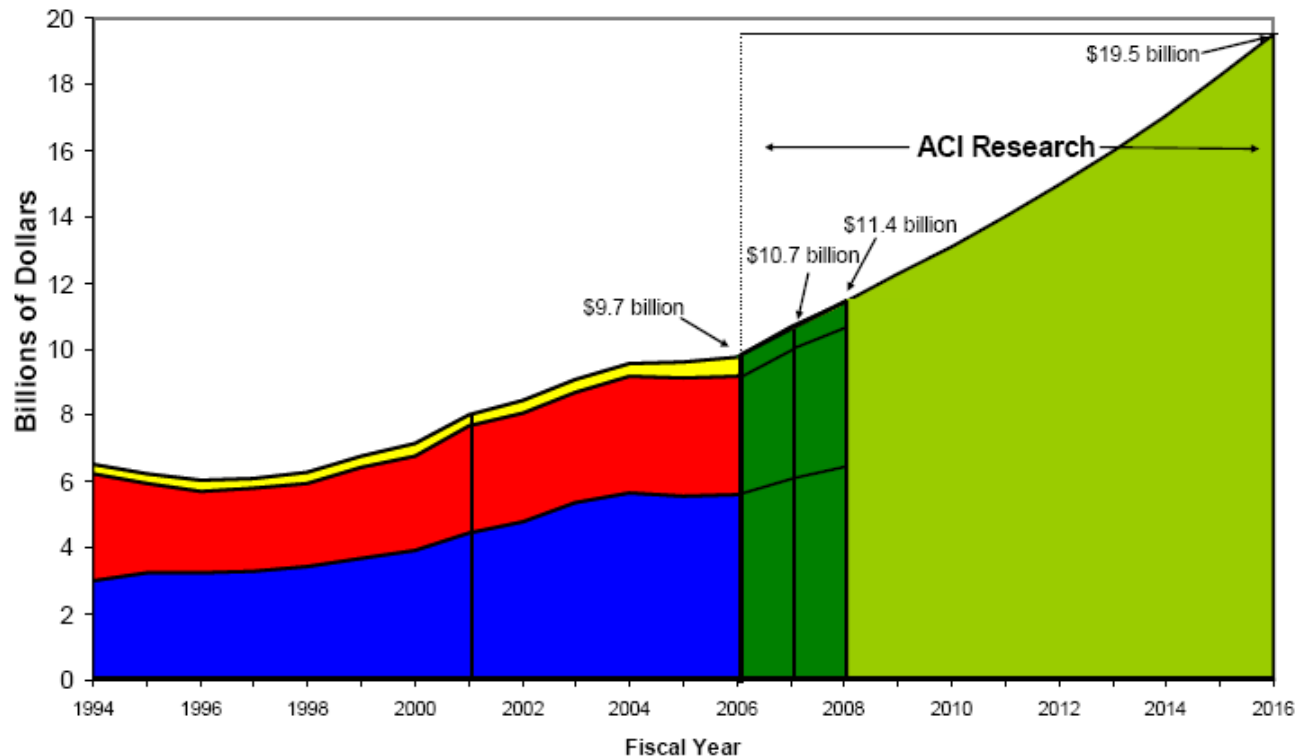

**The President's FY 2008 Budget Request for
the National Institute of Standards and Technology...
Part of the American Competitiveness Initiative**

William Jeffrey
Director

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

American Competitiveness Initiative (ACI)

- Proposed in FY 2007 and continued in FY 2008 budget
- Doubles, over 10 years, investment in:
 - NIST core (laboratory and infrastructure)
 - National Science Foundation
 - DOE Office of Science



NIST FY 2008 Budget Request (In millions of dollars)

	FY 2006 <u>Enacted</u>	FY 2007 JR <u>House Mark</u>	FY 2008 <u>Request</u>
STRS (w/o directed grants)	\$382.9	\$432.8	\$500.5
CRF (w/o directed grants)	<u>48.2</u>	<u>58.7</u>	<u>93.9</u>
NIST Core Total:	\$431.1	\$491.5	\$594.4

NIST Core Δ (07 JR-08) = +\$102.9 (21%)

ITS	\$183.6 (MEP+ATP)	\$183.6 (MEP+ATP)	\$46.3 (MEP)
Directed Grants	\$137.3	N/A	N/A
Total NIST	\$752.0	\$675.1	\$640.7

Research and Facility Investments (\$M)

