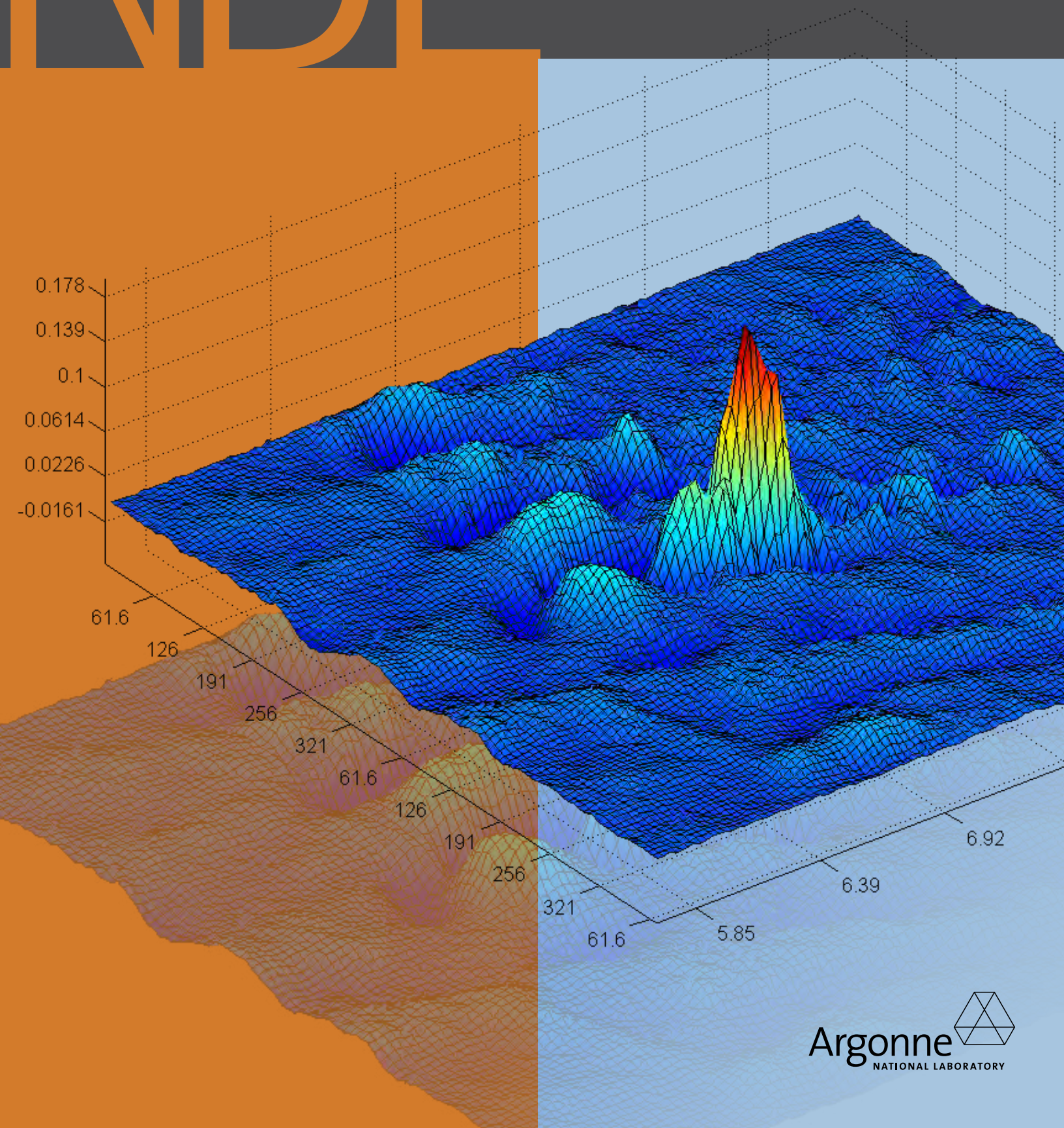
NDE

Argonne National Laboratory's

Nondestructive Evaluation Technologies



Argonne NATIONAL LABORATORY

Over 45 years experience in Nondestructive Evaluation . . .

Argonne National Laboratory's world-renowned researchers have a proven and extensive track record of success in nondestructive testing and evaluation (NDT/NDE) of critical components for nuclear and fossil power plants, automotive and military equipment, and aerospace industry.

. . . enables the safe operation of advanced nuclear reactors.

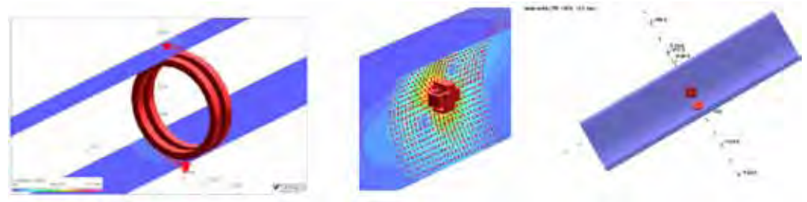
Argonne's diverse NDE expertise, coupled with the laboratory's state-of-the-art equipment and facilities – including several national user facilities – uniquely positions the laboratory to develop enabling NDE technologies for safe operation of the new generation of advanced nuclear reactors.

Argonne's World-Class Nondestructive Evaluation Technologies

Argonne scientists and engineers work closely with leading private institutions worldwide and other government laboratories to develop new techniques and assess the reliability of conventional and emerging nondestructive technologies and methods to detect defects in metals, ceramics, alloys and advanced composite materials. A wide range of Argonne-developed technologies, including electromagnetic and acoustic methods, is used for in-service inspection of nuclear power plant components, such as tubing, piping and pressure vessels.

