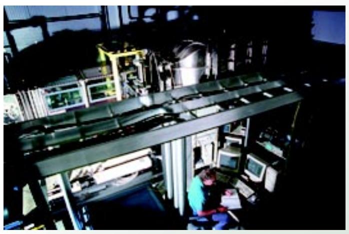
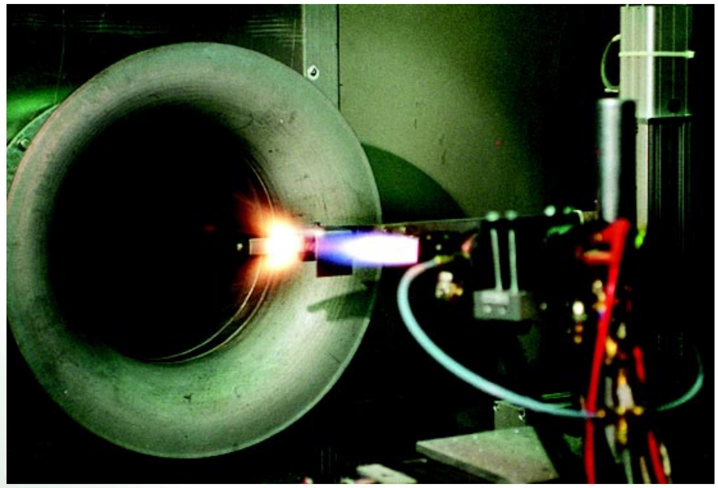
Physics

INEEL's Matched-Index-of-Refraction facility is one of the largest experimental fluid flow research user facilities in the world.



The Physics group conducts basic and applied research to develop measurement systems, often with emphasis on hardened, noncontact sensors for field measurements, industrial process control, or in situ use. Staff members are active in plasma physics for materials processing and have extensive simulation capabilities. Specific disciplines include optical spectroscopy, nonlinear optics, nondestructive examination with acoustic and electromagnetic techniques, and fluid dynamics.

The group supports the Department of Energy's missions in science, environmental quality, national security, and energy efficiency, as well as industry customers worldwide. The range of applications being developed is broad, including environmentally friendly hydrocarbon processing, rapid munitions identification systems, field instrumentation for environmental monitoring, and nanotechnology materials processing. Much of the work is research and development, but the organizational experience in rugged, field-deployable instruments and nondestructive evaluation is also used to support INEEL's waste management operations and nuclear programs at the Idaho National Engineering and Environmental Laboratory. Additionally, the group has built and manages the INEEL's Matched Index-of-Refraction Facility. The basic areas of expertise are described as follows.



This photo shows a metal coupon being sprayed with a corrosion resistant metal coating. The coating is sprayed on in layers to achieve whatever thickness the application requires.

Thermal Processing

Through our plasma diagnostics and modeling capability, the INEEL is a world leader in plasma jet technology as applied to thermal processing. The high temperatures and rapid cooling at the exit of a plasma jet allow control of the thermal history of particles injected into the jet, providing unique materials processing opportunities. Our work in fundamental science includes the study of nanophase particles such as carbon nanotubes, which are of special interest for their potential use as electronic components at the molecular scale. Examples of applied research include development of corrosion and wear coatings and functionally-graded coatings, such as ceramic-to-metallic coatings for use as thermal barriers on combustion engine components.

Nondestructive Examination

Our scientists are developing nondestructive examination (NDE) technology, focusing on extending conventional eddy current and ultrasonic diagnostic techniques to new applications tailored to specific customer needs. Examples of this applied research include development of improved acoustic methods for locating and evaluating methane hydrate deposits in the ocean, air-coupled ultrasonics for rapid, noncontact inspection, new ultrasonic array technology for steam generator tube inspection in coal-fired boilers, and NDE for nuclear plant inspection.

Nonlinear Optics

Researchers are using optics to develop a wide range of noncontact measurement technologies including optical interferometry which is being used in material and structural

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Continued from front

analysis. The INEEL has developed a unique ultrasonic camera, a technology that provides a video display of surface acoustic motion—effectively replacing time-consuming point-by-point measurement approaches. The camera has broad industrial applications for real-time quality analysis in manufacturing processes, as well as the development of miniaturized components such as acoustic wave devices for the communications industry. Other work includes development of a portable Moire interferometry system to measure the long-term deformation of structures such as bridges and buildings, or even deformation of nuclear reactor core components.

