ating element can be used to accelerate the spreading angle of the particle flow, as a result of turbulent mixing, for more complete particle coverage throughout the flow stream.

The concept provides the additional advantages of unlimited choice of solid particles, including somewhat sharp and abrasive particles; no need for an outside pressurized gas feed source; complete containment and enclosure of the flow environment; and the ability to be used in non-standard (temperature and pressure) environments and closed systems. Additionally, the rate of particle flux and the upper cut size of particles delivered to the flow can be controlled. The particles can also be released and distributed over a broad cross-section of the flow duct/pipe.

This work was done by Juan H. Agui of Glenn Research Center, and R. Vijayakumar of Aerfil. 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: Steven Fedor, Mail Stop 4–8, 21000 Brookpark Road, Cleveland, Ohio 44135. Refer to LEW-18837-1.

Analysis of the Effects of Streamwise Lift Distribution on Sonic Boom Signature

The objective is to find ways to reduce sonic booms.

Dryden Flight Research Center, Edwards, California

Investigation of sonic boom has been one of the major areas of study in aeronautics due to the benefits a low-boom aircraft has in both civilian and military applications. Current Federal Aviation Administration regulations prohibit supersonic flight over land due to potential effects the sonic boom may have on structures and humans.

This work conducts a numerical analysis of the effects of streamwise lift distribution on the shock coalescence characteristics. A simple wing-canard-stabilator body model is used in the numerical simulation. The streamwise lift distribution is varied by fixing the canard at a deflection angle while trimming the aircraft with the wing and the stabilator at the desired lift coefficient. The lift and the pitching moment coefficients are computed using the Missile DATCOM v. 707. The flow field around the wing-canard-stabilator body model is resolved using the OVERFLOW-2 flow solver. Overset/chimera grid topology is used to simplify the grid generation of various configurations representing different streamwise lift distributions. The numerical simulations are performed without viscosity unless it is required for numerical stability. All configurations are simulated at Mach 1.4, angle-of-attack of 1.50, lift coefficient of 0.05, and pitching moment coefficient of approximately 0. Four streamwise lift distribution configurations were tested.

The pressure signatures are measured at 1.6 body lengths below the aircraft on the symmetry plane of the aircraft. The results to note are the relative location and the strength of the shocks for different configurations. Correlating between the amount of positive lift generated by a lifting surface and the shock location, it is clear to see that shock of the lifting surface that generates more positive lift "arrives" at the measurement point in front of the shocks of lifting surface that generate less positive lift. This observation is valid for all three lifting surfaces. This is clearly evident when comparing the shocks of the wing and canard for different configurations. The observation is not as clear in the stabilator; however, it is still valid when examining a magnified view of the plot. This shows that lift can directly influence the local Mach angle of shocks. In addition, an observation can be made that the shock of the wing that generates more positive lift is stronger compared to shocks generated from wing with less positive lift.

From the above observation of relationships among the lift, shock strength, local Mach angle, and shock location, it can be reasoned that the shock coalescence can be mitigated if all shocks generated on the aircraft are of equal strength. The shocks of such configuration would propagate at a same angle, which would prevent shock coalescence. Therefore, instead of producing two strong sonic booms, it would produce multiple, weaker sonic booms.

This work was done by Paul Yoo of Dryden Flight Research Center. Further information is contained in a TSP (see page 1). DRC-009-025

Rad-Tolerant, Thermally Stable, High-Speed Fiber-Optic Network for Harsh Environments

Goddard Space Flight Center, Greenbelt, Maryland

Future NASA destinations will be challenging to get to, have extreme environmental conditions, and may present difficulty in retrieving a spacecraft or its data. Space Photonics is developing a radiation-tolerant (rad-tolerant), high-speed, multi-channel fiber-optic transceiver, associated reconfigurable intelligent node communications architecture, and supporting hardware for intravehicular and ground-based optical networking applications. Data rates approaching 3.2 Gbps per channel will be achieved.

The high-speed 3.2-Gbps components, coupled with their Intelligent Node architecture, or universally with other architectures, will allow for orders of magnitude increases in the levels of automated onboard science data processing. Pure hardware processing capabilities have been achieved with the flexibility of reprogrammability utilizing FPGA control chips in the Intelligent Node architecture. Rad-tolerant versions of the current FPGA being evaluated are available through Xylinx. Due to the high-speed designs and partnerships 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-purpose 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). (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 subsurface 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. 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