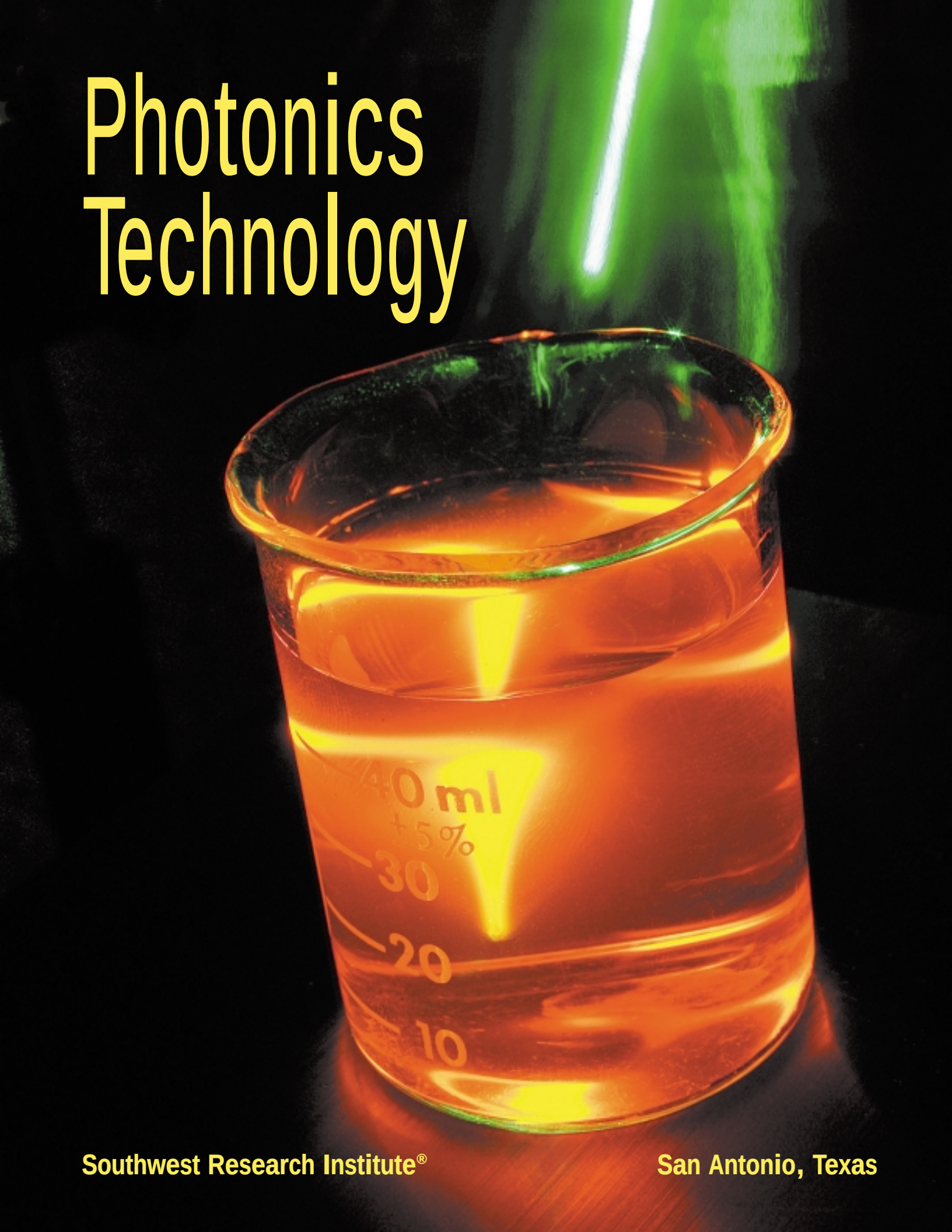
Photonics Technology



Southwest Research Institute®

San Antonio, Texas

SOUTHWEST RESEARCH INSTITUTE®

Founded in 1947 as an independent, nonprofit research and development organization, Southwest Research Institute provides a significant research, engineering, and testing resource for industry, business, and government. The Institute uses a multidisciplinary, integrated approach to solving complex problems in science and applied technology.

