

Pairs of Correlated Photons would be generated at the transmitter and preferentially detected at the receiver in the proposed system.

dence in the receiving photodetector.

Because most or all of the signal photons would be correlated while most or all of the noise photons would be uncorrelated, the S/N would be correspondingly enhanced in the photodetector output. An additional advantage to be gained by use of a correlated-photon detector is that it could be capable of recovering the signal even in the presence of background light so bright that a classical uncorrelated-photon detector would be saturated.

A blocked-impurity-band (BIB) photodetector that preferentially detects pairs of correlated photons over uncorrelated ones and that operates at a quantum efficiency of 88 percent is commercially available. This detector must be cooled to the temperature of liquid helium to obtain the desired low-noise performance. It is planned to use this detector in a proof-of-principle demonstration. In addition, it may be possible to develop GaN-based photodetectors that could offer the desired low-noise performance at room temperature.

This work was done by Deborah Jackson, George Hockney, and Jonathan Dowling of Caltech for NASA's Jet Propulsion Laboratory. Further information is contained in a TSP (see page 1). NPO-30633

Atmospheric-Fade-Tolerant Tracking and Pointing in Wireless Optical Communication

Tracking is maintained through beacon signal fades.

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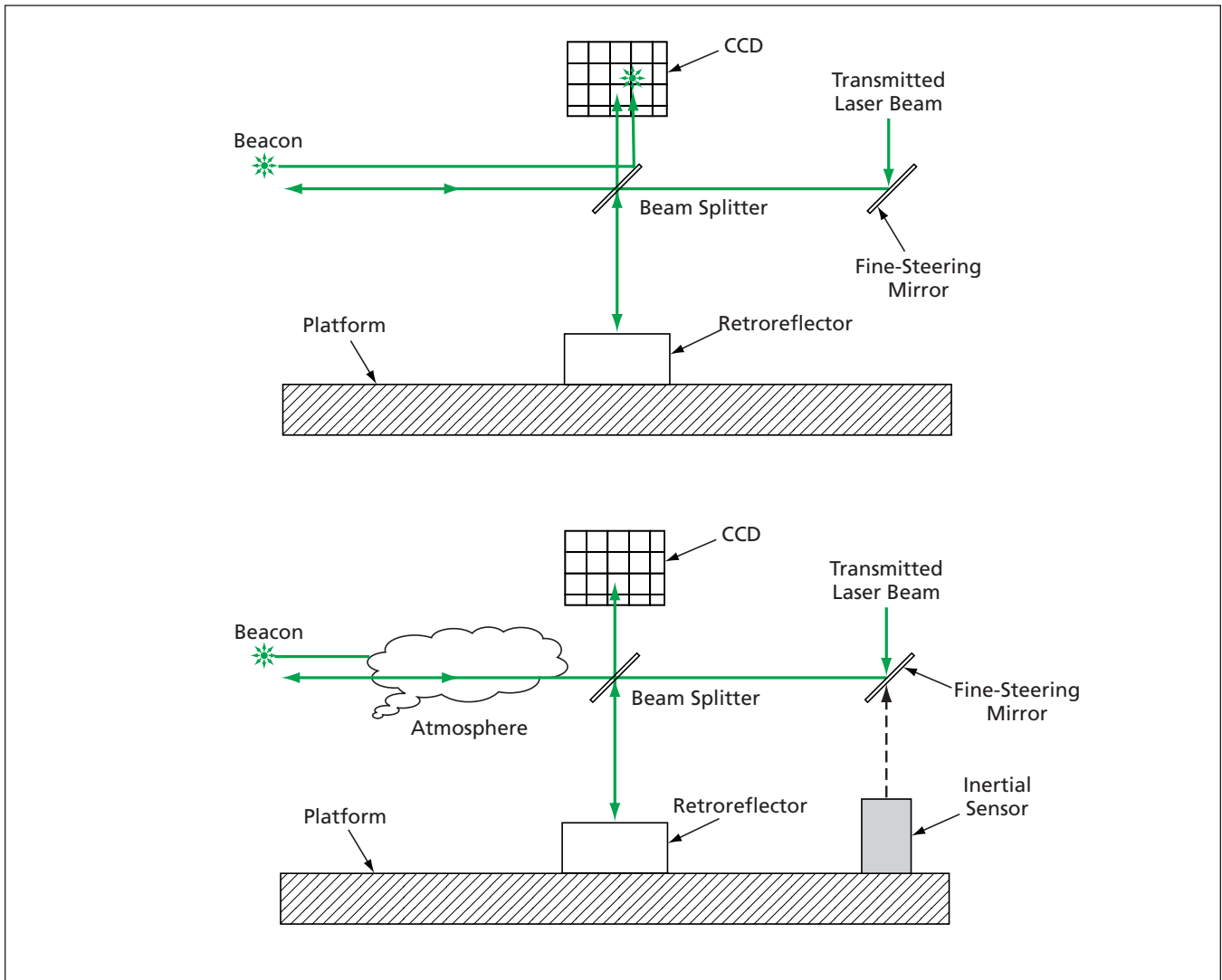
An acquisition, tracking, and pointing (ATP) system, under development at the time of reporting the information for this article, is intended to enable a terminal in a free-space optical communication system to continue to aim its transmitting laser beam toward a receiver at a remote terminal when the laser beacon signal from the remote terminal temporarily fades or drops out of sight altogether. Such fades and dropouts can be caused by adverse atmospheric conditions (e.g., rain or clouds). They can also occur when intervening objects block the line of sight between terminals as a result of motions of those objects or of either or both terminals.

