IIP PROJECT HIGHLIGHT

QPMS: Quantum Parametric Mode Sorting Lidar

OVERVIEW

This project is a concept study to determine whether the **Quantum Parametric Mode Sorting (QPMS)** lidar technique could observe Earth systems like snow and inland/nearshore water from SmallSats in low-Earth orbit. QPMS offers several potential advantages over traditional lidar techniques. QPMS would reduce interference caused by solar background light and cloud cover, increasing the accuracy of gathered lidar data. While the QPMS lidar technique has already been explored within the 1550 nm telecom band, this effort aims to demonstrate its utility for observing targets in the visible wavelength where water and snow are transmissive.

SCIENCE AREA

Surface topography and vegetation is a vast field of study that includes oceanography, biology, and cryology. QPMS could enable new studies in each of these fields, allowing researchers to probe the interior of glacial snow packs with greater accuracy and observe the ocean sea floor more clearly, even when the water is turbid. Fixed to a small satellite platform in low earth orbit, QPMS may radically change how scientists monitor a wide variety of systems.

QPMS will explore a new lidar technique that could enable revolutionary studies of Earth's Surface Topography and Vegetation, a critical metric for understanding numerous other systems.

TECHNOLOGY

The proposed QPMS lidar technique uses a mode-locked laser, which outputs at 1030 nm and 515 nm. This is used to probe the target (such as a snow or water sample). The lidar receiver utilizes two classical direct detect channels (1030nm, 515 nm) and a quantum enabled channel (515nm). Backscat¬tered 515 nm light is routed to the Fiber QPMS Module, where a pumped nonlinear convertor ideally filters out mode-matched photons separating them from background light and detecting them on a photon counting detector. The two direct detection channels provide complementary information, allowing differential measurements that also allow quantum/classical comparisons.

Advancements

- **Quantum enabled filtering** of scattered light from solar background allowing superior daytime measurements to enhance precision altimetric types of measurements.
- **Radiative transfer models** of lidar returns for coupled atmosphere-snow; ice-water systems, pioneering new processes for obtaining accurate snow parameters.
- **Simulated performance testing for snow and turbid water environments** will help determine whether QPMS is ready to observe Earth systems within the visible light spectrum, preparing the use aboard future science missions.

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This project is managed under the Instrument Incubator Program (IIP). For more information, please visit esto.nasa.gov.

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