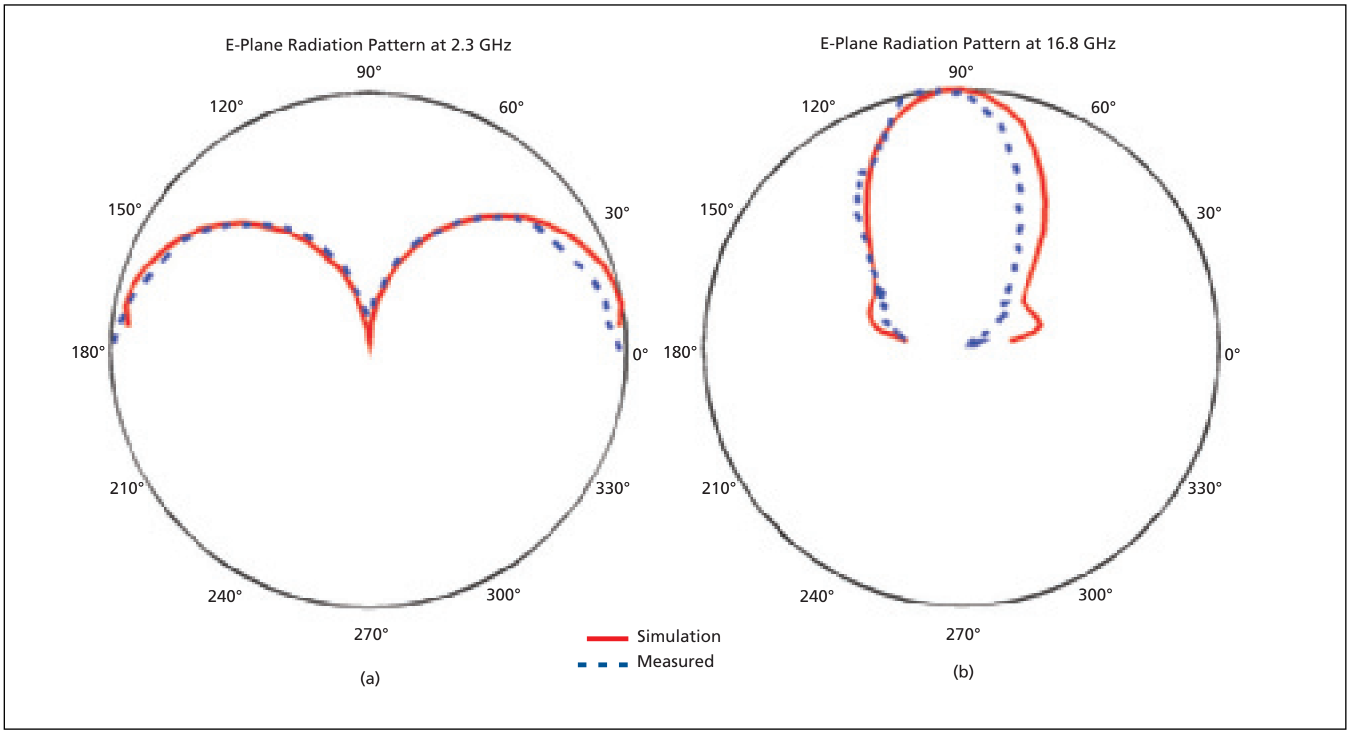

Figure 2. **Two Radiation Patterns** are attainable, as shown : (a) end-fire radiation pattern at S-band and (b) broadside radiation pattern at Ku-band.

the vicinity of 16.8 GHz, the antenna resembles a square patch antenna having dimensions close to a half wavelength, resulting in a broadside radiation pattern characterized by gain and bandwidth comparable to those of a microstrip patch antenna designed for operation in the same frequency range [see Figure 2(b)].

This work was done by James A. Nessel, Félix A. Miranda, and Afroz Zaman of Glenn Research Center. Further information is contained in a TSP (see page 1).

Inquiries concerning rights for the commercial use of this invention should be addressed to NASA Glenn Research Center, Innovative Partnerships Office, Attn: Steve Fedor, Mail Stop 4–8, 21000 Brookpark Road, Cleveland, Ohio 44135. Refer to LEW-17927-1.

Single-Camera Panoramic-Imaging Systems

It is not necessary to use multiple cameras covering narrower fields of view.

Marshall Space Flight Center, Alabama

Panoramic detection systems (PDSs) are developmental video monitoring and image-data processing systems that, as their name indicates, acquire panoramic views. More specifically, a PDS acquires images from an approximately cylindrical field of view that surrounds an observation platform. In example of a major class of intended applications, a PDS mounted on top of a motor vehicle could be used to obtain unobstructed views of the surroundings (see Figure 1). In another such example, a PDS could be mounted above a roadway intersection for monitoring approaching and receding vehicles in order to provide image data on the vehicles as input to an automated traffic-control system. In either application, a running archive of the image data acquired by the PDS could be maintained as a means of reconstructing the events leading up to a vehicular collision: used in this way, a PDS would be analogous to an aircraft "black box" data recorder.

Figure 1. A **Prototype PDS Mounted on Top of a Car** acquired a panoramic image of the surroundings.

The main subsystems and components of a basic PDS are a charge-coupled-device (CCD) video camera and lens, transfer optics, a panoramic imaging optic, a mounting cylinder, and an image-data-processing computer. The panoramic imaging optic is what makes it possible for the single video camera to image the complete cylindrical field of view; in order to image the same scene without the benefit of the panoramic imaging optic, it would be necessary to use multiple conventional video cameras, which have relatively narrow fields of view.

