

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.

*This work was done by Gerardo Ortiz and Shinhak Lee of Caltech for NASA's Jet Propulsion Laboratory. Further information is contained in a TSP (see page 1). NPO-40061*

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

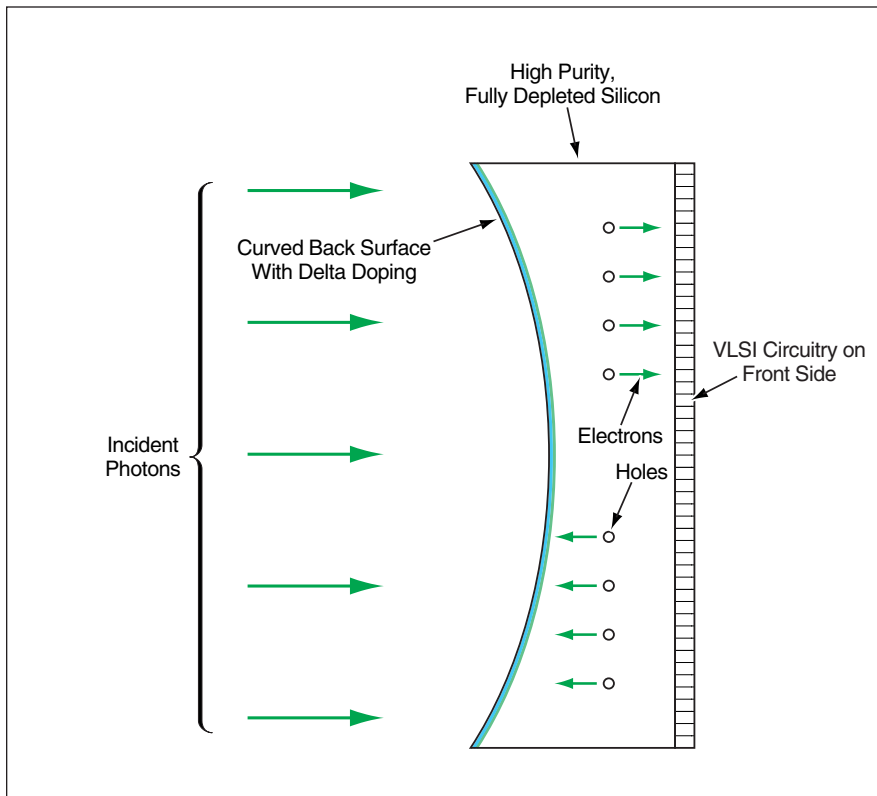
**Advantages of curved-focal-surface imaging could be obtained at lower cost.**

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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.



**VLSI Circuitry of a Photodetector Array** would be formed on the flat front surface of a high-resistivity silicon substrate. The photodetectors would be illuminated on the back surface, which would conform to a curved focal surface.

One prior approach to implementation of this concept involves the use of curved-input-surface microchannel plates as arrays of photodetectors. In comparison with microchannel plates, these curved-focal-plane arrays would weigh less, operate at much lower voltages, and consume less power. It should also be possible to fabricate the proposed devices at lower cost.

It would be possible to fabricate an array of photodetectors and readout circuitry in the form of a very-large-scale integrated (VLSI) circuit on a curved focal surface, but it would be difficult and expensive to do so. In a simple and inexpensive alternate approach, a device (see figure) would have (1) a curved back surface, onto which light would be focused; and (2) a flat front surface, on

which VLSI circuitry would be fabricated by techniques that are well established for flat surfaces.

The device would be made from ultra-pure silicon, in which it is possible to form high-resistivity, thick photodetectors that are fully depleted through their thicknesses. (As used here, "thick" means having a thickness between a fraction of a millimeter and a few millimeters.) The back surface would be polished to the curvature of the focal surface of the intended application. To enable the collection of charge carriers excited by photons near the back surface or in the bulk of the device, it would be necessary to form a transparent or semitransparent back-surface electrode, possibly by delta doping. [Delta doping is so named because its density-vs.-depth characteristic is reminiscent of the Dirac  $\delta$  function (impulse function): the dopant is concentrated in a very thin layer — nominally, a single atomic layer.]

*This work was done by Shouleh Nikzad and Michael E. Hoenk of Caltech for NASA's Jet Propulsion Laboratory. Further information is contained in a TSP (see page 1).*

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