	<i>FY 2008</i>
<i>Research Initiatives (STRS)</i>	
Enabling Nanotechnology	+ \$6
Quantum Science	+ \$4
Climate Change: Measurements & Standards	+ \$5
Disaster-Resilient Structures & Communities	+ \$4
National Earthquake Hazards Reduction Program (NEHRP)	+ \$3.25
<i>SUBTOTAL</i>	+ \$22.25
<i>Capacity and Capability Improvements Initiatives (CRF)</i>	
NCNR Expansion/Reliability	+ \$19
Boulder – Building 1 Extension	+ \$28
<i>SUBTOTAL</i>	+ \$47
Rollover of FY2007 Initiatives Not in the Joint Res	+ \$33.65
<i>GRAND TOTAL</i>	+ \$102.9

Meeting National Priorities: NIST FY 2008 R&D Initiatives

Goal: Targeting High Impact Research (+\$22.25 million)

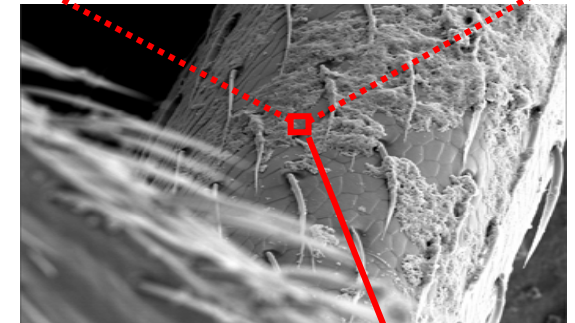
<i>R&D Priority</i>	<i>NIST Response (STRS)</i>
World-class capability and capacity in nanofabrication and nanomanufacturing (ACI Goal, NNI Strategic Plan, OMB/OSTP FY08 Priority Memo)	Enabling Nanotechnology from Discovery to Manufacture (\$6M)
Improve our understanding of climate variability and change (Global Climate Chg. Strategic Plan, OMB/OSTP FY08 Priority Memo)	Measurements and Standards for the Climate Change Science Program (\$5M)
Overcoming technological barriers to the practical use of quantum information processing (ACI Goal)	Quantum Science (\$4M)
Develop technologies and standards for improving structural performance during hazardous events (OMB/OSTP FY08 Priority Memo; ACI Goal; Subcommittee on Natural Disaster Reduction; NEHRP strategic plan)	Disaster Resilient Structures and Communities (\$4M)
	National Earthquake Hazard Reduction (\$3.25M)

Goal: Increasing Capacity and Capability (+\$47 million)

<i>R&D Priority</i>	<i>NIST Response (CRF)</i>
Improving capacity, maintenance, and operations of NIST labs (ACI Goal)	Boulder Building 1 Extension (\$28M)
Breakthroughs...through essential infrastructure such as the NCNR (ACI Goal, NSTC report)	NCNR Expansion and Reliability Enhancement (\$19M)

Enabling Nanotechnology from Discovery to Manufacture (+\$6M)

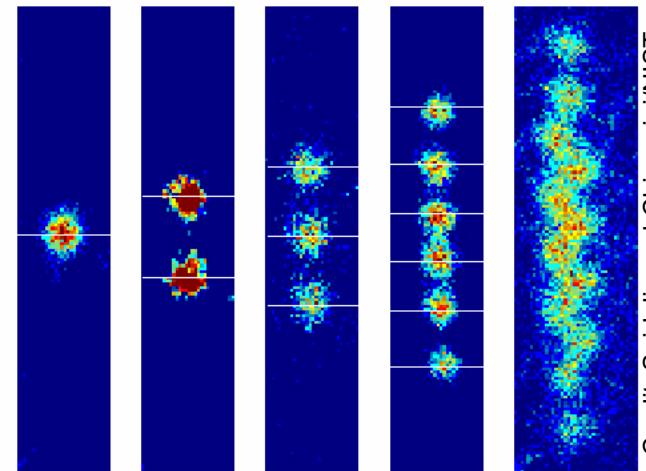
- Manufacturing with nanoscale components expected to be a dominant factor in the 21st century economy
- Exploiting nanoscale behaviors and properties requires new tools and methods
 - NIST is the NNI lead agency on “*Nanoscale measurement science, instrument calibration, standard reference materials, and nanoscale physical and chemical properties standard reference data.*”
- Initiative continues the creation of the Center for Nanoscale Science and Technology (CNST)
 - Partner with industry, universities, and other agencies to bridge the gap between science and production
 - Over 300 new researchers from industry and academia
- Expands research to support industry through nanoscale measurement science and standards
 - Develop new atomic-scale measurement capabilities
 - Support standards for environment, health, and safety



Carbon nanotube on the hair of an ant's leg

Quantum Science: Infrastructure for 21st Century Innovation (+\$4 million)