Physics

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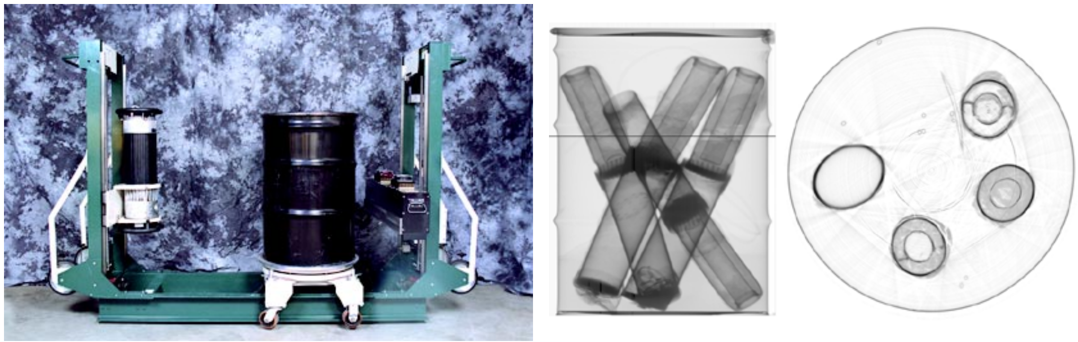


Portable X-ray imaging systems developed at the INEEL utilize compact X-ray generators and linear diode array detectors to collect digital radiographic (DR) and computed tomographic (CT) images. The X-ray generator (the cylinder on the left tower in the photograph) and detector (on the right tower) move vertically past the stationary drum to collect a digital radiograph (the image on the right). To collect a tomographic slice, projection data are collected as the object is rotated and the slice images are reconstructed in a software step. In the image, the horizontal lines through the drum radiograph represent the region at which CT data were collected.

Additionally, in 2002, R&D Magazine recognized the Micro Laser Ultrasonic Bond Detection System as one of the year's top technological innovations with an R&D 100 Award.

X-ray Imaging

Researchers are developing portable digital imaging technologies such as digital radiography and computed tomography instruments for custom applications. The team focuses on highly accurate field-deployable systems. This directly supports the INEEL in hazardous and radioactive waste assessments, and the team has also developed rapid analysis systems for old munitions in storage or those found in excavation. An additional element of this group's work is the use of expert system software for automated data analysis and data validation for nondestructive nuclear assay.

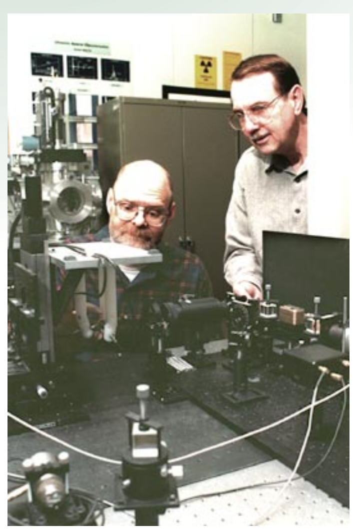
Laser-based Spectroscopy

Researchers are developing real-time noncontact spectroscopic techniques and field instruments to monitor industrial chemical processing, environmental parameters, and other applications. Research incorporates new solid state optical technologies, such as wavelength-modulated diode lasers, into rugged, reliable systems. INEEL staff members are also active in research with ultrafast (picosecond) optical pulses as a means to provide spatial and temporal resolution for chemical analysis. These techniques have applicability to surface science.

Matched Index-of-Refraction User Facility

INEEL developed and built one of the world's largest matched index-of-refraction facilities to study complex turbulent flow, two-phase particulate flows and flows in porous media by optical measuring techniques. The flow visualization facility, located at the INEEL Research Center, is a user facility for fundamental and applied fluid flow research. INEEL scientists and engineers have supported DOE programs in advanced reactor systems and safety issues dealing with spent nuclear fuel as well as university and industry research projects.

The Physics organization actively seeks partnership opportunities with university and industry groups worldwide. Researchers can support basic and applied research including commercial instrument and system development.



The INEEL Laser Ultrasonic Camera directly images (without the need for scanning) the surface distribution of subnanometer ultrasonic motion at frequencies from Hz to GHz.