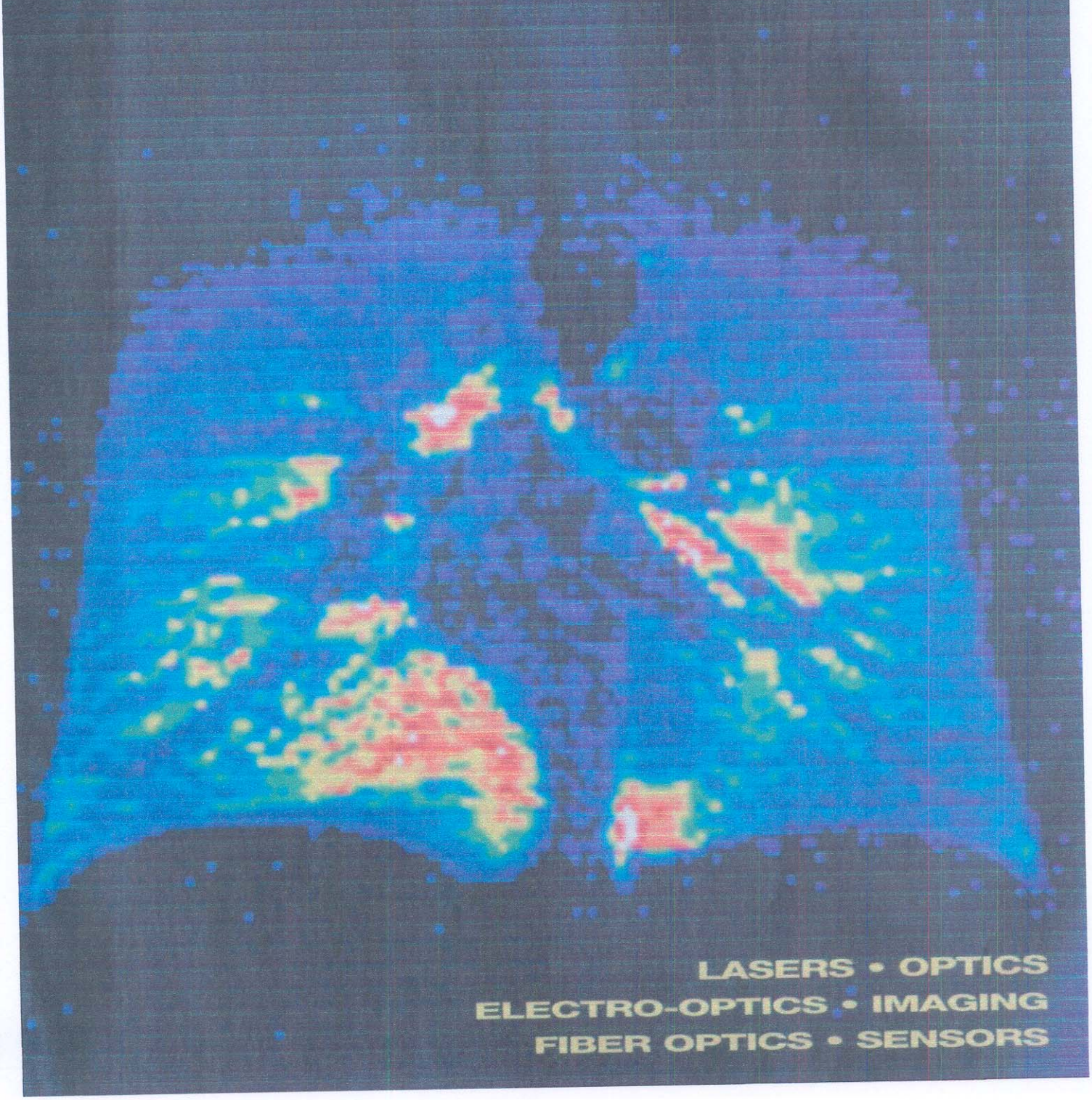
FEDERAL LAB

LASER TECH BRIEFS

REPORTING THE LATEST FEDERALLY-DEVELOPED PHOTONICS TECHNOLOGY



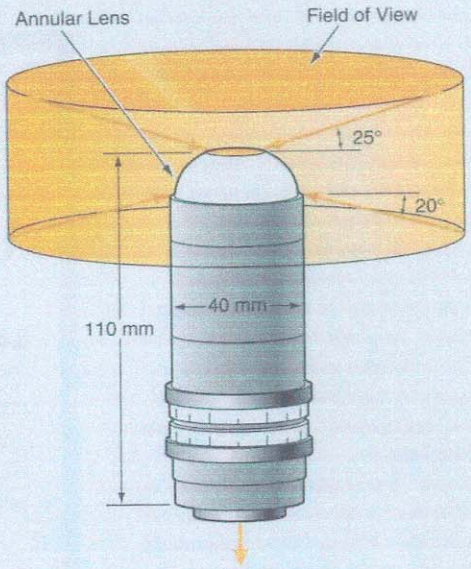
LASERS • OPTICS
ELECTRO-OPTICS • IMAGING
FIBER OPTICS • SENSORS

Video System for Inspecting Walls of Cavities

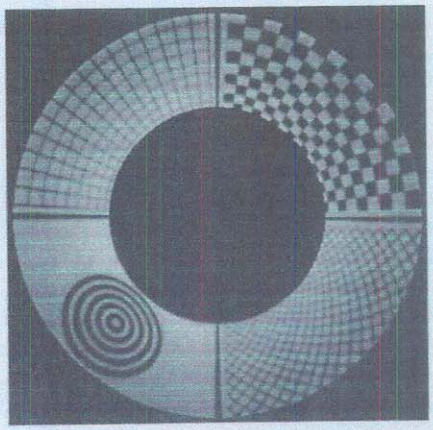
It is not necessary to rotate the probe to obtain a panoramic image.

Marshall Space Flight Center, Alabama

An endoscopic video-imaging system generates a panoramic image of part of the wall of a cavity surrounding the tip of a probe that is inserted in the cavity. The system can be used, for example, to inspect the inner surface of a tube, passage, or manifold located deep within an engine or other complex structure.



ANNULAR LENS AND FIELD OF VIEW



ANNULAR IMAGE OF TEST PATTERN

The **Panoramic Annular Lens** is 38 mm in diameter and operates in conjunction with a transfer lens of 25-mm focal length and a stop of *f*/1.4. These lenses project the cylindrical scene onto an annulus.

The probe includes an annular lens, a transfer lens, and a video camera. The annular lens is located at the probe tip, with the plane of the lens perpendicular to the cylindrical axis of the probe. It is not necessary to rotate the probe tip to obtain the

panoramic view because the field of view of the combination of lenses consists of an apparent cylindrical region that completely surrounds the probe tip circumferentially and that extends from 20° back to 25° ahead of the plane of the lens (see figure). For practical purposes, the depth of field extends from the surface of the annular lens to infinite distance. The combination of the annular lens and transfer lens projects the scene from the cylindrical field of view onto an annulus in the image plane of the video camera. In the flat annular image, radius corresponds to axial position and azimuth corresponds to circumferential position on the wall.

If simple inspection without measurement is required, a device called a "cylindrical light ring" can be mounted on the probe to illuminate the scene. Light from an incandescent lamp is delivered to the cylindrical light ring via an optical waveguide.

