السلام عليكم و رحمه الله و بركاتة

To Measure is to Know:
The Impact of Metrology on Innovation and Economic Growth

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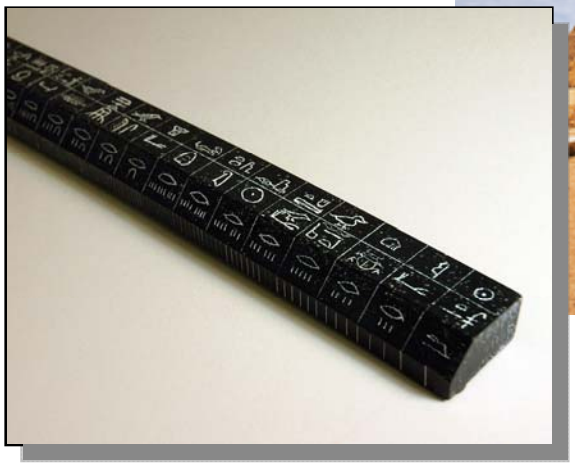
Nov. 6, 2007

NIST
National Institute of Standards and Technology
U.S. Department of Commerce

Metrology in Ancient Egypt



Royal Egyptian cubit, based on the size of the Pharaoh's forearm and hand

- Primary "master" cubit made of granite
- Working standards made of wood
- Recalibration each full moon
- Severe penalty for noncompliance

From the Magna Carta to the Metric System

Magna Carta

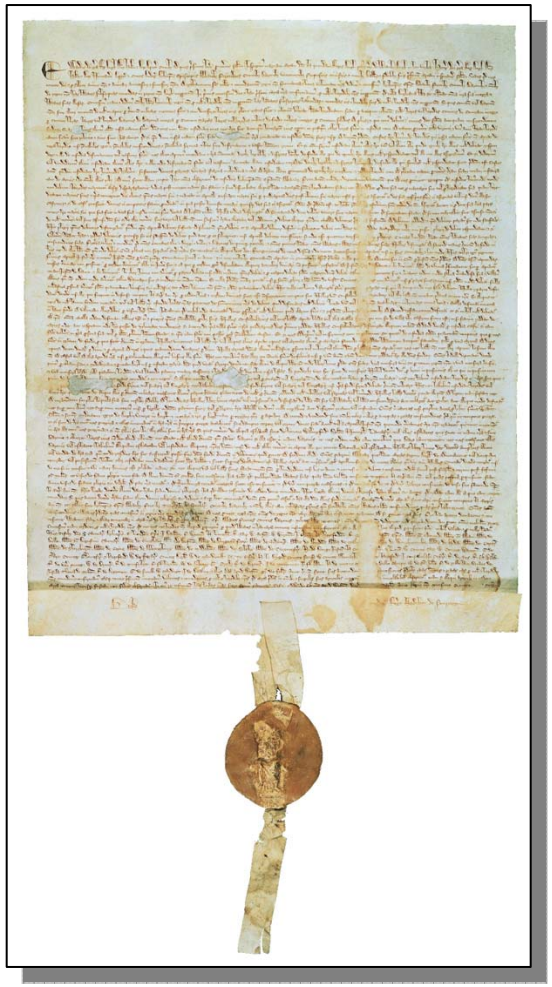


Image credit: The Perot Foundation

"One measure of Wine shall be through our Realm, and one measure of Ale, and one measure of Corn. . . . And it shall be of Weights as it is of Measures."

excerpt from the Magna Carta, 1215

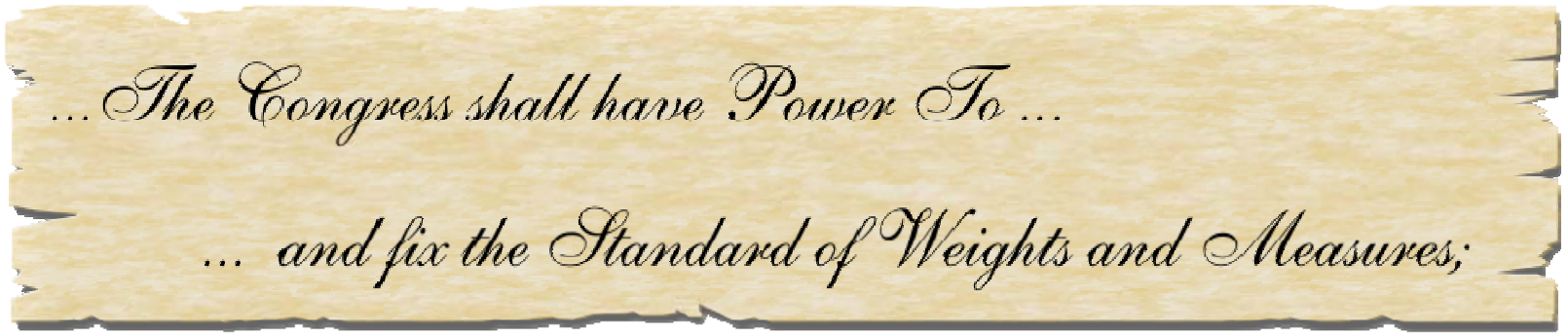
Medal commemorating establishment of the metric system in 1791

Image credit: Armand Machabey, chef du service de documentation et d'Etudes, Paris

In the minds of the U.S. founding fathers

"Uniformity in the currency, weights, and measures of the United States is an object of great importance, and will, I am persuaded, be duly attended to."

