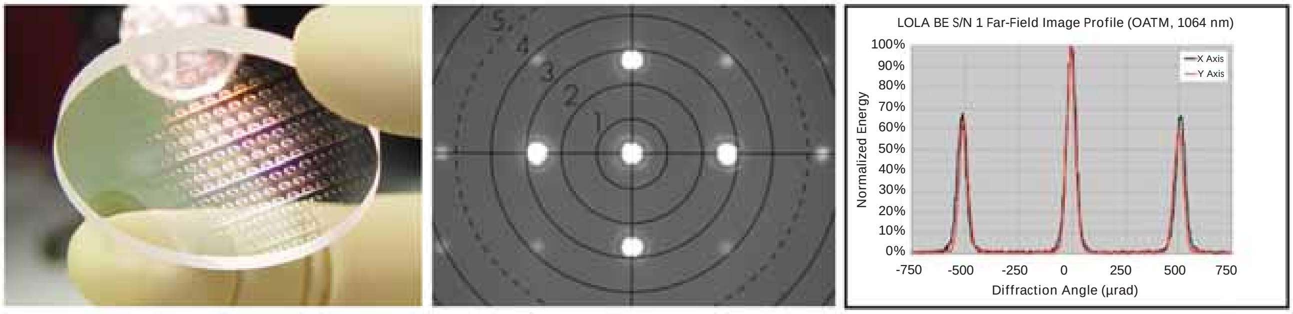


(a) (b) (c)

LOLA DOE: (a) Picture, (b) Far-field image, and (c) Image normalized cross-section.

Current single-zone DOE lithographic manufacturing techniques could also be used to fabricate a multiple-zone DOE by masking the different DOE zones during the manufacturing process, and the same space-compatible DOE substrates (fused silica, sapphire) that are used on standard DOE's could be used for multiple-zone DOE's.

DOEs are an elegant and cost-effective optical design option for space-based laser altimeters that require multiple output laser beams. The use of multiple-zone DOEs would allow for the design and optimization of a laser altimeter instrument required to operate over a large range of target distances, such as those designed to both map and land on a planetary body. In addition to space-based laser altimeters, this technology could find applications in military or commercial unmanned aerial vehicles (UAVs) that fly at an altitude of several kilometers and need to land. It is also conceivable that variations of this approach could be used in land-based applications such as collision avoidance and robotic control of cars, trains, and ships.

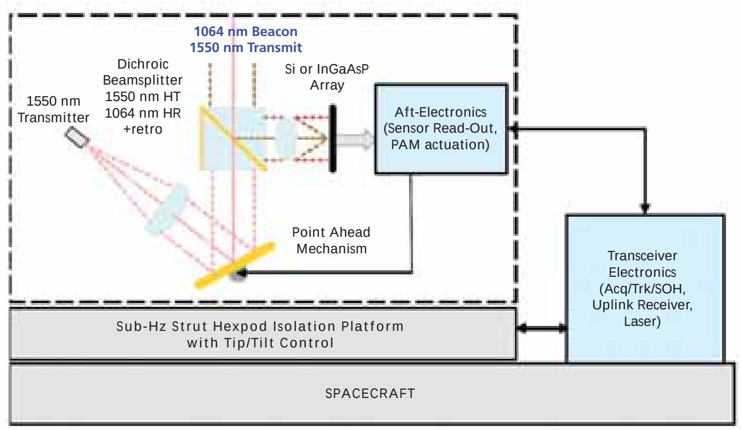
This work was done by Luis A. Ramos-Izquierdo of Goddard Space Flight Center. Further information is contained in a TSP (see page 1). GSC-15620-1

Simplified Architecture for Precise Aiming of a Deep-Space Communication Laser Transceiver

New optical transceiver is a combination of innovative technologies.

NASA's Jet Propulsion Laboratory, Pasadena, California

The simplified architecture is a minimal system for a deep-space optical communications transceiver. For a deep-space optical communications link the simplest form of the transceiver requires (1) an efficient modulated optical source, (2) a point-ahead mechanism (PAM) to compensate for two-way light travel, (3) an aperture to reduce the divergence of the transmit laser communication signal and also to collect the uplink communication signal, and (4) a receive detector to sense the uplink communication signal. Additional components are introduced to mitigate for spacecraft microvibrations and to improve the pointing accuracy.



The **Canonical Transceiver Architecture** simplifies the design of the deep-space optical transceiver. Innovative technologies enabling its implementation include a single photon-counting detector array, two-photon absorption downlink tracking, a low-power point-ahead mechanism, and a sub-Hertz vibration isolation platform.

The Canonical Transceiver implements this simplified architecture (see figure). A single photon-counting "smart focal plane" sensor combines acquisition, tracking, and forward link data detection functionality. This improves optical efficiency by eliminating channel splits. A transmit laser blind sensor (e.g. silicon with 1,550-nm beam) provides transmit beam-pointing feedback via the two-photon absorption (TPA) process. This vastly improves the transmit / receive isolation because only the focused transmit beam is detected. A piezoelectric tip-tilt actuator implements the required point-ahead angle. This point-ahead mechanism has been demonstrated to have near zero quiescent power and is flight qualified. This architecture also uses an innovative 100-mHz resonant frequency passive isolation platform to filter spacecraft vibrations with voice coil actuators for active tip-tilt correction below the resonant frequency.