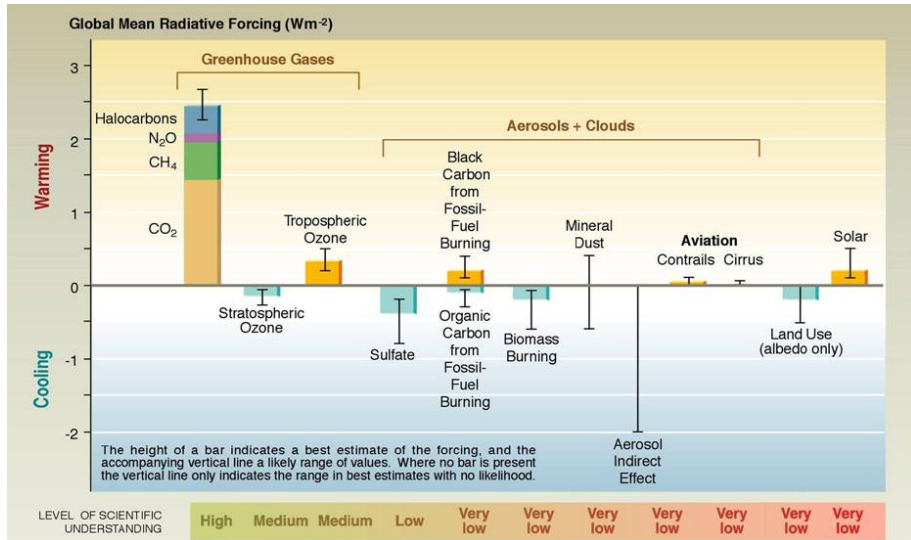
- The laws of physics are fundamentally different in the quantum world of atoms, electrons, and light particles. This enables revolutionary potential for:
 - Measurement capabilities otherwise impossible “classically”
 - “Unbreakable” codes (i.e. to protect financial transactions)
 - Powerful computers capable of solving problems impractical to solve today
- NIST is a recognized world leader in the field
- This initiative will
 - Accelerate the economic potential for exploiting the unique properties of the quantum world
 - Advance research on quantum information
 - Develop fundamentally new and unique measurement tools and methods
 - Further leverage the partnership with the Joint Quantum Institute (NIST, Univ. of MD, and NSA)



Magnesium ions loaded into NIST's new planar ion trap.

Credit: Seidelin and Chiaverini/NIST

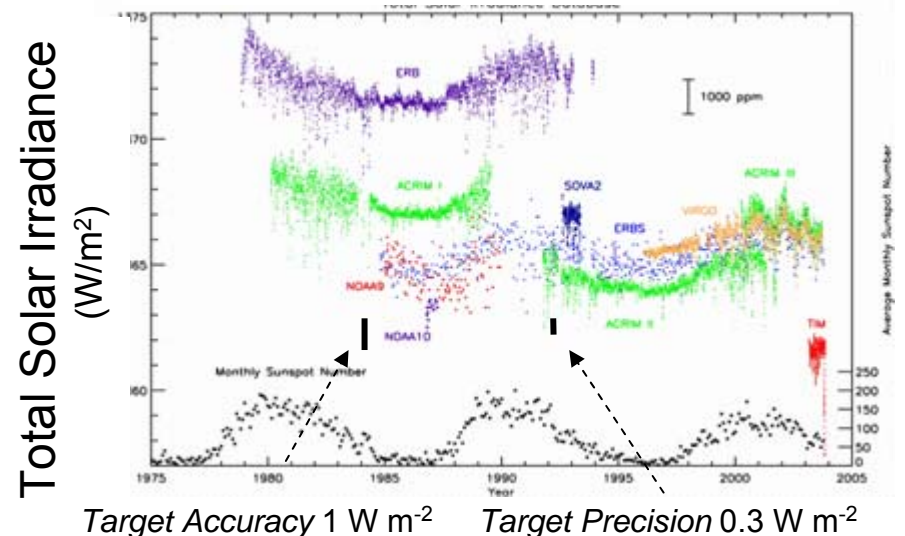
Measurements and Standards for the Climate Change Science Program (+\$5M)



- Critical measurement uncertainties in solar output and effects of aerosols limit Nation's ability to model global climate change
- Initiative addresses 2 critical gaps identified in Interagency Strategic Plan
 - Resolves discrepancies in satellite-based measurements of solar intensity
 - Provides quantitative understanding of effects of atmospheric aerosols on sunlight