George Washington, State of the Union Address, 1790



From the U.S. Constitution

Early NIST: Founded 1901

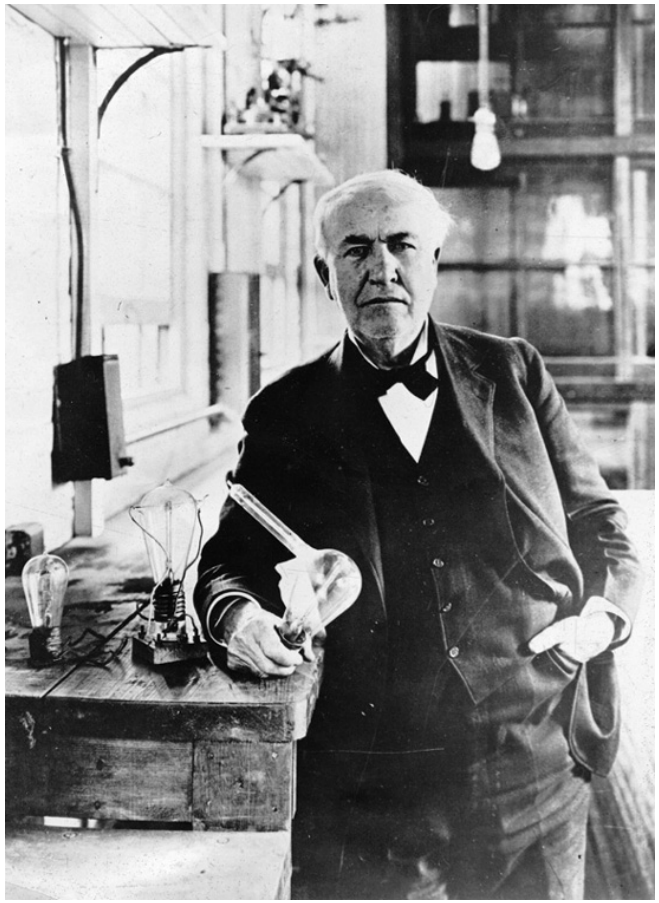
Established by Congress in 1901

Eight different “authoritative’ values for the gallon

Nascent electrical industry needed standards

American instruments sent abroad for calibration

Consumer products and construction materials uneven in quality and unreliable



National Archives

Thomas Edison, inventor of the light bulb

NIST provides the “innovation infrastructure”

The equivalent of research “roads and bridges” the industrial and scientific communities need to develop and commercialize new technologies

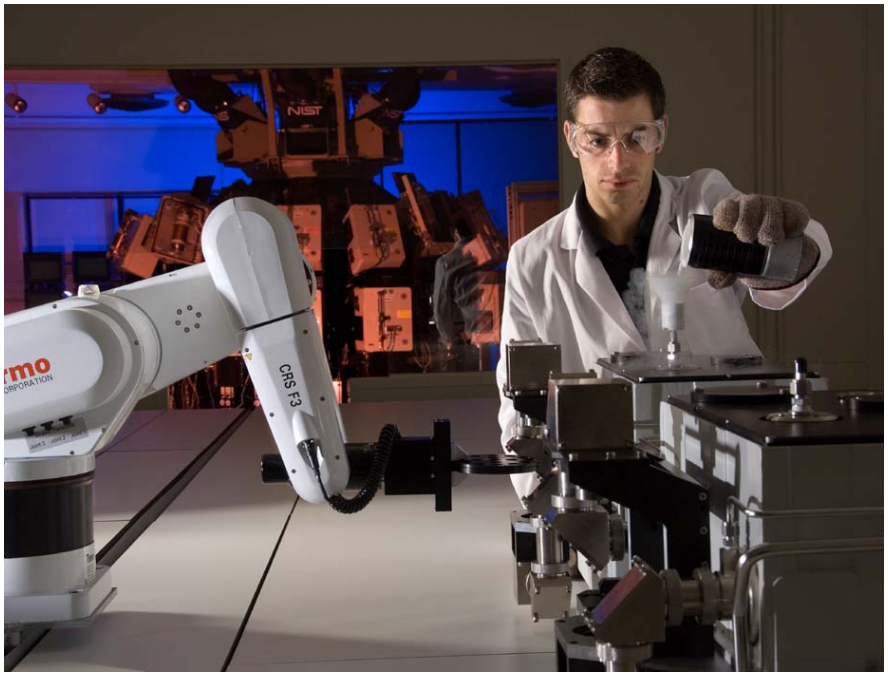
- Groundbreaking research tools that foster new fields — quantum information, nanotechnology, bioscience
- Evaluated data for technology development
- Better measurement methods to ensure quality
- Performance measures for accurate technology comparisons
- Standards to assure fairness in trade