A typical prior ATP system in an optical-communication terminal, shown in

the upper part of the figure, includes a retroreflector, a beam splitter, and a charge-coupled-device (CCD) image detector mounted on the same platform that holds the transmitting laser. With help of the beam splitter and the retroreflector, the direction of aim of the laser beam, relative to the direction to the beacon, is measured in terms of the relative positions of the beacon and a sample of the laser beam on the CCD. Hence, the CCD output constitutes an indication of the instantaneous aim of the transmitted laser beam and can be used as a feedback control signal for a steering mirror to point the transmitted laser beam toward the beacon. The CCD output is sampled at a high update rate to provide feedback compensation for any motion (including microscopic vi-

bration) of the platform. If the intensity of the beacon signal reaching the CCD is reduced, the beam-pointing performance is reduced. If the reduction is severe or prolonged, the transmitted laser beam may cease to track the beacon, with consequent loss of the communication link.

The developmental ATP system, shown in the lower part of the figure, includes all the components of the prior system, plus an inertial sensor, which measures the vibrations and other motions of the platform. The feedback control subsystem utilizes the inertial-sensor output, in addition to the CCD output, as a source of feedback for control of the steering mirror: The inertial signal serves as an approximate indication of the instantaneous orientation of the



The **Inertial Sensor** measures motions of the platform, thereby providing an approximate measure of the direction of aim when the beacon signal is attenuated or not visible.

dimmed (or missing) beacon, making it possible to continue to compensate for vibrations and other motions when the system is partially or totally blind to the beacon.

The time during which compensation can be maintained is limited by the ac-

cumulation of integration error since the last observation of the beacon at adequate intensity. Typical atmospheric fades last about 1 ms. It has been estimated that compensation could be maintained for times ranging from tens of milliseconds to tens of seconds, de-

pending on the amount of pointing error that can be tolerated.

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Curved Focal-Plane Arrays Using Back-Illuminated High-Purity Photodetectors

Advantages of curved-focal-surface imaging could be obtained at lower cost.

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Curved-focal-plane arrays of back-illuminated silicon-based photodetectors are being developed. The basic idea is to improve the performance of an imaging instrument and simplify the optics needed

to obtain a given level of performance by making an image sensor (e.g., a photographic film or an array of photodetectors) conform to a curved focal surface, instead of following the customary prac-

tice of designing the optics to project an image onto a flat focal surface. Eyes are natural examples of optical systems that have curved focal surfaces on which image sensors (retinas) are located.