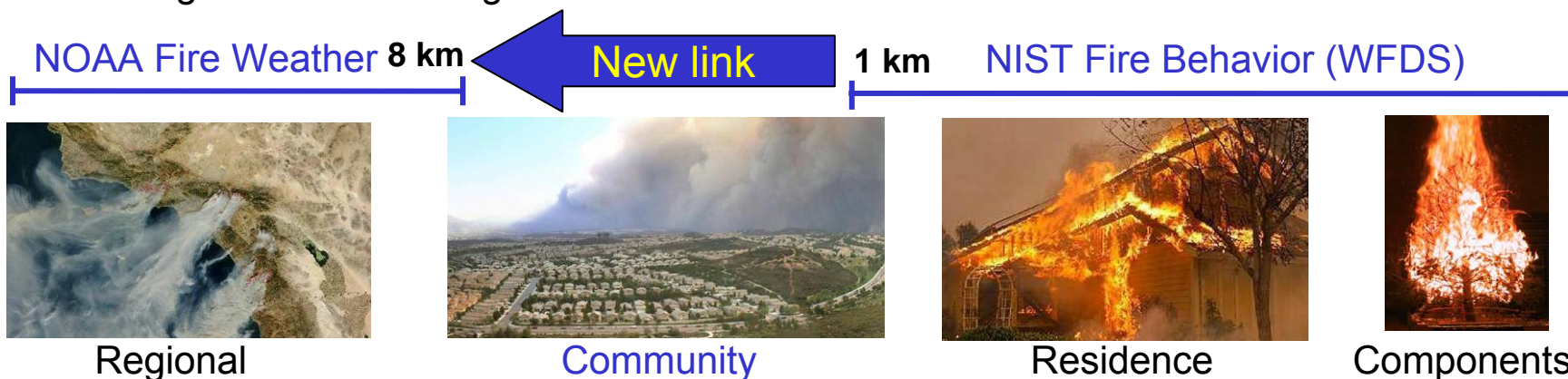
- Results will help modelers to create an accurate picture of Earth's climate through calibrations traceable to international standards
 - Standardized instrument calibration for satellites for accurate international intercomparisons and lower uncertainties
 - New measurement methods for aerosols
 - Database of aerosol properties

Total Solar Irradiance Database



Disaster-Resilient Structures and Communities (+\$4M)

- Risk to lives, property, and major disruption of commerce increases as communities encroach on hurricane-prone coasts and fire-prone wildland-urban interface regions
- Single major event (e.g., hurricane) can cost \$80B-\$200B
- Need to assess community and regional scale risks
- This initiative will develop predictive tools that enable:
 - Local officials to evaluate and mitigate risks via land-use planning and practices;
 - Development of risk-based hazard maps at the community-scale; and
 - Development of risk-consistent and cost-effective mitigation solutions incorporated into next-generation building codes and standards.



Predict fire behavior for communities based on fuel maps, local topography, cultural features, and micro wind patterns for real-time firefighting as well as improved building codes and community planning.

National Earthquake Hazards Reduction Program (NEHRP) (+\$3.25M)

- Earthquakes strike without warning – and a single major event can cost \$100B - \$200B
- 75 million Americans and \$8.6 trillion worth of structures in the U.S. in moderate to high-risk areas
- NIST tasked with conducting research to bridge the gap from construction theory to practice and to promote its adoption
- This initiative will enhance the safety of:
 - New structures by establishing and promoting performance-based standards for entire building designs and by accelerating the adoption of basic research into the model building codes, standards, and practices
 - Existing structures through research on actual building performance in earthquakes; developing structural performance models and tools; and establishing cost-effective retrofit techniques for existing buildings



1994 Northridge Earthquake,
Los Angeles (NIST)

NIST Center for Neutron Research (NCNR) Expansion and Reliability Improvements (+\$19M CRF – Year 2)

■ Neutron-based measurements are critical for 21st century innovation – for example:

- Design of new medications by determining protein structure & function
- Development of practical alternative energy sources
- Determining the structure of materials and devices at the nanometer scale
- Discover advanced new materials for technologies beyond semiconductors

■ Due to tremendous scientific value – demand for access by industry and academia far exceeds capacity

■ NCNR serves more customers than all other U.S. neutron facilities combined – and this initiative will:

- Further increase capacity by 30% to serve 500 additional researchers each year
- Add additional cold source and new guide hall
 - New cold source is 2x brighter; Guide system is up to 4x more efficient
- Provide new generation of world-class instruments
 - Critical new instruments either not available in U.S. or 100x improvement



photo © Robert Ralhe

Boulder Laboratories: Building 1 Extension (+\$28M)

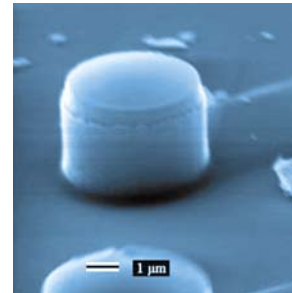
- Modern measurement science requires extremely advanced capabilities such as manipulating objects at the atomic scale
- The 1950s infrastructure in Boulder is insufficient to meet the Nation's needs for increasingly accurate measurements

- High speed/high frequency measurements required for advanced electronics, defense, and homeland security;
- Measurements and tests at the single atom level;
- Measure forces below 1 billionth of a penny's weight: forces between cells, nanoscale systems, etc;
- Measure time to 1 second in 30 billion years enabling new science and vastly improved navigation/positioning systems

