

## inside

### Laboratory Frontiers

NIST Advanced  
Measurement Laboratory

### Challenges on the Frontier

Temperature control

### Buildings for Advanced Technology Workshop

HDR recently co-sponsored a  
three-day workshop

### News Items

Nanotech is BIG at NIST

### What is the Nano Frontier?

In our continuing effort to share knowledge, we have created the Nano Frontier, a quick-hitting informational newsletter that you'll receive quarterly.

HDR is an award-winning and nationally recognized architecture, engineering, planning, and consulting firm and a leader in the growing field of research labs for nanotechnology. Established in 1917, the company employs more than 3,000 professionals throughout the U.S. and abroad.

## Amazing Journeys

### Begin with one small step

**W**ith more than \$750 million in federal funding for the National Nanotechnology Initiative and significant additional state and private funding, many new world-class research facilities are coming on line for research at the nanoscale. By its very nature, nanotechnology is interdisciplinary and often merges microelectronics, biotechnology, information technology, materials science and metrology.

Likewise, facilities for conducting nano research often promote collaboration among scientists drawn from various disciplines within the university research environments, the national laboratories and the private industry. HDR's expertise in each of these realms enables us to bring together the best practices of each environment and design a laboratory that acknowledges the diverse cultures of each.

HDR is the world leader in designing nanotechnology research facilities. HDR's labs have supported researchers working in areas such as:

- Quantum computing
- Nanobioengineering
- Photonics/optics
- Materials science
- Metrology
- Advanced microscopy
- Nano manipulation
- MEMS
- Device characterization
- Semiconductors

Work at the nanoscale requires unprecedented levels of precision and measurement capability. The U.S. National Institute of Standards and Technology (NIST) is fast approaching the opening of its new Advanced Measurement Laboratory (AML) in Gaithersburg, MD. The NIST AML will house some of the world's most environmentally stable laboratories and will push the conventional limits of measurement technology.

# Laboratory Frontiers

## National Institute of Standards and Technology Advanced Measurement Laboratory

Since 1901, the National Institute of Standards and Technology (NIST) has played a pivotal role in ensuring the integrity of our nation's measurement and standards system. NIST carries out this mission through a portfolio of four major programs: Measurements and Standards Laboratories, Advanced Technology Program, Manufacturing Extension Partnership and the Baldrige National Quality Award.

To continue to provide the unparalleled research that defines NIST requires world-class laboratories. The lack of high-quality laboratories hindered its ability to conduct research, which required precision and exacting measurements in vibration isolation, temperature and humidity control, air cleanliness and electrical power quality. The Advanced Measurement Laboratory (AML), perhaps the most technologically advanced building in the world, will provide NIST the environment it needs to continue to effectively respond to the industry's need for sophisticated standards and measurements.

HDR's team of architects, engineers, and consultants provided full A/E services, including project management, design and construction administration for the \$235-million AML in Gaithersburg, Maryland. When completed in 2004, it will provide research space available nowhere else in the world. No existing laboratory has successfully combined the features of close temperature control, vibration isolation, air cleanliness and power quality into a facility of this magnitude... until now.

*"We've employed multiple layers of vibration isolation as well as special active and passive devices and methods... to achieve a vibration velocity amplitude of less than one micrometer per second at frequencies greater than 4 Hz."*

*— Ahmad Soueid, HDR Principal*

To achieve the exacting conditions necessary for research success, the 511,070-SF AML consists of five building wings, each with one occupiable scientific level:

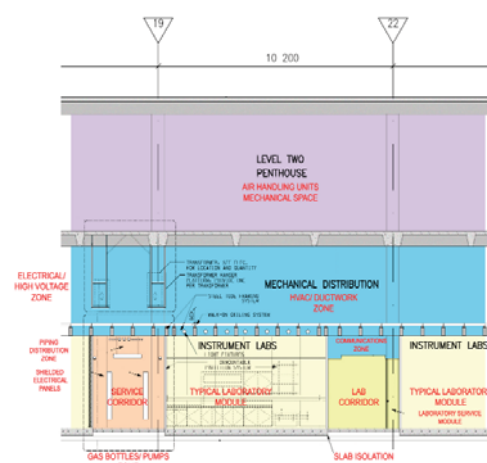
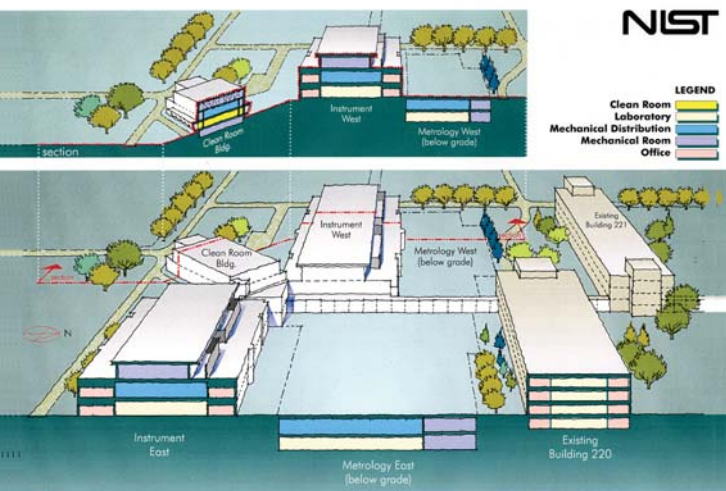
- Two metrology wings, below grade
- Two instrumentation wings, above grade
- Cleanroom wing, above grade

The lab facilities will be used to conduct advanced nanoscale research in areas such as:

- Semiconductor electronics
- Manufacturing engineering
- Atomic scale physics
- Computer science
- Advanced materials science
- Metrology

Since temperature fluctuations can disturb the results of very sensitive measurements, critical design factors include spaces requiring a baseline temperature control to within +/- 0.25 degree Celsius. In the 48 precision temperature control laboratories in metrology sections, the temperature will be within +/- 0.1 and +/- 0.01 degree Celsius. Bay and Chase cleanrooms are class 100, upgradeable to class 10. Humidity control will provide variations of no more than 1 percent in specialized areas and 5 percent throughout the rest of the facility.

Additional critical design factors include vibration levels as low as 100 micro-inch per second and cleanroom classifications from 10 to 10,000. Laboratories will be located on grade, the best possible location with respect to vibration. Where more stringent vibration controls are necessary, special air spring isolation slabs will be constructed. "We've employed special active and passive isolation devices and methods, including computer-controlled slabs and placement of the most sensitive areas about 40 feet below ground level to



achieve a vibration velocity amplitude of three micrometers per second or less,” said Ahmad Soueid, HDR Principal.

In addition to providing state-of-the-art research environments, the design incorporates five major lab planning concepts:

- Modular lab dimensions
- Hierarchical zoning
- Separation of service galleys from staff/public circulation corridors
- Interstitial service zone
- Provisions for future service and space upgrades

The laboratory organization is not highly segregated and provides for the flexibility to conduct research in more than one lab; it is also designed to encourage a collaborative research environment. To maximize flexibility and cleanliness, mechanical services, as well as “dirty” lab support equipment and gas bottles, will be located in service galleys between laboratory modules.

As part of the sustainable design solutions, natural daylighting, energy conservation and recycling are incorporated into the building design and planned operation.

## Challenges on the Frontier

Minimizing temperature fluctuations has long been an elusive goal for metrology laboratories. For instance, since temperature fluctuations can disturb the results of sensitive measurements, high accuracy AML laboratories require miniscule variation in temperature, including  $\pm 0.10$  and  $\pm 0.01$  degree Celsius temperature control. “When we started design, there were no controllers available that could support the goal of  $\pm 0.01$  degree,” said Ted Zsirai, HDR’s lead mechanical engineer for the project. To solve this challenge, a full-sized facility was constructed to test the new controllers, which ultimately delivered control of up to  $\pm 0.004$  degree.