A different illumination device can be used when it is required to measure the distance of the wall of the cavity from the cylindrical axis of the probe: This device includes a laser diode and a rotating mirror that projects a ring of light onto the wall of the cavity. The apparent radial position of a point on this ring as a function of angular position in the annular image is related in a known way to the distance that one seeks to measure. For purposes of both measurement and enhancement of appearance for ordinary viewing, the annular video image is digitized and processed in a desktop computer. Processing can include approximate linearization of the mapping between points in the cylindrical field of view and points in the annular image, so as to minimize distortion of features that one seeks to examine.

This work was done by John A. Gilbert of the University of Alabama in Huntsville and Donald R. Matthys of Marquette University for **Marshall Space Flight Center**. *For further information,* ***write in 77*** *on the TSP Request Card.*

Inquiries concerning rights for the commercial use of this invention should be addressed to the Patent Counsel, Marshall Space Flight Center [205-544-0021]. Refer to MFS-26247.

Laser-Beam-Absorption Chemical-Species Monitor

Marshall Space Flight Center, Alabama

An apparatus measures the concentration of a chemical species in a fluid medium (e.g., a gaseous industrial process stream). The apparatus directs a laser beam through the medium, and measures the intensity of the beam after passage through the medium. The relative amount of beam power absorbed in the medium is indicative of the concentration of a chemical species; the laser wavelength is chosen to be one at which the species of interest absorbs.

This work was done by Michael Gersh, Neil Goldstein, Jamine Lee, Fritz Bien, and Steven Richtsmeier of Spectral Sciences, Inc., for **Marshall Space Flight Center**. *For further information,* ***write in 33*** *on the TSP Request Card.*

In accordance with Public Law 96-517, the contractor has elected to retain title to this invention. Inquiries concerning rights for its commercial use should be addressed to Spectral Sciences, Inc., 99 South Bedford Street #7, Burlington, MA 01803-5169. Refer to MFS-26351.