NIST Today: Mission

To promote U.S. innovation and industrial competitiveness by advancing

measurement science, standards, and technology

in ways that enhance economic security and improve our quality of life



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NIST At A Glance

Major Assets

- ~ 2,800 employees
- ~ 2600 associates and facilities users
- ~ 1,600 field staff in partner organizations
- ~ 400 NIST staff serving on about 1,000 national and international standards committees

Courtesy HDR Architecture, Inc./Steve Hall © Hedrich Blessing

Major Programs

- NIST Laboratories
- Baldrige National Quality Program
- Manufacturing Extension Partnership
- Technology Innovation Program

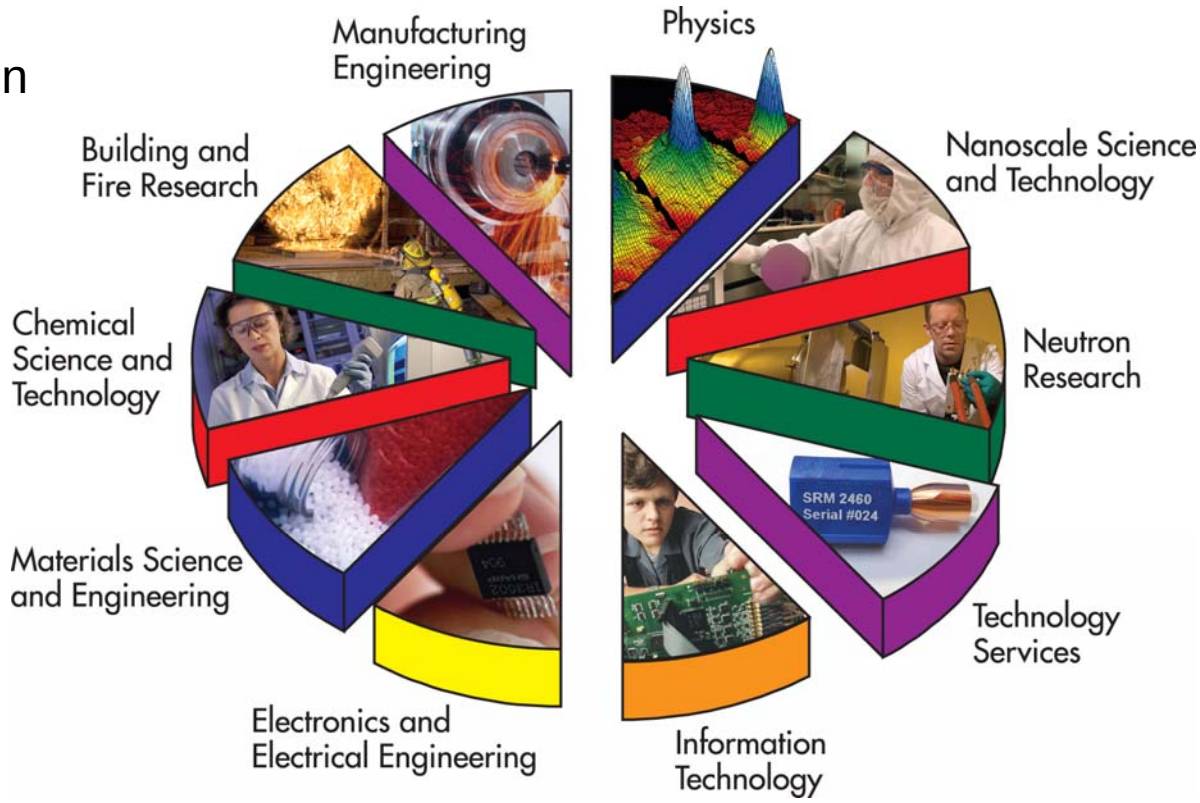
The NIST Laboratories

NIST's work enables:

- science
- technological innovation
- trade
- better quality of life

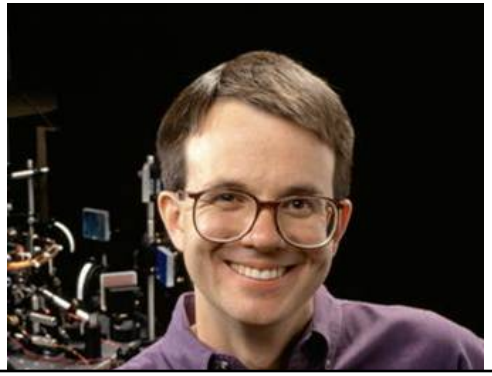
NIST works with:

- industry
- universities
- other government agencies
- other measurement laboratories
- standards development organizations