The canonical deep-space optical communications transceiver makes synergistic use of innovative technologies to reduce size, weight, power, and cost. This optical transceiver can be used to retire risks associated with deep-space optical communications on a planetary pathfinder mission and is complementary to ongoing lunar and access link developments.

This work was done by Gerard G. Ortiz, William H. Farr, and Jeffrey R. Charles of Caltech for NASA's Jet Propulsion Laboratory. Further information is contained in a TSP (see page 1). ***NPO-46073***

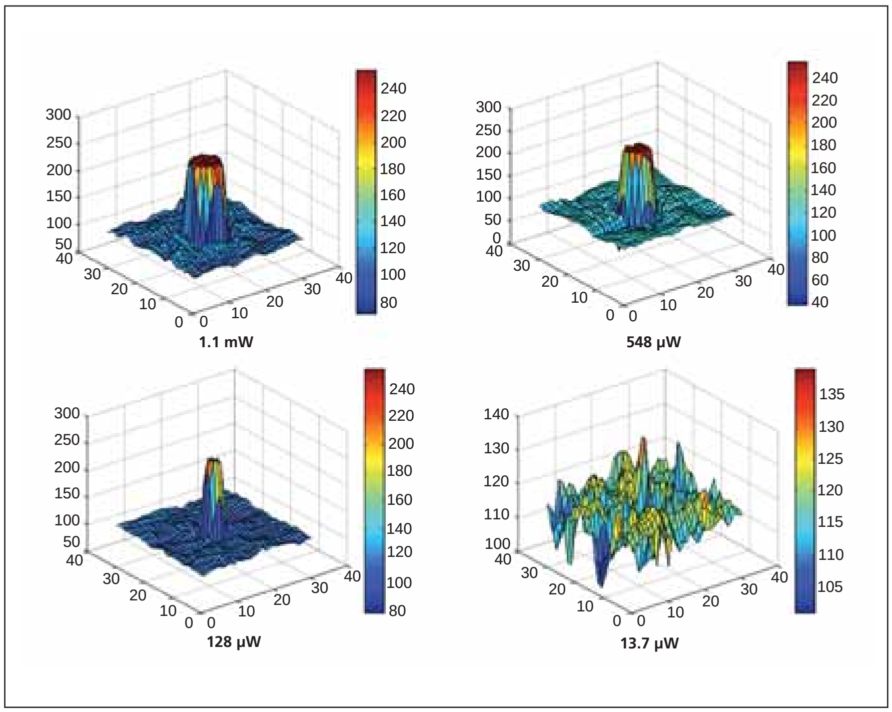
Two-Photon-Absorption Scheme for Optical Beam Tracking

This approach reduces cost for free-space optical communication receivers.

NASA's Jet Propulsion Laboratory, Pasadena, California

A new optical beam tracking approach for free-space optical communication links using two-photon absorption (TPA) in a high-bandgap detector material was demonstrated. This tracking scheme is part of the canonical architecture described in the preceding article. TPA is used to track a long-wavelength transmit laser while direct absorption on the same sensor simultaneously tracks a shorter-wavelength beacon. The TPA responsivity was measured for silicon using a PIN photodiode at a laser beacon wavelength of 1,550 nm. As expected, the responsivity shows a linear dependence with incident power level. The responsivity slope is 4.5 $\times\ 10^{-7}$ A/W^2. Also, optical beam spots from the 1,550-nm laser beacon were characterized on commercial charge-coupled device (CCD) and complementary metal-oxide semiconductor (CMOS) imagers with as little as 13.7 µW of optical power (see figure). This new tracker technology offers an innovative solution to reduce system complexity, improve transmit/receive isolation, improve optical efficiency, improve signal-to-noise ratio (SNR), and reduce cost for free-space optical communications transceivers.

This work was done by Gerardo G. Ortiz and William H. Farr of Caltech for NASA's Jet Propulsion Laboratory. Further information is contained in a TSP (see page 1). ***NPO-46063***



Two-Photon Absorption generated signal levels caused by a 1,550 nm laser focused spot on a silicon CMOS focal plane array detector at various power levels. Note that the spot is distinguishable even with incident power levels in the 10's of microwatts.

High-Sensitivity, Broad-Range Vacuum Gauge Using Nanotubes for Micromachined Cavities

NASA's Jet Propulsion Laboratory, Pasadena, California

A broad-range vacuum gauge has been created by suspending a single-walled carbon nanotube (SWNT) (metallic or semiconducting) in a Schottky diode format or in a bridge conductor format, between two electrically charged mesas. SWNTs are highly sensitive to molecular collisions because of their extremely small diameters in the range of 1 to 3 nanometers. The measurement parameter will be the change in conductivity of SWNT due to decreasing rate of molecular collisions as the pressure inside a chamber decreases.

The rate of heat removal approaches a saturation limit as the mean free path (m.f.p.) lengths of molecules increase due to decreasing pressure. Only those sensing elements that have a long relaxation time can produce a measureable response when m.f.p. of molecules increases (or time between two consecutive collisions increases). A suspended SWNT offers such a capability because