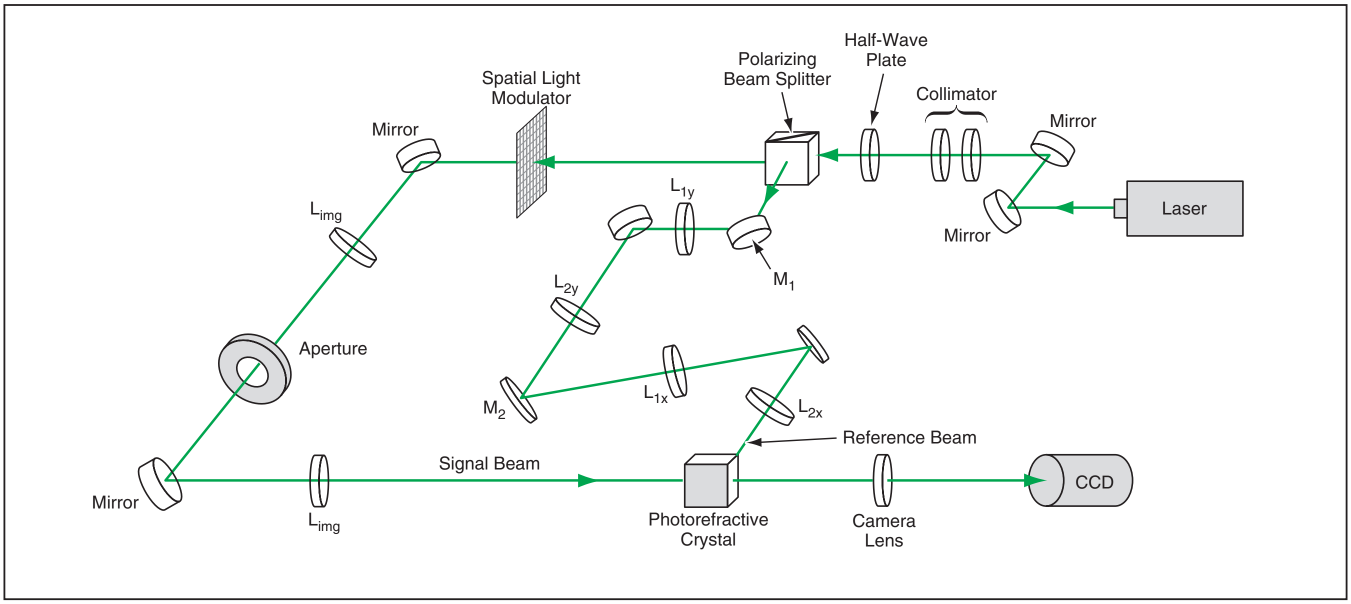


Figure 1. A **Hologram Is Formed in a Crystal** to be exposed to γ rays. After exposure to γ rays, the crystal is remounted in this apparatus for reading of the hologram.

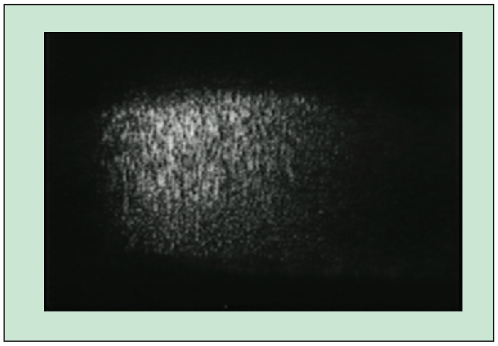


Figure 2. This **Image Shows the Effect of γ Rays** that have passed through a crystal of $Fe{:}LiNbO_3$.

erence beam goes through a two-dimensional optical scanner that contains two pairs of lenses (L_{1y},L_{2y} and L_{1x},L_{2x}) and mirrors M_1 and M_2, which can be rotated by use of micrometer drives to make fine adjustments. The signal beam is sent through a spatial light modulator that imposes the holographic pattern, then through two imaging lenses L_{img} on its way to the crystal. An aperture is placed at the common focus of lenses L_{img} to suppress high-order diffraction from the spatial light modulator. The hologram is formed by interference between the signal and reference beams.