About the Cover: *Laser-induced fluorescence is used to evaluate the concentration of a compound in a solution.*

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Committed to Diversity in the Workplace

At Southwest Research Institute (SwRI®), multidisciplinary teams of scientists and engineers work with industry and government to develop and bring to market advanced optical sensing and coating technologies.

For more than a quarter of a century, SwRI has developed methods to create and improve optical-imaging techniques and sensors for use in a range of industrial and security applications. As part of a long-held tradition, patent rights arising from sponsored research at the Institute are often assigned to the client. SwRI generally retains the rights to Institute-funded advancements.

The Institute applies advanced engineering and computational capabilities and state-of-the-art laboratories to develop specific photonic systems and techniques including:

- Materials and coatings
- Optical imaging and machine vision
- Spectroscopy
- Light delivery systems
- Ultraviolet and infrared sensing

SwRI scientists use ion beams and plasmas to treat material surfaces to add functionalities such as sensing, actuation, and hydrophobicity. Institute engineers design, fabricate, coat, and evaluate a variety of thin-film and custom optics, including:

- Ultraviolet, visible, and infrared antireflection coatings
- Enhanced high reflectors
- Interference filters
- Durable and corrosion-resistant coatings
- Electromagnetic interference coatings
- Patterned and structured coatings


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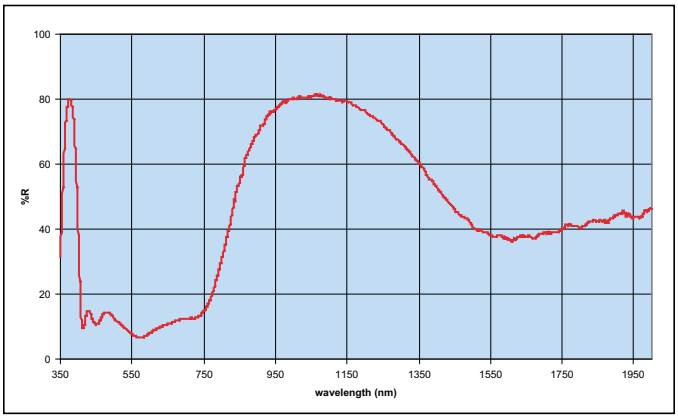
SwRI-developed coatings include pellicle beam-splitters, high-power laser coatings, precision custom dichroics and filters, and scratch- and contamination-resistant optics.



Sample metrology such as this near infrared reflectance scan provides quantitative feedback for coating optimization.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Engineers deposit optical coatings using a state-of-the art cryopumped chamber housed in a dedicated Class 1000 clean room.

Deposition processes at SwRI include electron beam evaporation, resistance source, ion-assisted, magnetron sputtering, co-evaporation, and reactive processes. Scientists apply coatings to a variety of substrates such as glass, plastic, and metal.

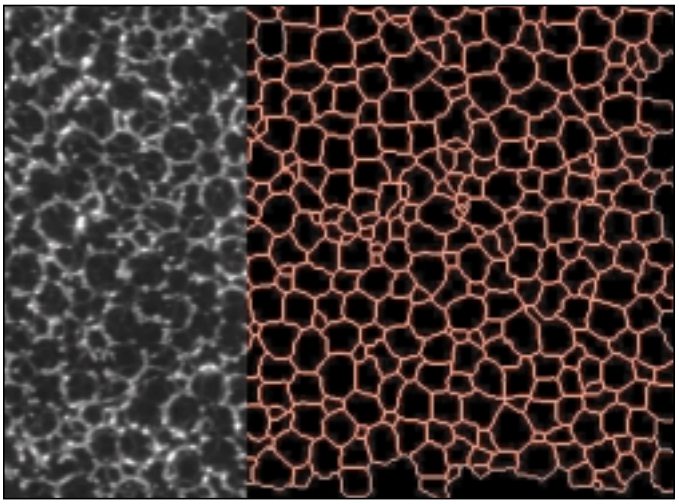
The Institute offers a state-of-the-art, thin-film design program that allows the modeling of innovative coatings, transitioning from design to practice with extreme accuracy.