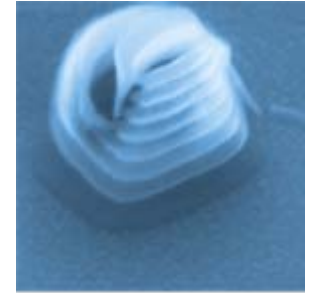
- **Create a 21st-century measurement capability for the Nation**

- Construct a high-performance laboratory extension to existing Building 1 with stringent control of temperature, vibration, humidity, and air cleanliness.
- Deliver higher performance laboratory space sooner and at lower cost than previous plans

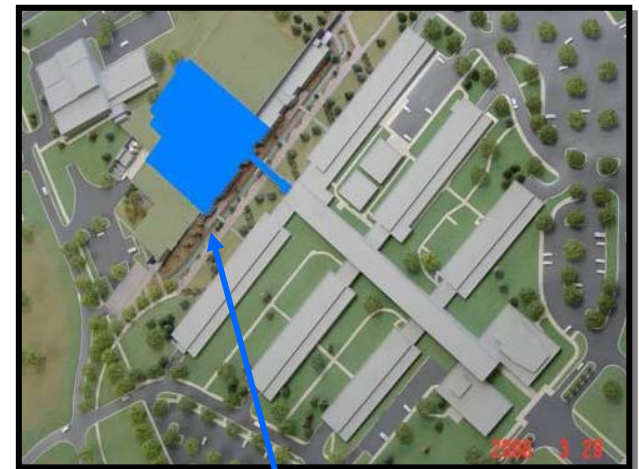
Nanofabrication Capabilities



Adequate Control:
Working Device

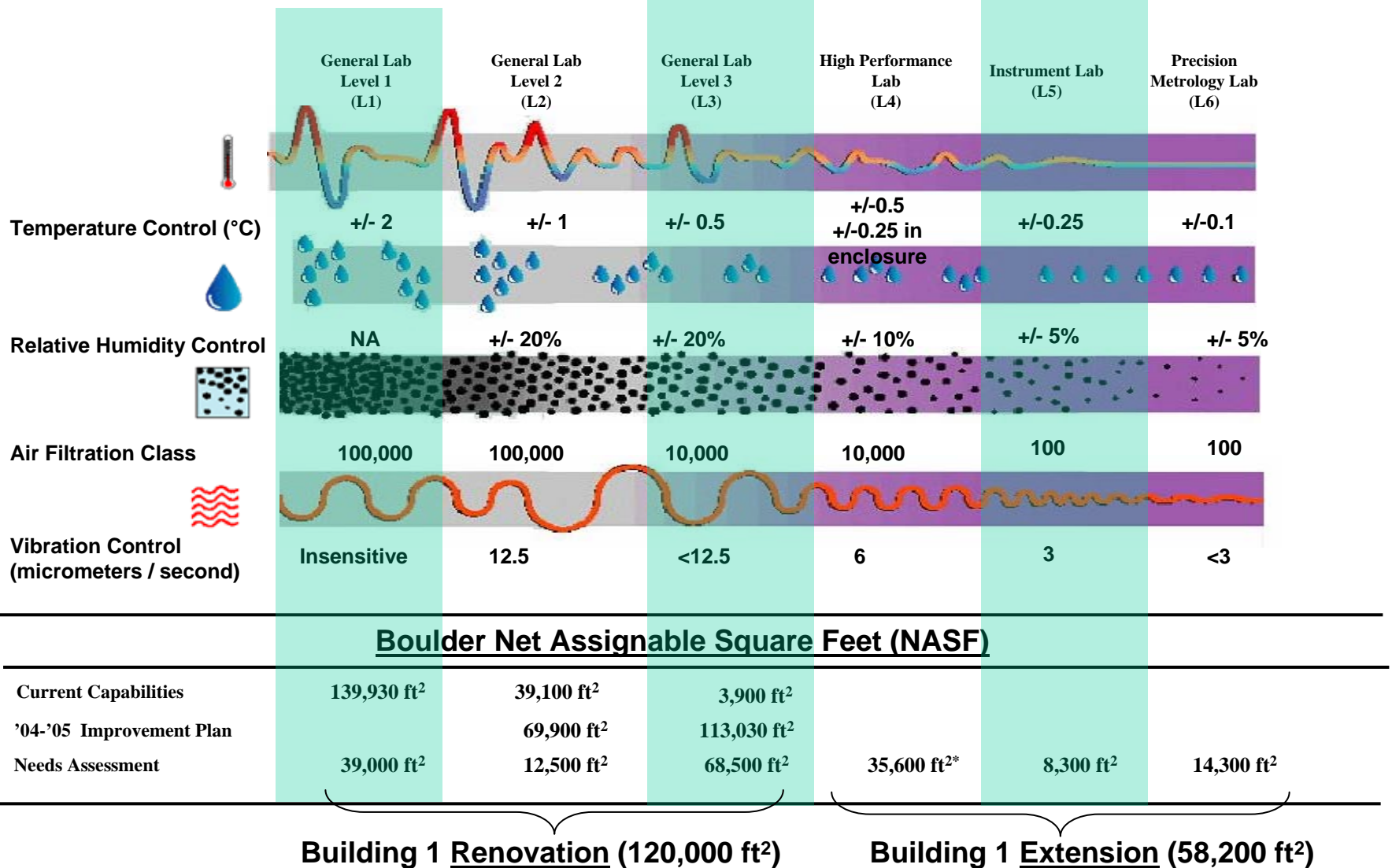


Poor Control:
Non-working device



Extension