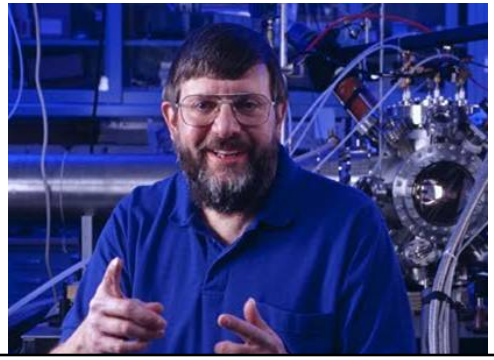


A world class institution with world-class staff

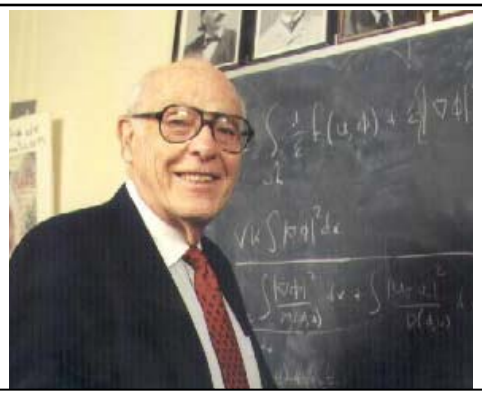
Jan Hall
2005 Nobel Prize
in Physics



Eric Cornell
2001 Nobel Prize
in Physics

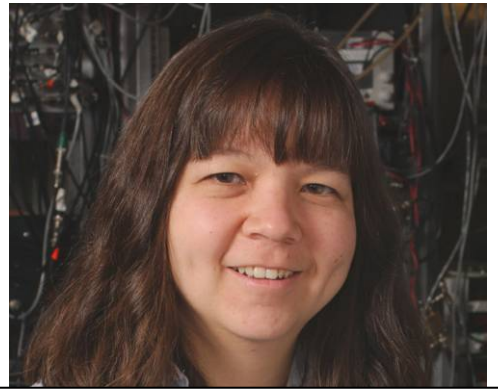


Bill Phillips
1997 Nobel Prize
in Physics



John Cahn
1998 National Medal of
Science

Anneke Sengers
2003 L'Oréal-UNESCO
Women in Science Award



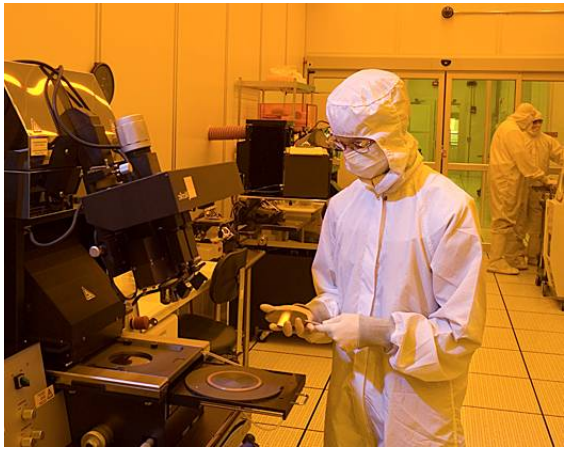
Debbie Jin
2003 MacArthur
Fellowship

A world-class institution with . . . unique facilities

Advanced Measurement Laboratory

Courtesy HDR Architecture, Inc./Steve Hall ©Hedrich Blessing

Center for Nanoscale Science & Technology



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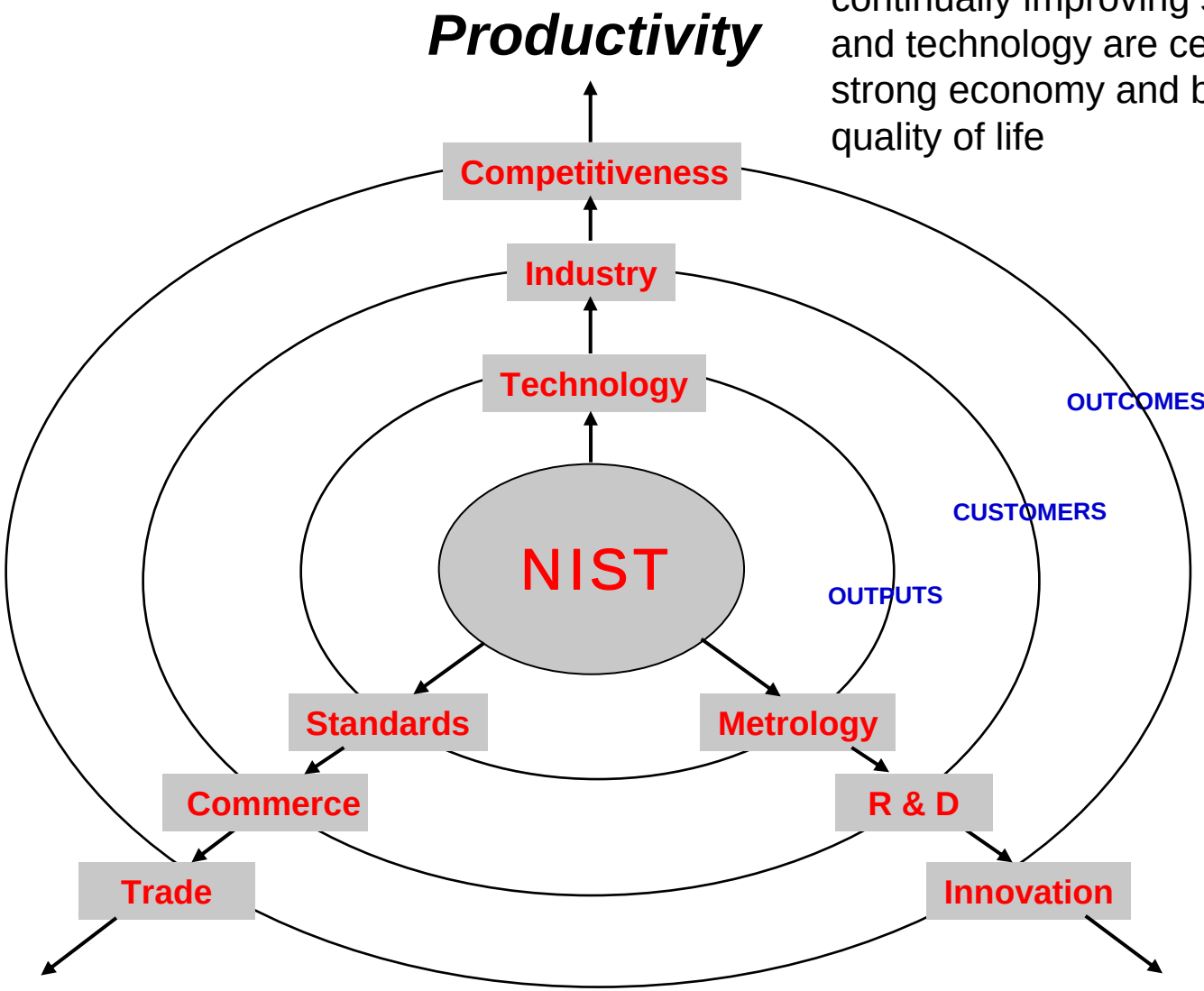
NIST Center for Neutron Research