The panoramic imaging optic can be any one of several different types of wide-angle optics. Examples include a panoramic annular lens (PAL), a convex mirror, a fish-eye lens, scanning optics, or a panoramic refracting optic (PRO), which is described in the next paragraph. If necessary, the transfer optics can include one or more mirror(s) to flip the image. Downstream from the panoramic imaging optic and transfer optics, the image is further conditioned by the camera lens, then detected by the CCD in the camera. The camera output is digitized, processed by the computer, and displayed and/or stored as needed.

A PRO is a recently developed optic that operates partly like a PAL, partly like a fish-eye lens, and partly like a convex mirror. In comparison with a PAL, a PRO provides a wider field of view, yet is simpler and can be fabricated at lower cost. As shown in Figure 2, light from a scene enters the optic at location 1 (where it is refracted), travels through the optic, is totally internally reflected at location 2, leaves the optic at location 3 (where it undergoes a small amount of refraction), then goes through the transfer optics and camera lens into the camera. The net effect of refraction and reflection from surfaces of the optic is to define the wide, approximately cylindrical field of view. The limits of the field of view are determined primarily by the index of refraction of the optic and the curvature of its refracting/reflecting surface. A significant issue that remains to be addressed in subsequent development efforts is that the resolution of the image is approximately inversely proportional to the angular width of the field of view.

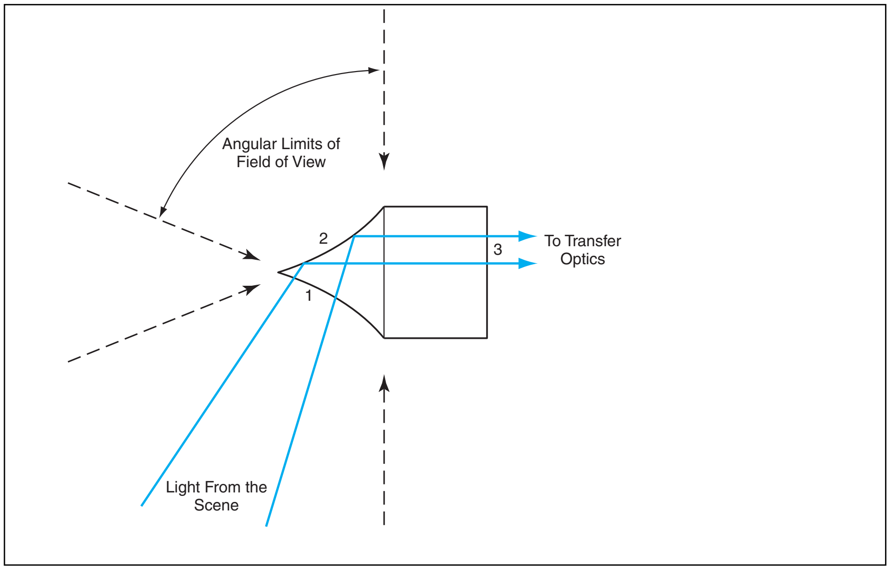

Figure 2. **A Panoramic Refractive Optic** utilizes both refraction and total internal reflection to enable projection from a wide, approximately cylindrical field of view onto a wide annulus in a focal plane.

This work was done by Jeffrey L. Lindner of Marshall Space Flight Center and John Gilbert of Optechnology, Inc. For further information, contact Jim Dowdy, MSFC Commercialization Assistance Lead, at jim.dowdy@nasa.gov.

This invention has been patented by NASA (U.S. Patent No. 6,580,567). Inquiries concerning nonexclusive or exclusive license for its commercial development should be addressed to Sammy Nabors, MSFC Commercialization Assistance Lead, at sammy.a.nabors@nasa.gov. Refer to MFS-31432/75.

Interface Electronic Circuitry for an Electronic Tongue

Compact, low-noise interface circuits are mounted in proximity to the tongue.

NASA's Jet Propulsion Laboratory, Pasadena, California

Electronic circuitry has been developed to serve as an interface between an electronic tongue and digital input/output boards in a laptop computer that is used to control the tongue and process its readings. Electronic tongues were described in two prior *NASA Tech Briefs* articles: "Electronic Tongue for Quantitation of Contaminants in Water" (NPO-30601), Vol. 28, No. 2 (February 2004), page 31; and "Electronic Tongue Containing Redox and Conductivity Sensors" (NPO-30862), Vol. 31, No. 8 (August 2007), page 58. Electronic tongues can be used for a variety of purposes, including evaluating water quality, analyzing biochemicals, analyzing biofilms, and measuring electrical conductivities of soils.

The present electronic tongue and interface circuitry are updated versions of those described in the latter-mentioned prior article. The instrument was designed for use in characterizing biofilms by Prof. D. Newman and Dr. D. Lies at Caltech. To recapitulate: An electronic tongue is a rugged, compact sensor unit that can include a heater, a temperature sensor, a conductivity sensor, and an array of three-electrode electrochemical cells, all on one planar surface of a ceramic substrate. The cells of an electronic tongue are connected to electronic excitation and readout circuits. Among the tasks identified by Prof. D. Newman and Dr. D. Lies that must be performed to characterize biofilms are stimulation of the microbial environment through generation of oxygen and hydrogen, detection of their metabolic products, and visual observation of biofilms. An electronic tongue can provide the needed stimulation while serving as a means of electrochemical detection of metabolic products of a biofilm.

A prototype apparatus for characterizing a biofilm includes an electronic tongue mounted in a flow-through, see-into chamber. The chamber is mounted on a platform under a microscope that is used to observe the biofilm growing on the electronic tongue. The flow-through, see-into chamber is made of polycarbonate structural components plus a cover glass. A watertight compartment containing the electrodes is formed by O-ring seals between the upper and lower surfaces of the electronic tongue and the facing surfaces of the chamber. On the top side of the electronic tongue, a spacer establishes the thickness of the flow-through cell as a gap between the electrodes and the cover glass.