

## **Optical Multi-Gas Monitor Technology Demonstration on the International Space Station**

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There are a variety of both portable and fixed gas monitors onboard the International Space Station (ISS). Devices range from rack-mounted mass spectrometers to hand-held electrochemical sensors. An optical Multi-Gas Monitor has been developed as an ISS Technology Demonstration to evaluate long-term continuous measurement of 4 gases. Based on tunable diode laser spectroscopy, this technology offers unprecedented selectivity, concentration range, precision, and calibration stability.

The monitor utilizes the combination of high performance laser absorption spectroscopy with a rugged optical path length enhancement cell that is nearly impossible to misalign. The enhancement cell serves simultaneously as the measurement sampling cell for multiple laser channels operating within a common measurement volume. Four laser diode based detection channels allow quantitative determination of ISS cabin concentrations of water vapor (humidity), carbon dioxide, ammonia and oxygen. Each channel utilizes a separate vertical cavity surface emitting laser (VCSEL) at a different wavelength. In addition to measuring major air constituents in their relevant ranges, the multiple gas monitor provides real time quantitative gaseous ammonia measurements between 5 and 20,000 parts-per-million (ppm). A small ventilation fan draws air with no pumps or valves into the enclosure in which analysis occurs. Power draw is only about 3 W from USB sources when installed in Nanoracks or when connected to 28V source from any EXPRESS rack interface. Internal battery power can run the sensor for over 20 hours during portable operation. The sensor is controlled digitally with an FPGA/microcontroller architecture that stores data internally while displaying running average measurements on an LCD screen and interfacing with the rack or laptop via USB.

Design, construction and certification of the Multi-Gas Monitor were a joint effort between Vista Photonics, Nanoracks and NASA-Johnson Space Center (JSC). Vista Photonics developed the core technology and built the sensor. Nanoracks designed, constructed the enclosure, interfaces, and battery power management circuitry, integrated all subsystems into the enclosure, and then managed the certification tests, documentation and manifesting. The unit was calibrated in the JSC Toxicology Laboratory. The Multi-Gas Monitor is manifested to fly as a technology demonstration to the ISS in November 2013 and will operate for at least 6 months with data sent to the ground for evaluation. The primary goal is to demonstrate long term interference free operation in the real spacecraft environment.