Advanced Chemical Sciences Laboratory

To Measure is to Know

Accurate measurements and continually improving standards and technology are central to a strong economy and better quality of life



Consumers Count on Standards

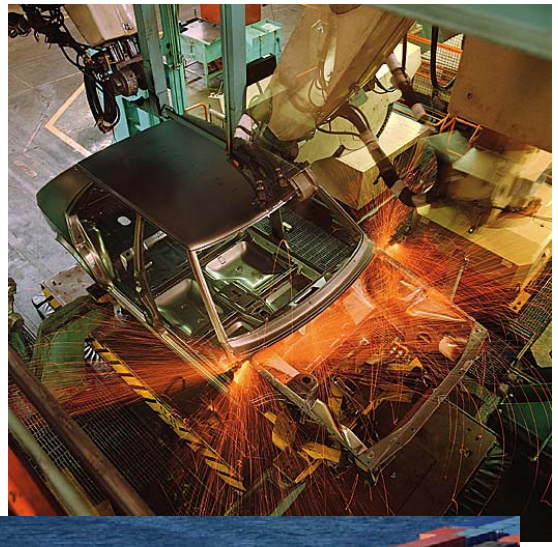
Consumer trust — ultimate reference for $5 trillion in annual sales based on measurement

Integrity of financial transactions — time stamping of stock trades, etc., totaling hundreds of billions of dollars daily

Secure automated banking — encryption technology embedded in 300,000+ U.S. ATMs

The result: a broad impact on everyday life

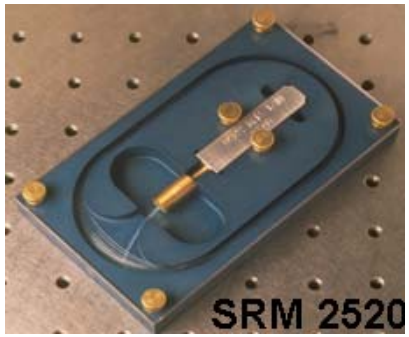
- Advancing manufacturing and services
- Helping ensure fair trade
- Improving public safety and security
- Improving quality of life

