

with custom laser diode and photodiode manufacturers, total power requirements of the complete four-channel, 2.0-Gbps FireRing products are less than 1.5 Watts. Similar results are anticipated from the proposed 3.2-Gbps development effort. Additional packaging innovations as alternatives to costly hermetic sealing, passive integration, and heat dissipation will also compliment this aspect of the proposed effort.

The ultimate goal of this project will

be the successful design, fabrication, and demonstration of a rad-hard, single-channel, 3.2-Gbps serial fiber-optic transceiver that is universally compatible with virtually all protocols and architectures that interest NASA and the DoD. Key functional attributes and/or improvements beyond the current state of the art in harsh-environment fiber-optic networking components are improved thermal stability, reduced power dissipation, reduced size and mass, special-pur-

pose data processing, reconfigurable computing, protocol-transparent/multi-protocol-compatible, subsystem data transfer, intra-system data transfer, data system support, and proven materials, fabrication, and packaging processes.

*This work was done by Matt Leftwich, Tony Hull, Michael Leary, and Marcus Leftwich of Space Photonics, Inc. for Goddard Space Flight Center. Further information is contained in a TSP (see page 1). GSC-16414-1*

## Towed Subsurface Optical Communications Buoy

*NASA's Jet Propulsion Laboratory, Pasadena, California*

The innovation allows critical, high-bandwidth submarine communications at speed and depth. This reported innovation is a subsurface optical communications buoy, with active neutral buoyancy and streamlined flow surface veins for depth control. This novel sub-

surface positioning for the towed communications buoy enables substantial reduction in water-absorption and increased optical transmission by eliminating the intervening water absorption and dispersion, as well as by reducing or eliminating the beam

spread and the pulse spreading that is associated with submarine-launched optical beams.

*This work was done by Robert C. Stirbl and William H. Farr of Caltech for NASA's Jet Propulsion Laboratory. For more information, contact [iaoffice@jpl.nasa.gov](mailto:iaoffice@jpl.nasa.gov). NPO-47737*

## High-Collection-Efficiency Fluorescence Detection Cell

**A relatively compact and economical unit is used for the detection of formaldehyde.**

*Goddard Space Flight Center, Greenbelt, Maryland*

A new fluorescence cell has been developed for the laser induced fluorescence (LIF) detection of formaldehyde. The cell is used to sample a flow of air that contains trace concentrations of formaldehyde. The cell provides a hermetically sealed volume in which a flow of air containing formaldehyde can be illuminated by a laser. The cell includes the optics for transmitting the laser beam that is used to excite the formaldehyde and for collecting the resulting fluorescence. The novelty of the cell is its small size and simple design that provides a more robust and cheaper alternative to the state of the art. Despite its simplicity, the cell provides the same sensitivity to detection as larger, more complicated cells.

Laser induced fluorescence detection uses a laser to excite the atomic or molecular species of interest to a higher energy state. As the excited species relaxes, it fluoresces, i.e., it releases a photon. A photon-counting photomultiplier tube (PMT) is used to detect the emitted photon. The design parameters that determine the sensitivity of LIF detection are

the excitation rate, the fluorescence collection efficiency, and the background from stray laser light. The design used for LIF detection is based on a multipass cell design, such as a White or Herriott cell. In these implementations, two or three mirrors are used to obtain multiple reflections of the laser (30+ passes) within the cell, resulting in increased laser fluence in the detection region and thus, higher detection sensitivity.

A smaller, simpler, and more robust LIF detection cell was designed for a new instrument prototype. The primary consideration in the detection cell is the sensitivity it provides to detecting a species with LIF. The new design forgoes the multipass approach that increases laser fluence. Instead, the focus is on the increased fluorescence collection efficiency and decreased stray light factors. The new fluorescence detection cell uses a single laser pass that is carefully baffled to reduce stray light. The key features in the reduction of stray light are the placement of precision, laser-machined apertures; the use of high-grade black absorptive paint; and

wedged or angled anti-reflection-coated laser windows.

The small detection volume illuminated by the single laser pass allows higher numerical aperture optics to collect the fluorescence. An aspheric lens with NA = 0.66 is used to image the fluorescence on a large-area PMT. The use of the high NA aspheric lens and the placement of the PMT close to the illuminated volume are the key features for the high collection efficiency.

The overall performance of the cell is comparable to the performance of a White-type multipass cell that has 32 passes. The size of the new cell is half the size of a White cell with comparable sensitivity. All components are either off-the-shelf or standard products. No custom optics were used in this design. Most importantly, the cell is extremely simple to adjust or align, and once aligned, it is insensitive to thermal and mechanical distortions.

*This work was done by Thomas Hanisco and Maria Cazorla of Goddard Space Flight Center, and Andrew Swanson of the University of Maryland, Baltimore County. Further information is contained in a TSP (see page 1). GSC-16433-1*