

and vibrations, thermoelectricity, and other energy scavenging techniques, when they are in shadow. Together this allows each Moball to have a low mass, enabling a large number of Moballs to be deployed by a single mission.

The effectiveness of sensor networks, as opposed to a single sophisticated sensor, is now well understood in a terrestrial setting. Mobile sensor networks are also gaining traction. There exist several proposals, for example, to exploit the accelerometers that exist in handheld cellphones to characterize earthquakes. Here it is the mobility of the cellphone users, the fact that they move about randomly and unpre-

dictably, and that they are in constant contact with base stations that allow this. One can think of GOWON as such a mobile sensor network, making a wide range of measurements distributed across the Martian terrain, and leveraging natural resources and facilities currently in place on Mars, such as existing satellite systems.

GOWON would be a system complementary to current Mars missions, making measurements over a much larger geographic expanse than current *in situ* experiments, providing ground-truth for orbiting experiments, and helping identify promising locations for future manned and unmanned missions.

*This work was done by Faranak Davoodi and Neil Murphy of Caltech for NASA's Jet Propulsion Laboratory. For more information, contact iaoffice@jpl.nasa.gov.*

*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:*

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## **In Situ Solid Particle Generator**

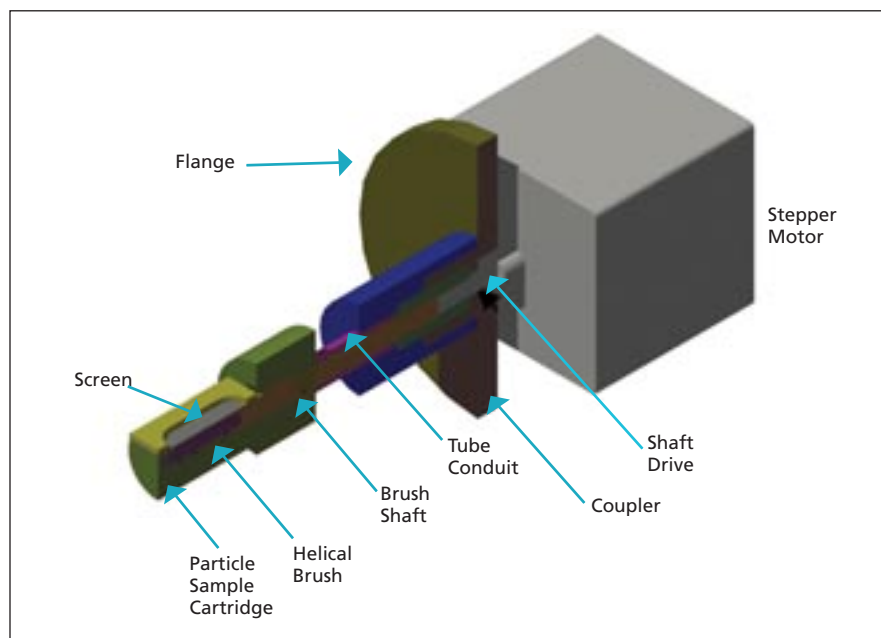
**This system enables filter testing, and fluid and gas dynamic research, in closed-system, non-standard, or extreme environments.**

*John H. Glenn Research Center, Cleveland, Ohio*

Particle seeding is a key diagnostic component of filter testing and flow imaging techniques. Typical particle generators rely on pressurized air or gas sources to propel the particles into the flow field. Other techniques involve liquid droplet atomizers. These conventional techniques have drawbacks that include challenging access to the flow field, flow and pressure disturbances to the investigated flow, and they are prohibitive in high-temperature, non-standard, extreme, and closed-system flow conditions and environments.

In this concept, the particles are supplied directly within a flow environment. A particle sample cartridge containing the particles is positioned somewhere inside the flow field. The particles are ejected into the flow by mechanical brush/wiper feeding and sieving that takes place within the cartridge chamber. Some aspects of this concept are based on established material handling techniques, but they have not been used previously in the current configuration, in combination with flow seeding concepts, and in the current operational mode. Unlike other particle generation methods, this concept has control over the particle size range ejected, breaks up agglomerates, and is gravity-independent. This makes this device useful for testing in microgravity environments.

Before any particles can be generated in the flow, the cartridge chamber is



The *In Situ Solid Particle Generator* supplies particles directly within a flow environment.

filled with the solid particles of choice. A programmable mechanical motor providing a range of rotational motion is used to drive a helical brush (or wiper) inside the chamber. Due to the action of the brush, the particles are dragged across the length of the internal chamber, particularly along the surface of the fine mesh screen, causing the particles to pass through the screen. The flow around the cylindrical body of the cartridge then entrains the ejected particles

into the flow stream. System components consist of: a motor, flange supports for mounting and sealing the internal chamber volume, a drive shaft and tube conduit, a particle sample cartridge, a helical wire brush or wiper, a fine mesh screen, and screws (see figure). An optional aerodynamic leading edge can be used to streamline or stabilize the flow around the cartridge body, and to decrease flow effects as the particles are entrained in the flow. Alternately, a turbulence gener-

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; com-

plete 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.*

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## 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. Over-set/chimera grid topology is used to simplify the grid generation of various config-

urations 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*

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## 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 sup-

porting 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 Xilinx. Due to the high-speed designs and partnerships