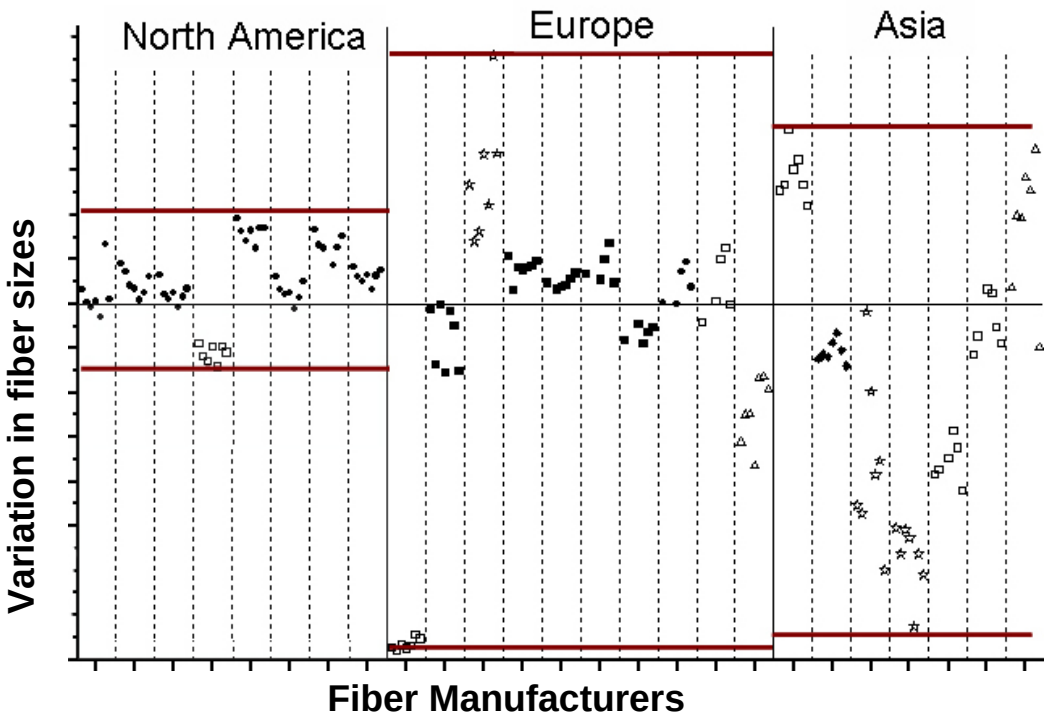


Better measurements equals a stronger economy

Fiber optics problem. Fibers could not interconnect without signal loss. NIST helped improve both measurements and standards.

By 1995 U.S. makers could measure fiber 3 times better than competitors and owned about 50 percent of the world market.



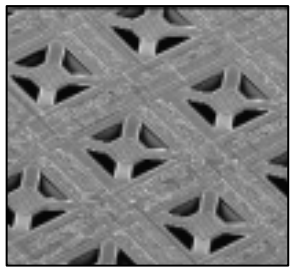


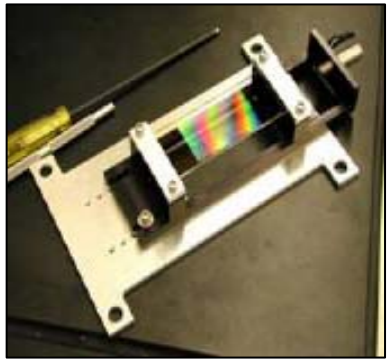
"The opportunity to work with NIST on this project gave Corning and other American fiber manufacturers a clear competitive advantage…."

Jan H. Suwinski, Executive Vice President, Corning, Inc. (1993)

Recent Success: Faster Materials Discovery

- Developing a new material can cost $20 million and take up to a decade — costs U.S. industry $20 billion/year
- NIST developed new measurement techniques used in products ranging from new detergents to improved adhesives for next-generation electronics
  - **1/5 the time and 1/5 the cost!**
- More than 20 organizations have already adopted these methods

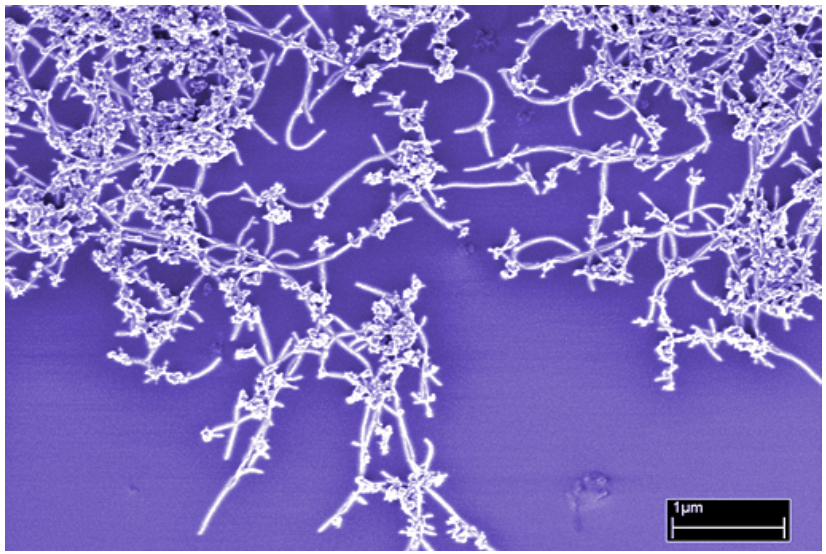




Recent Success: Understanding Nanotechnologies

Nanotechnologies — Devices and materials made with components and features smaller than 100 nanometers or billionths of a meter.

- Experts predict that in the next 10 years half of all new materials will incorporate nanotechnologies.
- NIST is developing reference materials and measurement methods to help this emerging industry ensure both quality and safety of nanotechnology products.