Required Environmental Controls



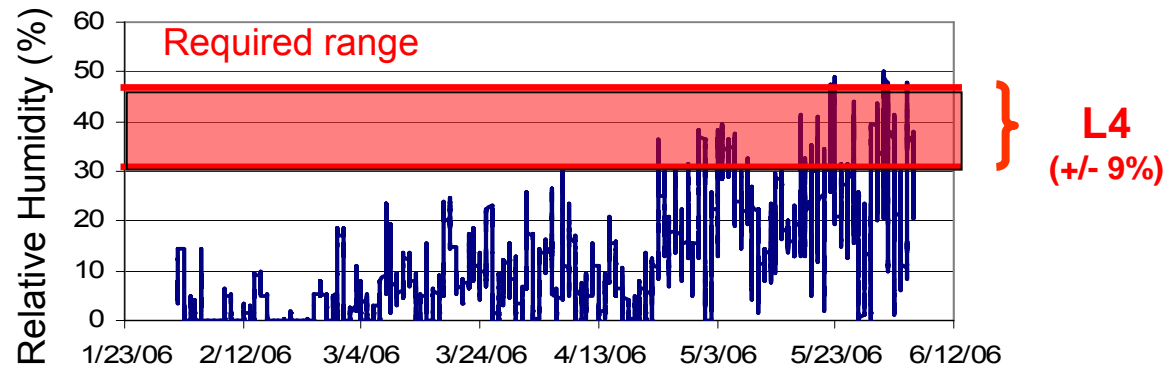
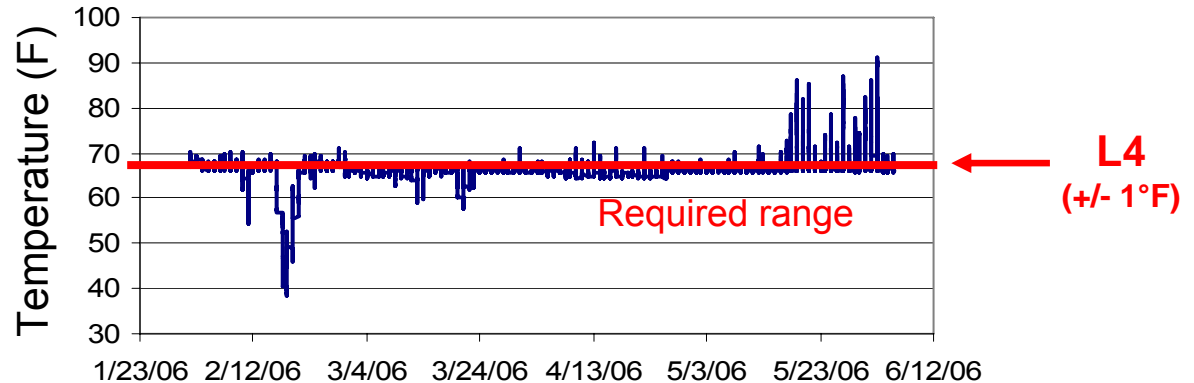
*10,200 ft² would be built at L4 and initially used to meet L3 needs

Environmental Factors Impact Microfabrication Laboratory Performance

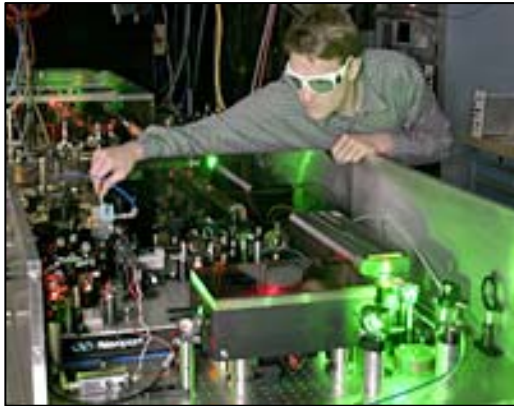
Microfabrication Performance Requirements



Good control of microfabrication lab environment required to make devices for research and measurements in quantum computing, quantum communications, new types of lasers for medical applications, sensors for homeland security, etc.

