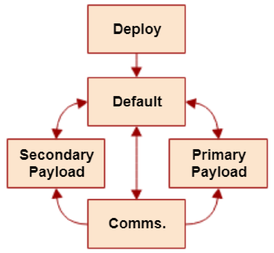
The satellite will be operated by Queen's Space Engineering Team members with amateur radio licenses, and data stored on-site.

Launch partners will be determined pending funding opportunities with the Canadian Space Agency.

Space Segment

The satellite ideally will deploy from the ISS NanoRacks Poly-Picosatellite Orbital Deployer and operate for one year.

- Avg. 6.8 passes/day
- ~68 mins./day available link time
- Secondary payload visibility dependent on season



Further Work

The satellite still requires thermal-vacuum qualification and power model validation prior to a system acceptance review.

Opportunities to expand the data library include:
- MEO and GEO environments
- Other materials and observation geometries
- The European Technology Exposure Facility may be a long-term location for LEO experiments.

Acknowledgements

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[1] G. A. W. K. A. Donald Bédard, "Laboratory Characterization of Homogeneous Spacecraft Materials," *Journal of Spacecraft and Rockets*, vol. 52, no. 4, pp. 1038 - 1056, 2015.
[2] P. S. A. W. P. S. Donald Bedard, "In-Situ VIS/NIR Measurements of Space Environment Effects on Spacecraft Surfaces," in *AMOS Technologies Conference*, Maui, 2016.