Optical Imaging

Institute engineers have developed innovative optical imaging systems and instruments for a variety of applications including:

- Precision measurements
- Surface inspection
- Defect detection
- Spectroscopic analysis
- Biological activity evaluation

SwRI has several laboratories dedicated to investigation and development work in visible, ultraviolet, and infrared spectral bands.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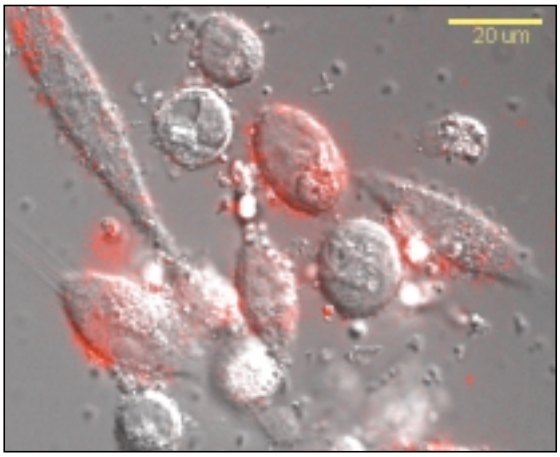
Using sophisticated optical imaging techniques, SwRI scientists measure the pore dimensions within foam materials.



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Live cell fluorescence imaging monitors the cellular internalization of nanoparticles (red quantum dots). Scientists use this technology to study live cell molecular activity.

Machine Vision

Optical imaging provides a noncontact method for inspecting and measuring manufactured items and processes. SwRI uses monochrome and color imaging to provide a variety of services including:

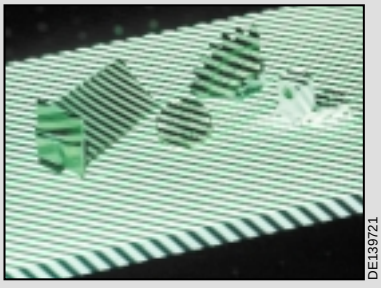
- Manufactured part inspection and process control
- Object identification
- Dimensional measurement
- Surface defect (such as pits and scratches) detection

High-speed imaging is also used to analyze errors and failures in processes and machine operation.

DSL 3D Imaging System designated one of top 100 technical innovations of 2004 by *R&D Magazine*

SwRI developed a unique system for three-dimensional measurement based on analysis of a rotating pattern of light projected over a surface to be measured. This scalable technique can accurately measure small surfaces as well as detect deformations on components as large as aircraft flaps. Applications for the DSL 3D (patent pending) measurement technique include:

- Generating object descriptions for object reproduction (reverse engineering)
- Measuring defects in aircraft surfaces
- Determining extent of impact damage
- Generating three-dimensional descriptions of scenes for virtual reality systems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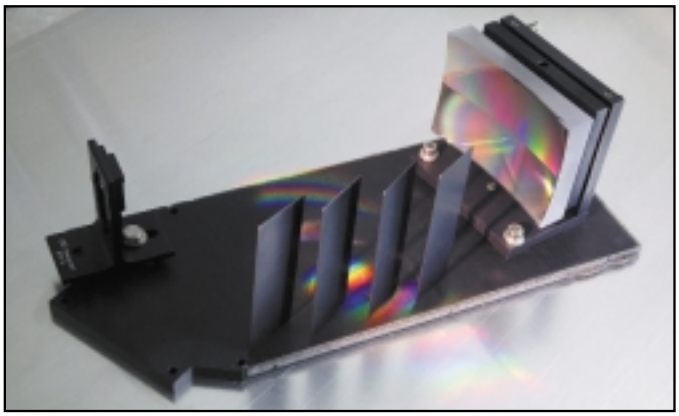
The Institute has spectral measurement capabilities ranging from ultraviolet to long-wave infrared. Instrumentation includes spectrometers, spectrum analyzers, and Fourier transform Infrared (FTIR) spectroscopy. SwRI has used these spectroscopic measurements for applications including:

- Determination of emission spectra of various sources, including lasers, fluorescent light bulbs, and light-emitting diodes (LEDs)
- Absorption and transmission measurements of coatings and materials
- Color measurements of dyes and inks for identification and process control
- Longwave infrared, hyperspectral imaging to identify nerve agents (simulants)

Raman Spectroscopy

Raman spectroscopy is an important technique for analyzing the structure and composition of matter, with important advantages in sensitivity over other spectral-analysis methods. SwRI has developed systems for Raman-based applications that include:

- Chemical measurements in geological specimens for application to planetary landers
- Imaging of cellular metabolic processes for drug development and evaluation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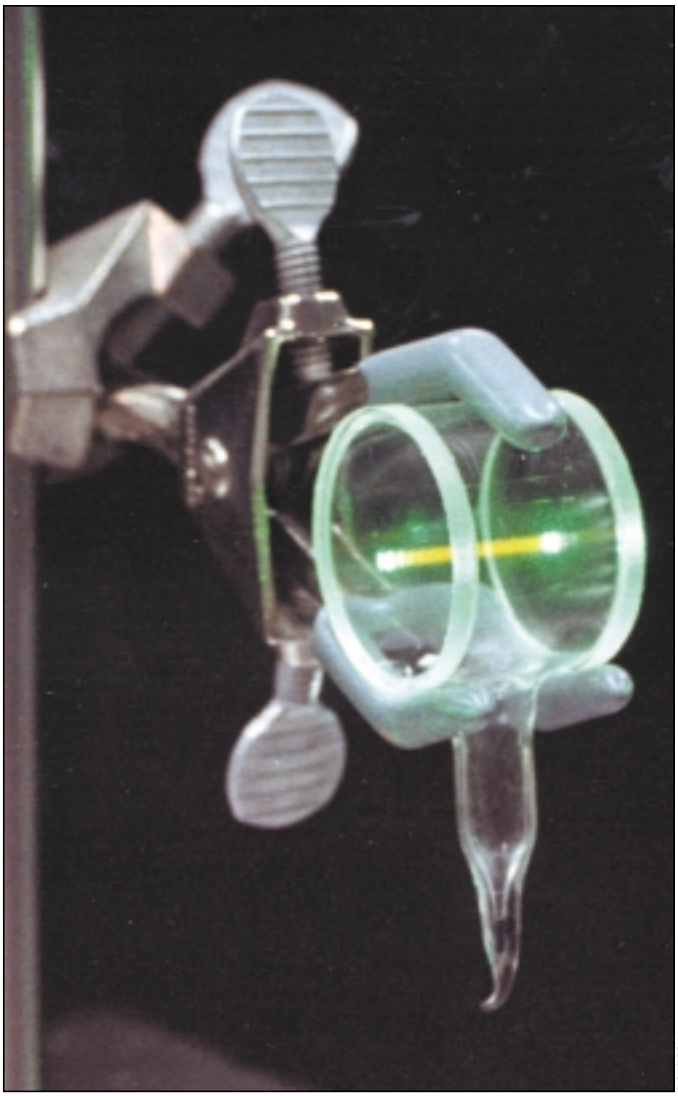
SwRI engineers developed this compact, lightweight Raman spectrometer prototype for use on planetary landers to study rock and soil composition.

Laser-Induced Fluorescence

Laser-induced fluorescence can be used to:

- Detect foreign material in food products
- Inspect polymer degradation
- Photo-characterize abnormal tissue
- Measure jet fuel degradation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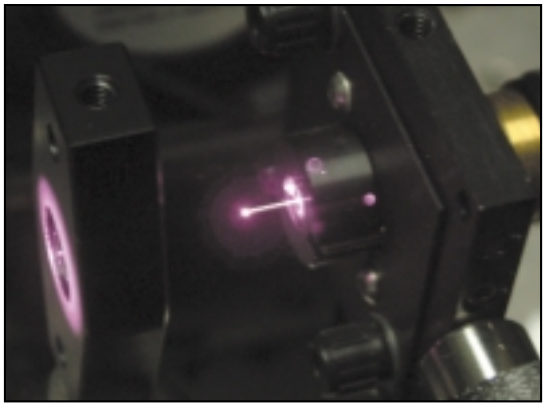
Scientists use laser-induced fluorescence from an iodine vapor cell as a reference spectrum for tunable-laser experiments.