## In the News

### Nanotech is BIG at NIST

With an acute understanding of the impact nanotechnology will have on the world, researchers at the National Institute of Standards and Technology (NIST), are paving the future of nanotechnology. As they develop and ensure the integrity of measurements, perform cutting-edge nanotechnology research and provide funding for nanotechnology research, NIST is leading the research effort in this ever-evolving industry.

Working in seven major laboratories, NIST scientists are developing measurements, standards and data crucial to private industry’s development of products for the nanotechnology industry. Laboratory projects represent five important areas:

1. Fundamental science and basic measurement capabilities
2. Characterization of nanostructured materials
3. Nanoscale electronics, optoelectronics and magnetics
4. Nanochemistry and nanobiotechnology
5. Quantum computing and communications

The opening of the world’s premier all-purpose facility for measurement-related research, the Advanced Measurement Laboratory, will give NIST and its partners in U.S. industry access to research and development capabilities not available anywhere else in the world.

For more information about the NIST AML, see [aml.nist.gov](http://aml.nist.gov).

### NIST AML by the Numbers:

- 511,070-SF total area
- 5 building wings
- 187 instrument laboratory modules
- 151 metrology laboratory modules
- 48 precision temperature control laboratories
- 27 low vibration laboratories
- 33,000-SF clean room

### AML Specifications in Most Critical Spaces:

- Vibration:** 30 micro-inch per second ( $4\text{Hz} < f < 100\text{Hz}$ )
- Cleanroom:** Class 100, upgradeable to Class 10
- Temperature:**  $\pm 0.01$  degree C temperature control
- Humidity:**  $\pm 1.0$  % RH
- Noise:** NC-30
- EMI:** 1 milligauss (mG)

## Buildings for Advanced Technology Workshop

HDR recently co-sponsored a three-day workshop entitled, "Buildings for Advanced Technology" at the National Institute of Standards and Technology (NIST) campus in Gaithersburg, Maryland. The workshop was co-sponsored by The National Institute of Standards and Technology, The National Nanotechnology Initiative, The Naval Research Laboratory, HDR, and Colin Gordon & Associates. Attended by more than 125 scientists, architects, engineers, technologists and builders from around the world, the workshop focused on issues related to the design and construction of facilities that support advanced technologies, including:

- 🌀 Vibration control
- 🔊 Acoustics and pressure variations
- 🌡️ Temperature and humidity control
- 🧼 Air cleanliness (particulate and chemical contamination)
- 📡 Electro Magnetic Interference (EMI) and Radio Frequency Interference (RFI)
- ⚡ Electrical power conditioning
- 🔗 Systems integration

Look for more information and updates at the website sponsored by the Buildings for Advanced Technology Workshop : [www.nanobuildings.com](http://www.nanobuildings.com).

*"The workshop was a great success in large measure due to Mr. Soueid's leadership, energy, enthusiasm, and organizational capabilities. He truly is a credit to your company and its reputation for quality and creativity."*

— Dr. E. Clayton Teague

Division Chief, Manufacturing Metrology Division  
Manufacturing Engineering Laboratory at NIST

Clayton Teague was the chairman of the Buildings for Advanced Technology Workshop held in Gaithersburg, Maryland.



### Providing Building Solutions

**Ahmad Soueid**

Principal / Senior Vice President HDR Architecture, Inc.

A registered architect with over 18 years of experience, Ahmad's work over the past decade has focused on the design and construction of advanced technology facilities for private and public sector clients. His involvement in more than 80 different task orders for NIST earned him and HDR superior ratings from his clients. He managed the NIST Advanced Measurement Laboratory, a 511,070-SF, \$235-million state-of-the-art laboratory in Gaithersburg, MD. He is HDR's Project Principal for the 220,590-SF, \$57-million Purdue University Birck Nanotechnology Center in West Lafayette, Indiana and served as technical consultant to the U.K.'s Department of Trade and Industry for the National Physical Laboratory project. Ahmad is the Principal for HDR's nationwide contracts with the Department of Homeland Security and recently was co-chairman of the Buildings for Advanced Technology Workshop organized in part under the National Nanotechnology Initiative (NNI) in conjunction with NIST and the Naval Research Laboratory.



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