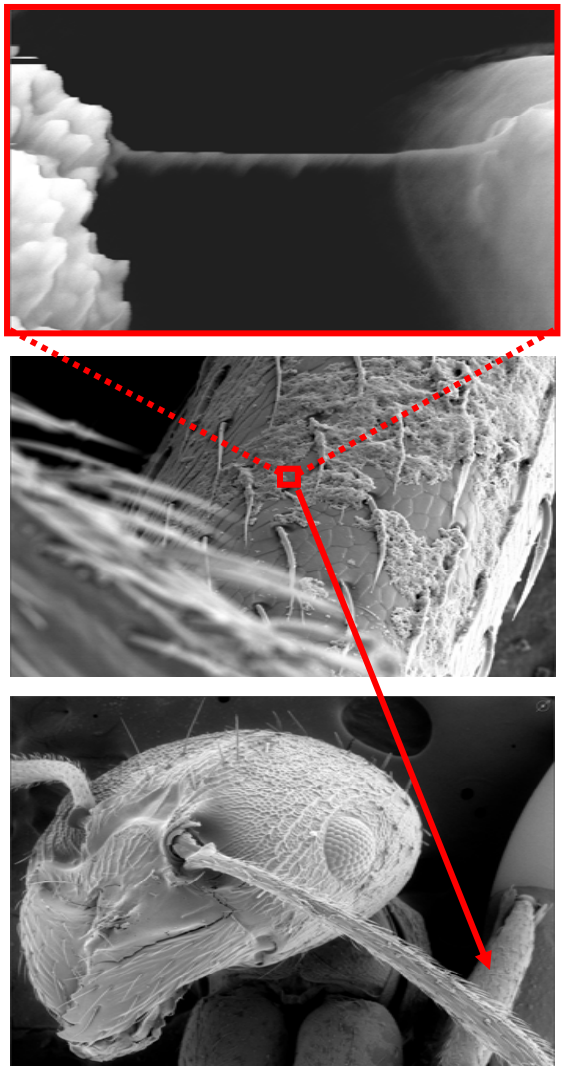
A new NIST measurement method rapidly determines the quality of a carbon nanotube sample.

A coating of a nanotube sample is sprayed on a quartz crystal. The crystal is gradually heated, vaporizing different forms of carbon at different temperatures.

NIST Center for Nanoscale Science and Technology

Potential Market $1–2 Trillion/year

- New multidisciplinary center aimed at bridging the gap between nanotechnology discovery and products
- Partner with industry, academia, and government to turn the *potential* of nanotechnology into reality
- Develop the characterization tools to enable scaled-up, reliable, cost effective, and safe manufacturing of nanoscale materials, structures, devices, and systems
- Initial focus will be on:
  - Future electronics
  - Nanofabrication and nanomanufacturing
  - Energy



Carbon nanotube on the hair of an ant's leg

NIST Center for Neutron Research — *Expanding*

Advanced materials:
Artificial Tissue

World-class resource for neutron-based measurements

- "See" structure at the nanoscale
- Uniquely sensitive to hydrogen
- Probe magnetic structure
- Nondestructive probe

Magnetic data storage

Chemistry:
Properties of cement

Petrochemicals

Courtesy Shell

Fuel cells & hydrogen storage materials

NIST Products and Services

Measurement Research

- ~ 2,200 publications per year

Standard Reference Data

- ~ 100 different types
- ~ 6,000 units sold per year
- ~ 130 million data downloads per year

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Standard Reference Materials

- ~ 1,300 products available
- ~ 33,000 units sold per year

Calibration Tests

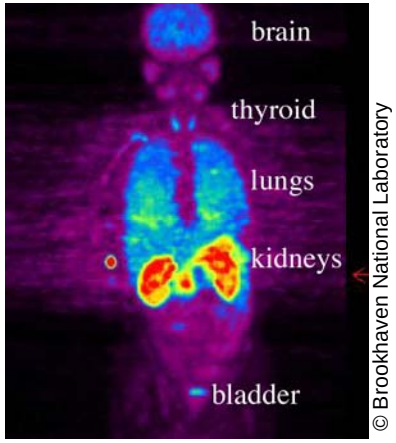
- ~ 16,000 tests per year

Laboratory Accreditation

- ~800 accreditations of testing and calibrations laboratories per year

Economic Impact Assessment Studies

1997: Radiopharmaceutical standards
97:1 benefit-to-cost ratio



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1998: Alternative refrigerants
4:1 benefit-to-cost ratio