Light-Delivery Systems

SwRI has extensive experience in developing optical systems for light-delivery applications. These systems vary from breadboard-mounted optics to complete, custom-machined optical systems. Institute engineers are experienced in the use of software-based optical design packages for system analysis and modeling. Recent work includes:

- Design and fabrication of broadly tunable diode lasers
- Research into high-power fiber optics
- Development of custom camera optics including telescopes, boroscopes, and ultra-compact lens systems
- Design of ultra-fast systems to generate terahertz radiation
- Development of ultraviolet (UV) holography for high-precision, nanometer-scale photolithography
- Fabrication of long-range light delivery and high-sensitivity collection systems with tracking and scanning capabilities
- Development of custom optical-system assemblies for field deployment



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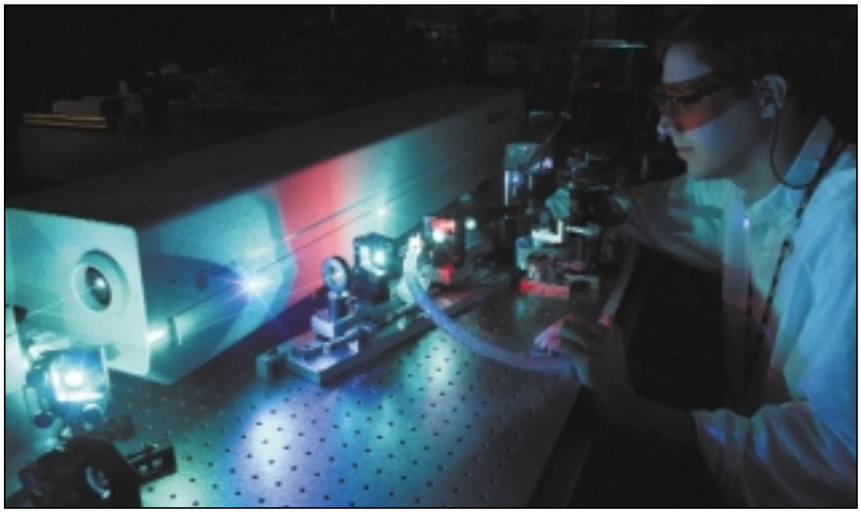
SwRI scientists use lasers for a variety of projects, including studying the effects of high power on optical fibers.



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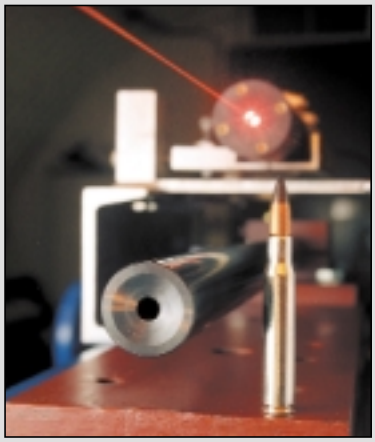
A terahertz imaging and spectroscopy station was developed for imaging and nondestructive inspection applications.



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Optical and Fiber Optic Instrumentation

SwRI offers sophisticated optical and fiber optic instrumentation, including:

- Lasers from ultraviolet to mid-infrared (IR) including gas, dye, solid-state, and diode-based systems
- High-power systems using Ar-ion, diode, excimer, pulsed Nd:YAG, and ruby lasers with energies up to 10 joules
- Fiber-optic components and systems including optical time domain reflectometry measurements, splicing, and connectorization
- Meters and spectrometers for sensing from the UV through mid-IR spectra
- Very compact optical systems using millimeter-scale optical components

Imaging outside the visible spectrum can reveal properties of an object or an environment that cannot be determined by other means. Many SwRI-developed and fabricated optical systems use techniques that employ sensing beyond the visible spectrum, including ultraviolet, infrared, and thermal sensing.

