Transverse Pupil Shifts for Adaptive Optics
Non-Common Path Calibration

NASA’s Jet Propulsion Laboratory, Pasadena, California

A simple new way of obtaining absolute wavefront measurements with a laboratory Fizeau interferometer was recently devised. In that case, the observed wavefront map is the difference of two cavity surfaces, those of the mirror under test and of an unknown reference surface on the Fizeau’s transmission flat. The absolute surface of each can be determined by applying standard wavefront reconstruction techniques to two grids of absolute surface height differences of the mirror under test, obtained from pairs of measurements made with slight transverse shifts in X and Y.

Adaptive optics systems typically provide an actuated periscope between wavefront sensor (WFS) and common-mode optics, used for lateral registration of deformable mirror (DM) to WFS. This periscope permits independent adjustment of either pupil or focal spot incident on the WFS. It would be used to give the required lateral pupil motion between common and non-common segments, analogous to the lateral shifts of the two phase contributions in the lab Fizeau.

The technique is based on a completely new approach to calibration of phase. It offers unusual flexibility with regard to the transverse spatial frequency scales probed, and will give results quite quickly, making use of no auxiliary equipment other than that built into the adaptive optics system. The new technique may be applied to provide novel calibration information about other optical systems in which the beam may be shifted transversely in a controlled way.

This work was done by Eric E. Bloenhof of Caltech for NASA’s Jet Propulsion Laboratory. Further information is contained in a TSP (see page I). NPO-48060

Qualification of Fiber Optic Cables for Martian Extreme Temperature Environments

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Means have been developed for enabling fiber optic cables of the Laser Induced Breakdown Spectrometer instrument to survive ground operations plus the nominal 670 Martian conditions that include Martian summer and winter seasons. The purpose of this development was to validate the use of the rover external fiber optic cabling of ChemCam for space applications under the extreme thermal environments to be encountered during the Mars Science Laboratory (MSL) mission.

Flight-representative fiber optic cables were subjected to extreme temperature thermal cycling of the same diurnal depth (or ΔT) as expected in flight, but for three times the expected number of in-flight thermal cycles. The survivability of fiber optic cables was tested for 600 cumulative thermal cycles from −130 to +15 °C to cover the winter season, and another 1,410 cumulative cycles from −105 to +40 °C to cover the

https://ntrs.nasa.gov/search.jsp?R=20120006714 2019-05-29T00:12:26+00:00Z
A solid-state light source combines an array of light-emitting diodes (LEDs) with advanced electronic control and stabilization over both the spectrum and overall level of the light output. The use of LEDs provides efficient operation over a wide range of wavelengths and power levels, while electronic control permits extremely stable output and dynamic control over the output.

In this innovation, LEDs are used instead of incandescent bulbs. Optical feedback and digital control are used to monitor and regulate the output of each LED. Because individual LEDs generate light within narrower ranges of wavelengths than incandescent bulbs, multiple LEDs are combined to provide a broad, continuous spectrum, or to produce light within discrete wavebands that are suitable for specific radiometric sensors.

This work was done by Robert Maffione and David Dana of Hydro-Optics, Biology & Instrumentation Laboratories, Inc. for Goddard Space Flight Center. Further information is contained in a TSP (see page 1).

**Multiple-Event, Single-Photon Counting Imaging Sensor**

This sensor has applications in high-energy physics and medical and biological imaging systems.

**NASA’s Jet Propulsion Laboratory, Pasadena, California**

The single-photon counting imaging sensor is typically an array of silicon Geiger-mode avalanche photodiodes that are monolithically integrated with CMOS (complementary metal oxide semiconductor) readout, signal processing, and addressing circuits located in each pixel and the peripheral area of the chip. The major problem is its “single-event” method for photon count number registration. A single-event single-photon counting imaging array only allows registration of up to one photon count in each of its pixels during a frame time, i.e., the interval between two successive pixel reset operations. Since the frame time can’t be too short, this will lead to very low dynamic range and make the sensor merely useful for very low flux environments. The second problem of the prior technique is a limited fill factor resulting from consumption of chip area by the monolithically integrated CMOS readout in pixels. The resulting low photon collection efficiency will substantially ruin any benefit gained from the very sensitive single-photon counting detection.

The single-photon counting imaging sensor developed in this work has a novel “multiple-event” architecture, which allows each of its pixels to register as more than one million (or more) photon-counting events during a frame time. Because of a consequently boosted dynamic range, the imaging array of the invention is capable of performing single-photon counting under ultra-low light through high-flux environments. On the other hand, since the multiple-event architecture is implemented in a hybrid structure, back-illumination and