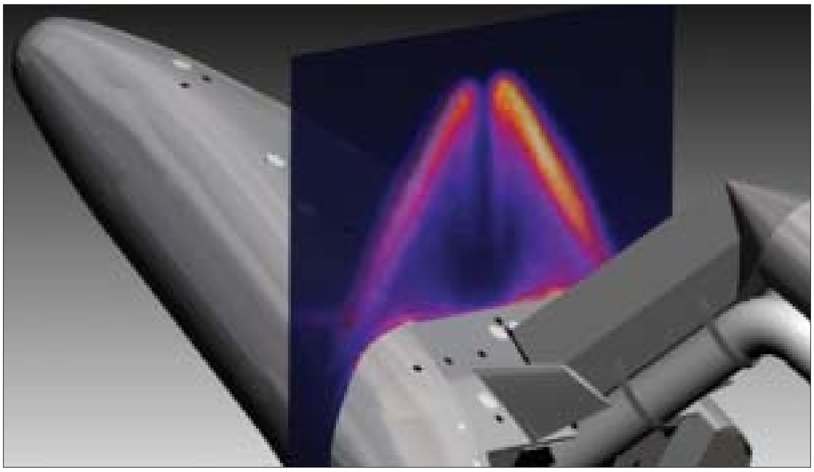
Aerodynamic measurement technology

Researchers at NASA Langley applied laser-induced thermal acoustics velocimetry and thermometry to the center's supersonic Unitary Plan Wind Tunnel. In collaboration with Swales Aerospace, the researchers enhanced Langley's Virtual Diagnostics data visualization environment with a new software tool called LiveView3D. This tool provides interactive real-time integration of theory, data, and streaming video images as experiments occur. The technology is being transferred to the Air Force Research Laboratory at Wright-Patterson AFB and the Arnold Engineering Development Center. Langley researchers also performed the first demonstration of planar laser-induced fluorescence (PLIF) of nitric oxide for flow visualization and velocimetry in Langley's 31-in. Mach-10 wind tunnel.

PLIF imaging of NO-seeded wake flow from an X-33 model (with wings removed) was conducted in Langley's 31-in. Mach-10 wind tunnel.



MetroLaser developed a laser-induced incandescence (LII) technique to provide real-time, spatially resolved soot mass concentrations and primary particle sizes in an aircraft engine exhaust. A laser pulse heats the soot particles to high temperatures, producing an incandescing line along a laser beam passing through an exhaust plume. An imaging system collects light from the incandescing line and images it onto a detector. The intensity of incandescence is nearly proportional to soot volume fraction. The decay rate of the time-dependent LII signal from soot particles is used to determine the primary particle size. This technology was used to characterize the soot emissions from a fighter engine during a 45-min "mission" in a test cell and from a DC-8 aircraft in a tie-down test.

A collaborative effort between two universities, Iowa State and Michigan State, produced a novel molecule-based flow diagnostic technique called molecular tagging velocimetry and thermometry (MTV&T) to achieve simultaneous measurements of flow velocity and temperature distributions in liquids. In the MTV&T technique, pulsed laser beams are used to tag phosphorescent tracer molecules premixed in the working flow. The tracer molecules will give off long-lifetime phosphorescence emission, serving as glowing marks for the flow measurements. The movements of the glowing molecules are imaged at two successive times after the same laser pulse. The measured Lagrangian displacements of the tagged molecules between the two interrogations provide the estimates of fluid flow velocity vectors. Simultaneous fluid temperature measurement is achieved by taking advantage of the temperature dependence of phosphorescence lifetime, which is estimated from the phosphorescence intensity ratio of the two interrogations.

Michigan Aerospace, in collaboration with Clemson University, developed and fabricated a passive Fabry-Perot-based instrument for the detection of thermospheric winds. The Miniaturized Nightglow Interferometer for Monitoring Emissions (MiniME) uses fringe imaging of the 630.3-nm emissions from thermospheric atomic oxygen to detect thermospheric winds through measurement of the Doppler shift of the collected emissions relative to a calibrated source.

Compact, portable, and rugged, MiniME represents a significant breakthrough in the development of deployable, stand-alone Fabry-Perot-based instruments. With field testing of the prototype instrument under way, the possibility of deploying a network of MiniME-type instruments could greatly expand the availability of data regarding thermospheric winds and the auroral phenomena that drive them, providing greater understanding of atmospheric and auroral interaction and helping to improve the reliability of satellite-based communications, which can be greatly affected by auroral disturbances.

The University of Florida, in collaboration with Sandia National Laboratories, developed a MEMS-based piezoelectric microphone for aeroacoustic measurement applications. The microphone consists of a circular silicon diaphragm on whose outer edge a thin annular ring of piezoelectric material has been deposited. The microphone was designed by combining a linear piezoelectric composite plate model with a lumped-element, electroacoustic model. Experimental characterization indicates a sensitivity of 0.75 µV/Pa, a dynamic range of 47.8-169 dB (Re 20 µPa), and a resonant frequency of 50.8 kHz.

by **Mark Sheplak**