Ultraviolet Sensing

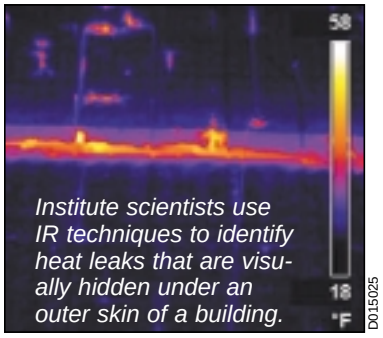
Ultraviolet sensing detects high-energy events such as high-temperature flames and electrical corona. Using radiometrically calibrated cameras and other UV instrumentation, SwRI engineers have conducted programs involving:

- Solar-blind imaging of tactical missiles
- Corona measurements on high-voltage power lines
- Biologically induced corrosion effects
- UV spectroscopy of planetary and cometary atmospheres

Infrared and Thermal Sensing

The infrared band of the spectrum is used in thermography, intrusion detection, machine diagnostics, and inspection. The near-IR band is useful in infrared spectroscopy to identify specific materials, coatings, and gases. Long-wave (thermal) IR images are used to measure thermal emissions for the detection of animals, concealed objects, and "hot spots" that indicate a failing bearing or problematic electrical connection. SwRI internally funded research projects have included:

- Liquid-level sensing
- Animal tracking
- Heating in nonceramic power-line insulators
- Materials and systems characterization
- Intrusion detection



Institute scientists use IR techniques to identify heat leaks that are visually hidden under an outer skin of a building.

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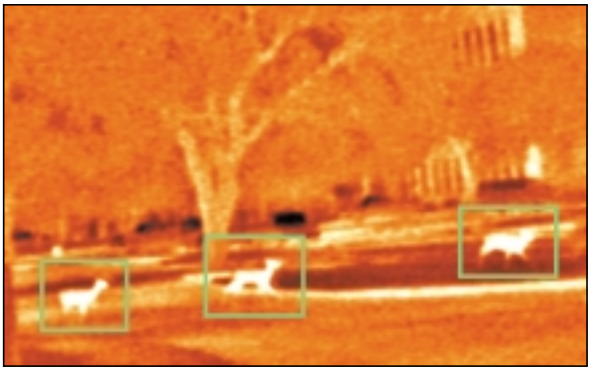
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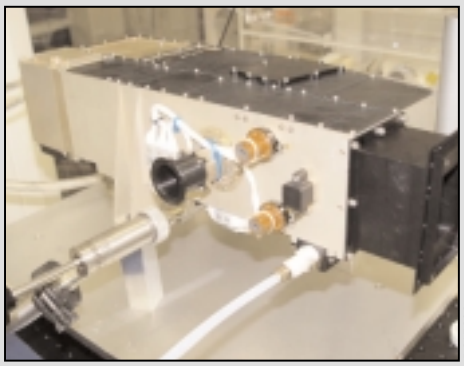
Thermal imaging allows detection and tracking of humans or animals at night or in other unfavorable environments.

Ultraviolet Cameras for Space Environment

SwRI has the unique capability of performing radiometric characterization and absolute calibration of ultraviolet-sensitive imaging instruments and spectrographs throughout the vacuum ultraviolet (VUV). This capability extends into the mid- to near-ultraviolet range of 300 to 3,000 angstroms (Å). Additional capabilities include optical reflectivity and bidirectional reflectivity distribution function measurements of optical surfaces (including multilayer optical coatings), and photocathode quantum efficiency measurements in the VUV.

The SwRI Ultraviolet Calibration Laboratory includes a Class 1000 clean room for bench radiometric and functional testing and a high-vacuum chamber facility with a built-in high-intensity windowless ultraviolet light source, a vacuum monochromator, and a 4-inch diameter optical collimator that can deliver highly collimated, monochromatic light to the test instrument.


D015020

SwRI engineers developed this New Horizons Alice spectrograph for ultraviolet imaging of Pluto and Charon.

Southwest Research Institute is an independent, nonprofit, applied engineering and physical sciences research and development organization using multidisciplinary approaches to problem solving. The Institute occupies 1,200 acres and provides nearly two million square feet of laboratories, test facilities, workshops, and offices for more than 3,000 employees who perform contract work for industry and government clients.

We welcome your inquiries.
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