A camera lens focuses an image of the interior of the crystal onto a charge-coupled device (CCD). If the crystal is illuminated by only the reference beam once the hologram has been formed, then an image of the hologram is formed on the CCD: this phenomenon is exploited to make visible the pattern of γ irradiation of the crystal, as described next.

In the second stage of the process, the crystal is removed from the holographic apparatus and irradiated with γ rays at a dose of about 100 krad. In the third stage of the process, the crystal is remounted in the holographic apparatus in the same position as in the first stage and illuminated with only the reference beam to obtain the image of the hologram as modified by the effect of the γ rays. The orientations of M_1 and M_2 can be adjusted slightly, if necessary, to maximize the intensity of the image. Figure 2 shows such an image that was formed in a crystal of $Fe{:}LiNbO_3$.

This work was done by Danut Dragoi, Steven McClure, Allan Johnston, and Tien-Hsin Chao of Caltech for **NASA's Jet Propulsion Laboratory**. *Further information is contained in a TSP (see page 1).*
NPO-30622

Photodiode-Based, Passive Ultraviolet Dosimeters

Outputs of photodiodes are fed to coulometers.

Marshall Space Flight Center, Alabama

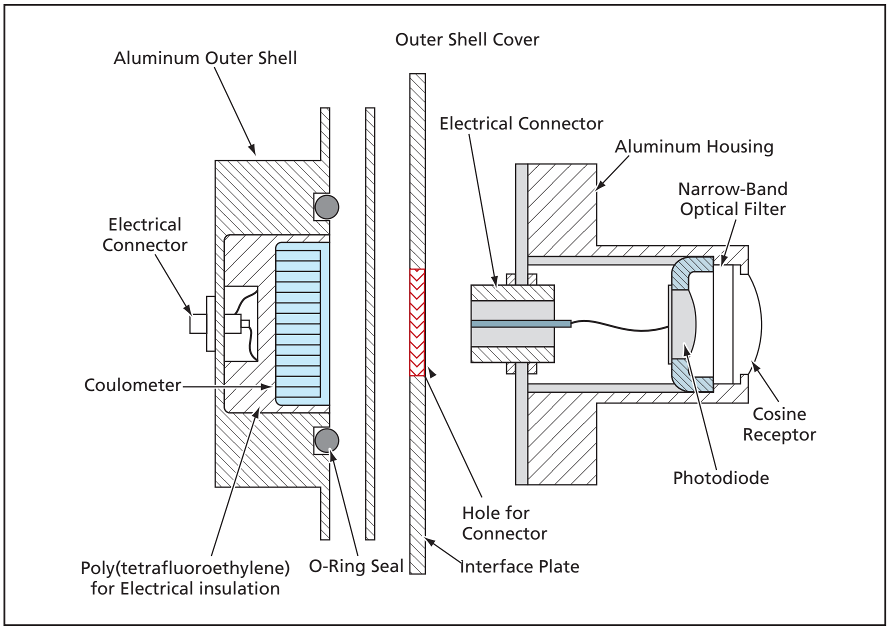
Simple, passive instruments have been developed for measuring the exposure of material specimens to vacuum ultraviolet (VUV) radiation from the Sun. Each instrument contains a silicon photodiode and a coulometer. The photocharge generated in the photodiode is stored in the coulometer. The accumulated electric charge measured by use of the coulometer is assumed to be proportional to the cumulative dose of VUV radiation expressed in such convenient units as equivalent Sun hours (ESH) [defined as the number of hours of exposure to sunlight at normal incidence]. Intended originally for use aboard spacecraft, these instruments could also be adapted to such terrestrial uses as monitoring the curing of ultraviolet-curable epoxies.

Each instrument includes a photodiode and a coulometer assembly mounted on an interface plate (see figure). The photodiode assembly includes an aluminum housing that holds the photodiode, a poly(tetrafluoroehylene) cosine receptor, and a narrow-band optical filter. The cosine receptor ensures that the angular response of the instrument approximates the ideal angular response (proportional to the cosine of the angle of incidence). The filter is chosen to pass the ultraviolet wavelength of interest in a specific experiment.