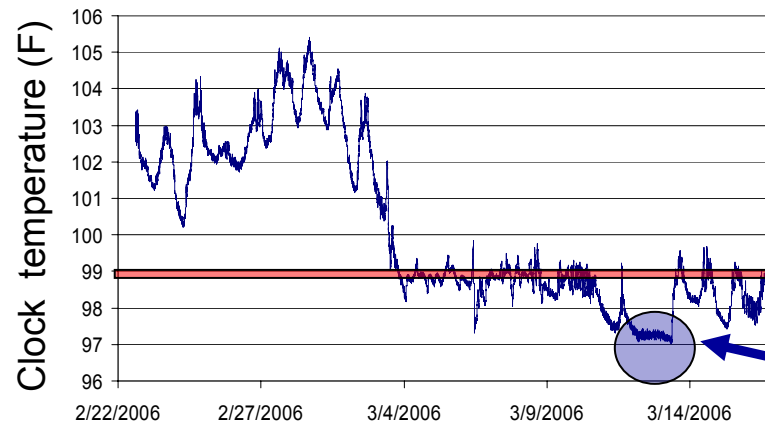


Atomic Clock Research Severely Impaired by Lab Temperature and Vibration Problems



- Critical national needs require 10,000 times better timing precision than current laboratories can deliver.
- Temperature drifts cause errors in atomic clock timing.
- Current conditions often require a full week of continuous measurement to get one hour of useful data (about 1% productivity).

Capabilities



Temperature fluctuations cause measurement error of 1000's picoseconds/day

Brief period where temperature stability approached current needs

Needs

Technologies critical to economic security and national defense

(advanced GPS, advanced Telecom, astronomy, deep space exploration, gravimetry)

Required atomic clock precision

Current: 10 picoseconds/day
Future: 0.1 picoseconds/day

Required Laboratory Performance

+/- 0.2°F

→ L5/L6

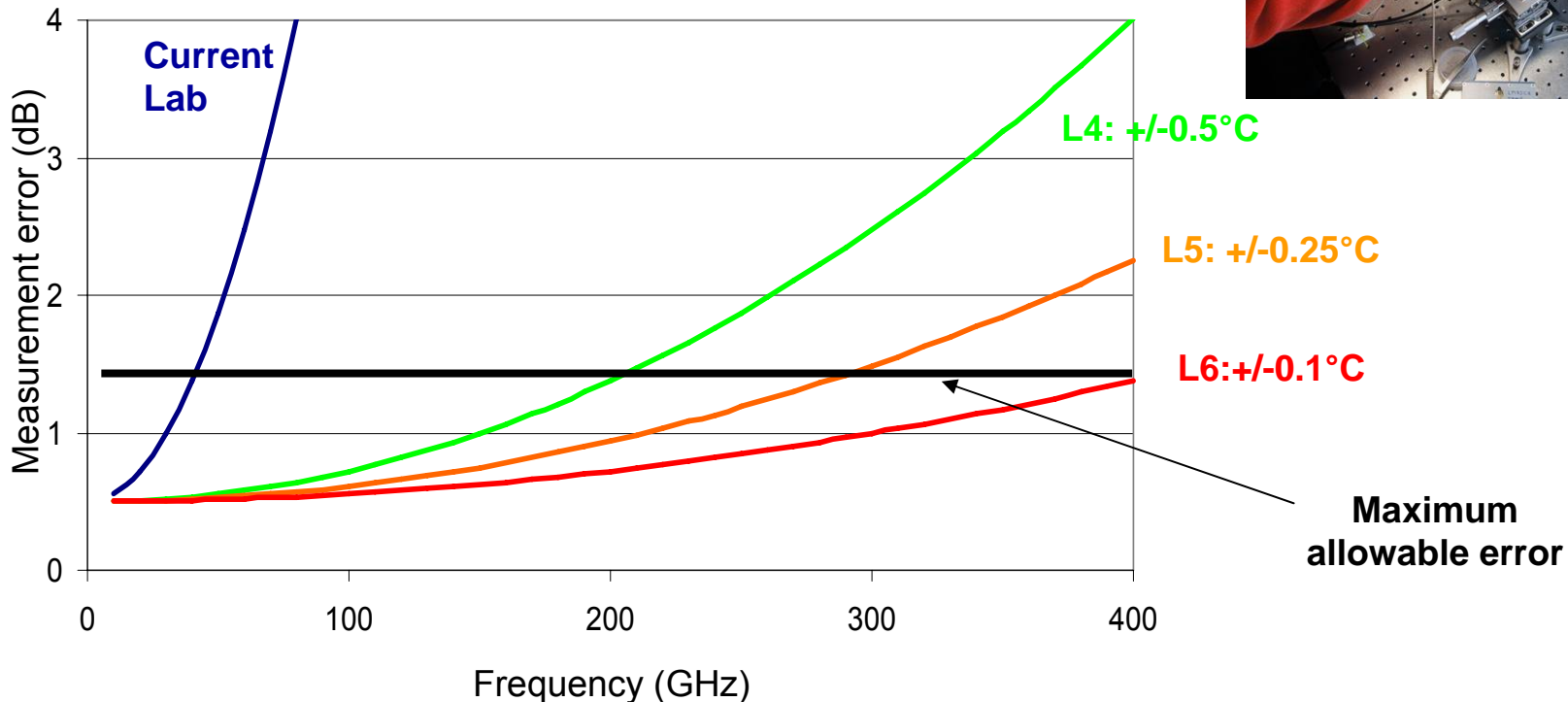
Critical High-Speed Electronic Measurements Limited by Lab Temperature Fluctuation