2000: Sulfur in fossil fuels
113:1 benefit-to-cost ratio


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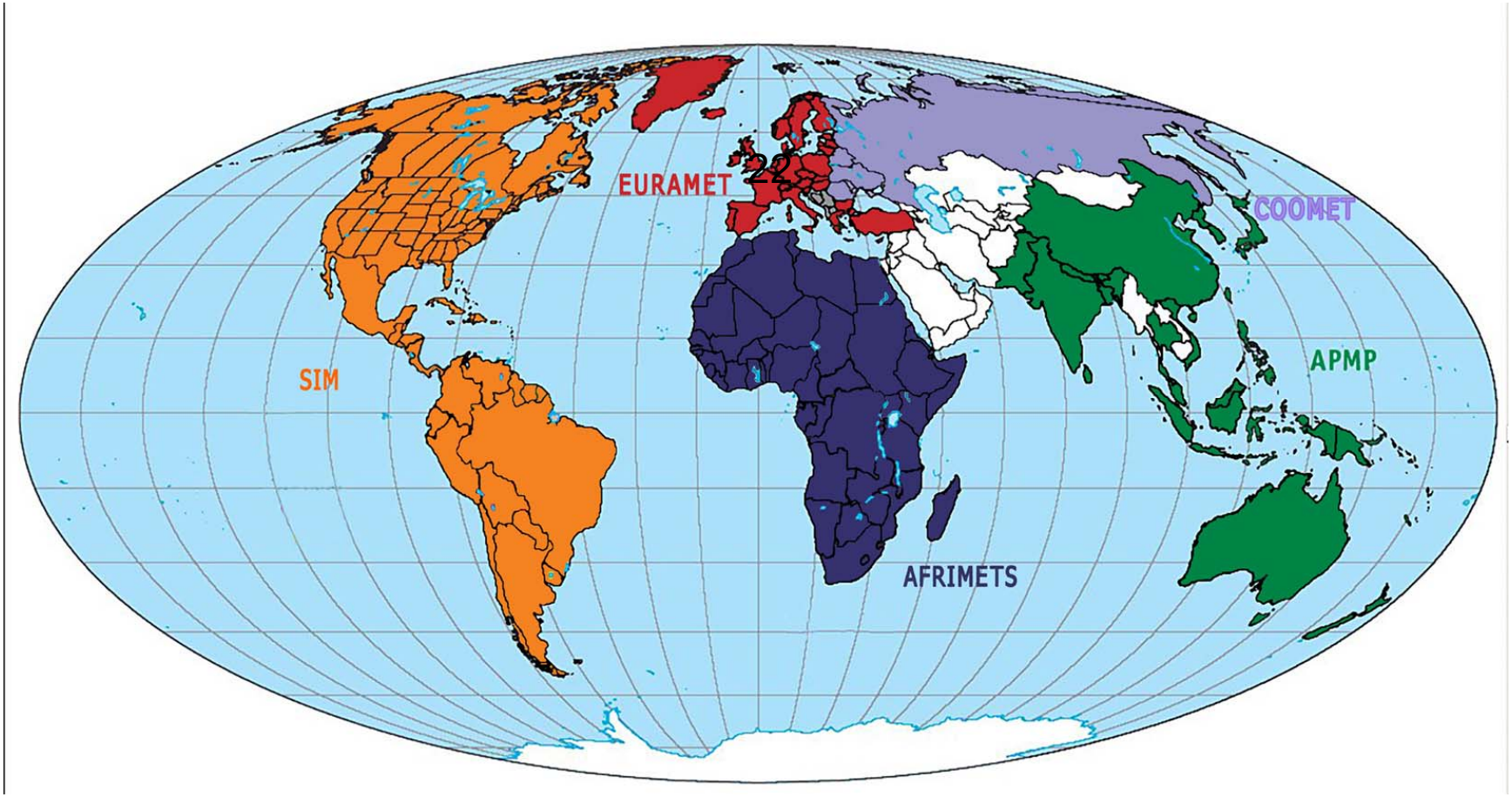
Average benefit-to-cost over 19 impact studies: 44:1

Regional Metrology Cooperation Efforts

Advantages of regional cooperation

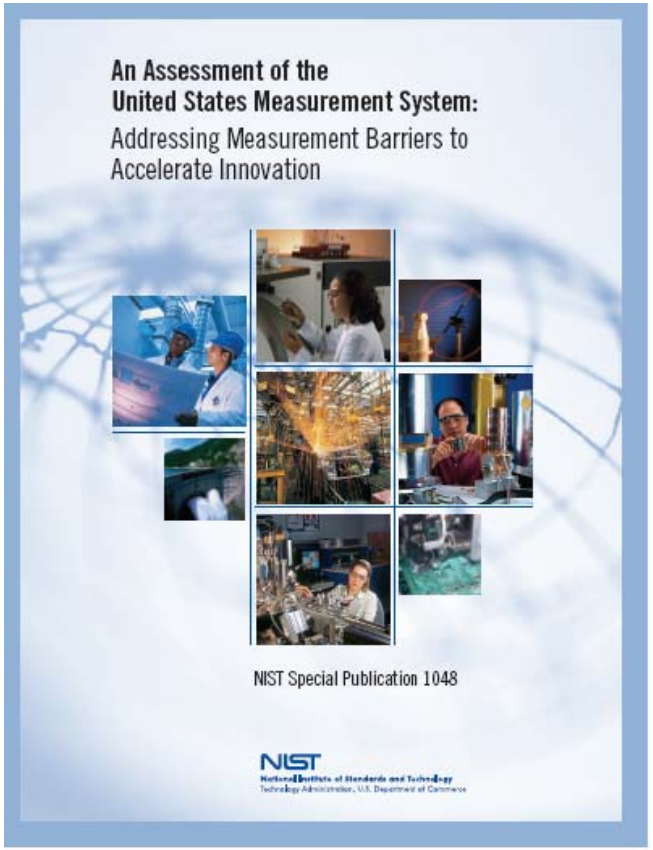
- Expanded affordable training opportunities
- Allows a region's scientists to provide metrology data to the Bureau Internationale des Poids et Measures (BIPM)
- Improved networking and sharing of best practices



NIST Future: Overcoming Barriers to Innovation

Assessment of the U.S. Measurement System

- Documents 723 measurement barriers to innovation
- Covers 11 industry sectors
- Over 1,000 contributors from industry, academia, and other government agencies



Examples:

- Biomarkers — detecting 1 molecule in a trillion!
- 3-D imaging at the nanoscale to understand material properties

Result:

- A roadmap to help NIST and other organizations plan research that accelerates innovation

Thank You !

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