The photodiode is electrically connected to the coulometer. The factor of proportionality between the charge stored in the coulometer and ultraviolet dosage (in units of ESH) is established, prior to use, in calibration experiments that involve the use of lamps and current sources traceable to the National Institute of Standards and Technology.

This work was done by Jason A. Vaughn of **Marshall Space Flight Center** *and Perry Gray of Micro Craft, Inc.*

This invention is owned by NASA, and a patent application has been filed. For further information, contact Sammy Nabors, MSFC Commercialization Assistance Lead, at (256) 544-5226 or sammy.a.nabors@nasa.gov. Refer to MFS-31316-1.



This **Simple, Passive Instrument** measures the dosage of ultraviolet light in the pass wavelength band of its filter.

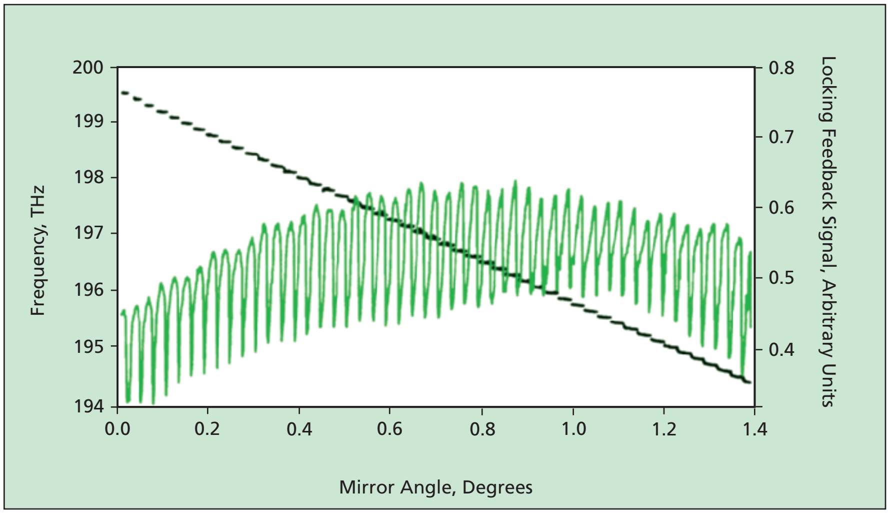
Discrete Wavelength-Locked External Cavity Laser

The laser is locked internally to frequencies of communication channels.

John H. Glenn Research Center, Cleveland, Ohio

A prototype improved external cavity laser (ECL) was demonstrated in the second phase of a continuing effort to develop wavelength-agile lasers for fiber-optic communications and trace-gas-sensing applications. This laser is designed to offer next-generation performance for incorporation into fiber-optic networks. By eliminating several optical components and simplifying others used in prior designs, the design of this laser reduces costs, making lasers of this type very competitive in a price-sensitive market.

Diode lasers have become enabling devices for fiber optic networks because of their cost, compactness, and spectral properties. ECLs built around diode laser gain elements further enhance capabilities by virtue of their excellent spectral properties with significantly increased (relative to prior lasers) wavelength tuning ranges. It is essential to exploit the increased spectral coverage of ECLs while simultaneously insuring that they operate only at precisely defined communication channels (wavelengths). Heretofore, this requirement has typically been satisfied through incorporation of add-in optical components that "lock" the ECL output wavelengths to these specific channels. Such add-in components contribute substantially to the costs of ECL lasers to be used as sources for optical communication networks. Furthermore, the optical alignment of these components, needed to attain the required wavelength precision, is a non-trivial task and can contribute substantially to production costs.



The **Frequency Varies in Steps** as a function of the mirror angle. Each step represents locking to the indicated frequency.

The design of the present improved ECL differs significantly from the designs of prior ECLs. The present design relies on inherent features of components already included within an ECL, with slight modifications so that these components perform their normal functions while simultaneously effecting locking to the required discrete wavelengths. Hence, add-in optical components and the associated cost of alignment can be eliminated.

The figure shows the locking feedback signal, and the frequency locking