High-speed measurements needed for:

- Future telecommunications networks
- High-speed computing
- New radars and sensors



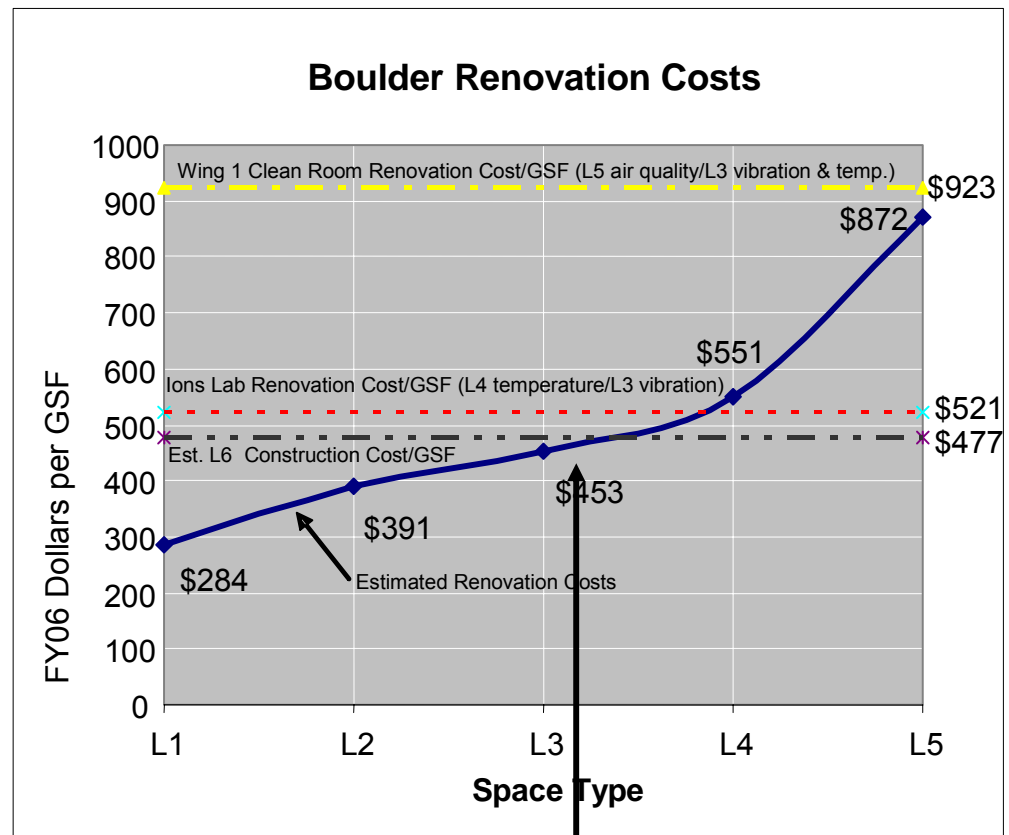
Measurement error caused by temperature drift



Comparison of Alternatives: Based on Analysis and Experience

- A facilities review was conducted in NIST-Boulder by a team that represented scientists, budget, and facilities and is based on:

- Lessons learned from previous projects (AML);
- Historical cost data from projects completed at the NIST-Boulder site;
- Cost data from similar, non-federal, construction projects;
- Consultation with a qualified A/E firm on estimated costs; and
- Design information and cost data previously provided to NIST by qualified A/E firms.



Above L3 it is cheaper to build new versus renovate

Summary

- **The proposed FY 2008 budget is an excellent budget**
 - Enhances NIST's ability for world-class research on measurement problems that impact our Nation's economic security and quality of life;
 - Provides the facility capabilities necessary to carry out our mission well into the future; and
 - Shows continued strong support for our Nation's science and technology