Argonne's expertise in analytical and numerical modeling of thermal, acoustic and electromagnetic interaction with complex media as well as advanced signal processing and data analysis capabilities is used extensively.

Argonne's NDE team was one of only seven in the United States selected by NASA to evaluate the reliability of NDE technologies following the Columbia space shuttle accident. Argonne was the only team involved with both theoretical and experimental aspects of NDE methods including thermal imaging, non-contact ultrasonic techniques, X-ray computed tomography, and eddy current testing.



▲ Numerical simulations are performed to better understand the complex nature of electromagnetic field interaction with various forms of degradation in steam generator tubes.

◀ The Argonne/Nuclear Regulatory Commission NDE test facility, part of the International Steam Generator Tube Integrity program.

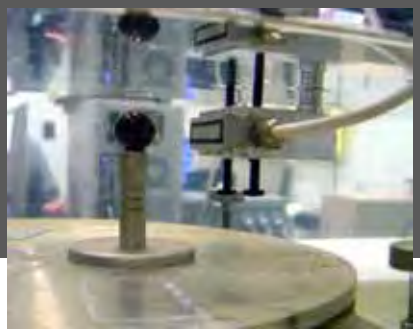
High resolution eddy current array probe technology for high-speed inspection of steam generator tubing. ▶

High-power X-ray (digital radiography and computed tomography) facilities. ▼

Argonne Facilities and Expertise

- Argonne's national user facilities, such as the Advanced Photon Source and Electron Microscopy Center, are available for NDE of advanced ceramics, composites, and metal alloys.
- For optically translucent engineering materials – including such structural ceramics as Si3N4, SiC and Al2O3 – optical coherence tomography detects near-surface defects. Confocal microscopy and polarized laser scattering detect subsurface flaws in ceramic components.
- The Argonne/Nuclear Regulatory Commission (NRC) steam generator NDE test facility serves as a test bed for NRC to independently evaluate the reliability of existing and emerging in-service inspection techniques used for field inspections. The facility has state-of-the-art NDE equipment and glove boxes instrumented for examination of components pulled from retired steam generators.
- Ultrasonic techniques including air-coupled, phased array and electromagnetic acoustic transducers are used extensively for component inspection.
- Pulsed thermal imaging techniques probe internal material properties and structure and detect surface and subsurface defects. Pulsed thermal imaging systems can determine thermal property distribution in three dimensions, detect defects and determine sizing.
- The under sodium viewing test facility designs and tests ultrasonic/acoustic NDE systems for in-service inspection of liquid metal fast reactors.
- Electromagnetic testing methods are used to inspect conductor and semiconductor materials. Eddy current testing in its various forms (employing impedance, T-R, array and remote field probes) is employed for inspecting metallic components.
- As a pioneer in microwave sensor technology, Argonne's scientists have developed active and passive microwave/millimeter-wave sensing techniques for NDE of dielectric composite materials, including ceramics used in high-temperature applications.
- Advanced X-ray computed tomography techniques have been developed for high-resolution volumetric imaging of engineering materials.
- Software-based tools have been developed for reliable, automated analysis of NDE data.

▼ Probe for Phased Array Ultrasonic Testing.



▲ Pulsed thermal imaging.

NDE Capabilities

Optical techniques

- Optical coherence tomography
- Elastic optical backscatter
- Polarized laser backscatter
- Confocal microscopy

X-ray radiography

- Digital radiography
- Computed tomography

Ultrasonic techniques

- Phased array ultrasound
- Air-coupled ultrasonic testing
- Electromagnetic acoustic transducer
- Various conventional ultrasonic testing methods

Thermal imaging techniques

- Pulsed thermal imaging
- Vibrothermography

Electromagnetic (EM) induction and radio frequency (RF) techniques

- Eddy current testing including impedance, pulsed, transmit-receive array and remote field inspection techniques
- Microwave/millimeter-wave imaging (RF to terahertz)

▲ Argonne's Ultrasonic Under Sodium Viewing Test Facility for liquid metal fast reactors can sustain high temperature and reactivity with most metals, providing nondestructive, real-time and in situ ranging and imaging.

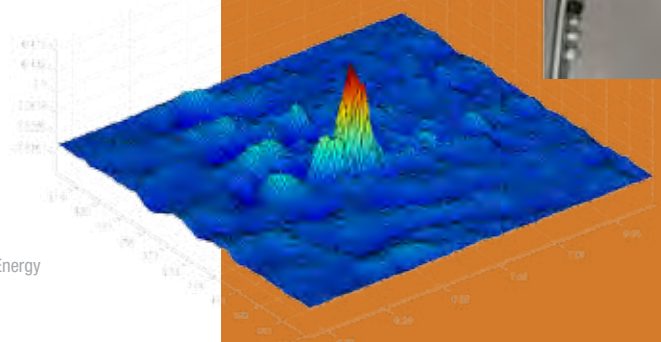
Seventy years of leadership in nuclear science and technology

Argonne developed and/or built experiments, research reactors or prototypes of nearly every kind of commercial nuclear reactor in the world today, as well as many research and training reactors. An overview of this history can be found at

www.ne.anl.gov/About/ANL-Reactors.shtml

On the cover

The C-scan plot shown on the front cover was taken by a rotating eddy current probe from a steam generator U-bend tube sample, with typical samples shown in the image to the right.



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