NASAfacts

UV-LED Project

The performance of certain classes of instruments—ones in which the test article is suspended, or floats, within the instrument—is adversely affected by the build up of electric charge on the floating object. When spacecraft components are grounded this charge can be easily controlled. But in the case of a free-floating asset, another method of charge dissipation is needed. One method is to use ultraviolet light to create a flow of electrons to or from the test mass, controlling its charge.

UV-LED is part of a small satellite technology demonstration mission that is demonstrating non-contacting charge control of an isolated or floating mass. It does this using new solid-state ultra-violet light emitting diodes (UV-LEDs).

Integrated to the Saudisat-4 spacecraft and launched onboard the Dnepr in June 19, 2014, the project is a collaboration between the NASA Ames Research Center, Stanford University, and King Abdulaziz City for Science and Technology. The instrument is performing as designed has been collecting data since December 2014.

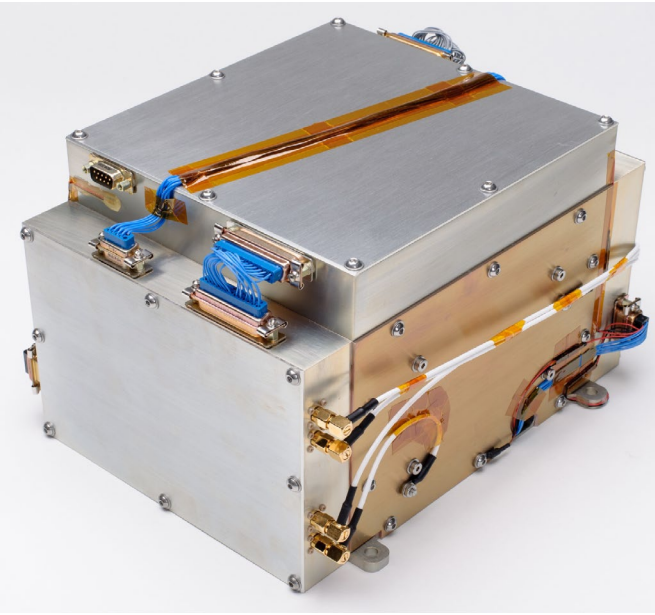
Technology Demonstration

Specifically, this technology demonstration is validating a novel method of charge control that will improve the performance of drag-free spacecraft. Such a spacecraft flies in an orbit defined solely by gravity, and is not be affected by solar pressure and atmospheric drag. The technology that allows this is known as a gravitational reference sensor (GRS) and is essentially an extremely accurate accelerometer. This technology demonstration is intended to show the ability of UV-LED to allow concurrent science collection and charge management operations. It will also reduce the mass, power and volume required while increasing lifetime and reliability of a charge management subsystem.

These improvements are crucial to the success of future missions, and demonstrate the ability of low-cost small satellite missions to provide technological advances that far exceed mission cost.

New Technology

To control electrostatic charge buildup on an isolated proof mass, power-hungry and heavy mercury vapor lamps are commonly



UV-LED Flight Payload before delivery (April 2014)

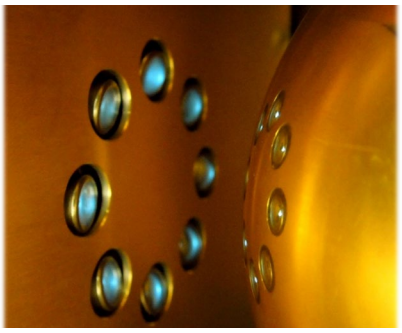
TO-39 LEDs (Flat window)

SM LEDs (hemispherical & flat window)

used. However, UV-LED utilizes innovative new deep UV Light Emitting Diodes (LEDs) as an alternative light source. Compared to mercury lamps, these UV-LEDs offer the significant advantages due to their small size, long lifetime, light weight, and fiber-coupled operation, with very low power consumption. Additionally, the emission from the UV-LEDs can be modulated at frequencies of 100Hz or more (current Hg discharge lamps cannot be modulated and must operate at zero frequency), allowing charge control to operate at frequencies that would not affect the science operations of a mission (typically 10-4 Hz to 10 Hz).

UV-LED Technology Demonstration Objectives

- Space qualify UV light emitting diode (TRL8)
  - Measure performance and monitor any degradation over lifetime of mission operations
  - Measure electrical voltage-current (V-I) characteristics
  - Measure voltage-current-optical power (V-I-P) characteristics
- Demonstrate non-contact AC charge management in space (TRL7)



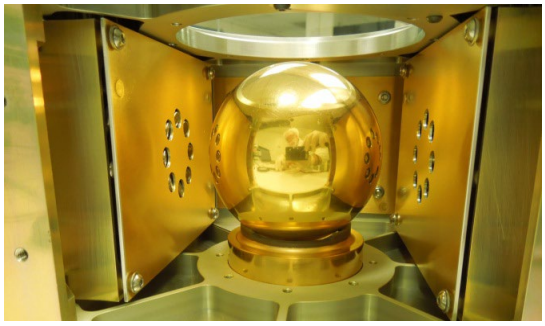
UV-LEDs powered ON, illuminating light onto the proof mass

Instrument Description

- Size 230x270x185mm
- Mass 6.3kg
- Average Power 9.5W
- 2 identical separate experiments containing:
  - 8 UV-LEDs integrated package
  - 4 bias plates
  - 1 power electronics and communication box

Charge Control

UV-LED controls the buildup of charge by creating a cloud of electrons between the floating component—or proof mass—and the bias plates surrounding it. The



Interior of the UV-LED Payload, showing gold coated proof mass at the center

electrons are created by illuminating the proof mass and bias plates with ultra-violet light (~255 nm) from the LEDs, causing the release of electrons via the photo-emission effect. By changing the potential of one or more bias plates, the electrons can be made to flow from or to the proof mass, thereby controlling its charge.

UV-LED Test Data

Thorough in-lab performance testing of the UV-LED instrument at the component and system level was conducted to:

- Characterize and monitor the performance of the UV light emitting diodes by measuring V-I and V-I-P characteristics
- Demonstrate AC Charge Control
- Validate and qualify the instrument for flight through environmental tests (Random Vibration, Shock, TVAC, Functional and Software)
- Validate the Spacecraft/Instrument interface through
  - TVAC and Random Vibration
  - Communication interface tests through Spacecraft and ground systems

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