How Can NIST Best Support Innovation?

NIST VCAT Meeting
June 13, 2006

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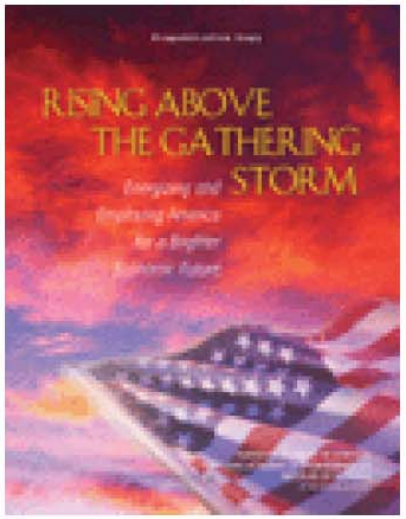
National Academy Study discusses critical issues about US innovation in the 21st Century



Rising Above The Gathering Storm: Energizing and Employing America for a Brighter Economic Future

Committee on Prospering in the Global Economy of the 21st Century:An Agenda for American Science and Technology, National Academy of Sciences, National Academy of Engineering, Institute of Medicine

ISBN: 0-309-65463-7, 504 pages, 6 x 9, (2005)

Academy Committee Definition:

Innovation:

The process of converting inventions, ideas, or concepts into commercial products or processes.

Word Frequencies

• Innovation	450
• NSF	120
• NIH	65
• NIST	10 (3)

Total US Research & Development Funding vs. Time

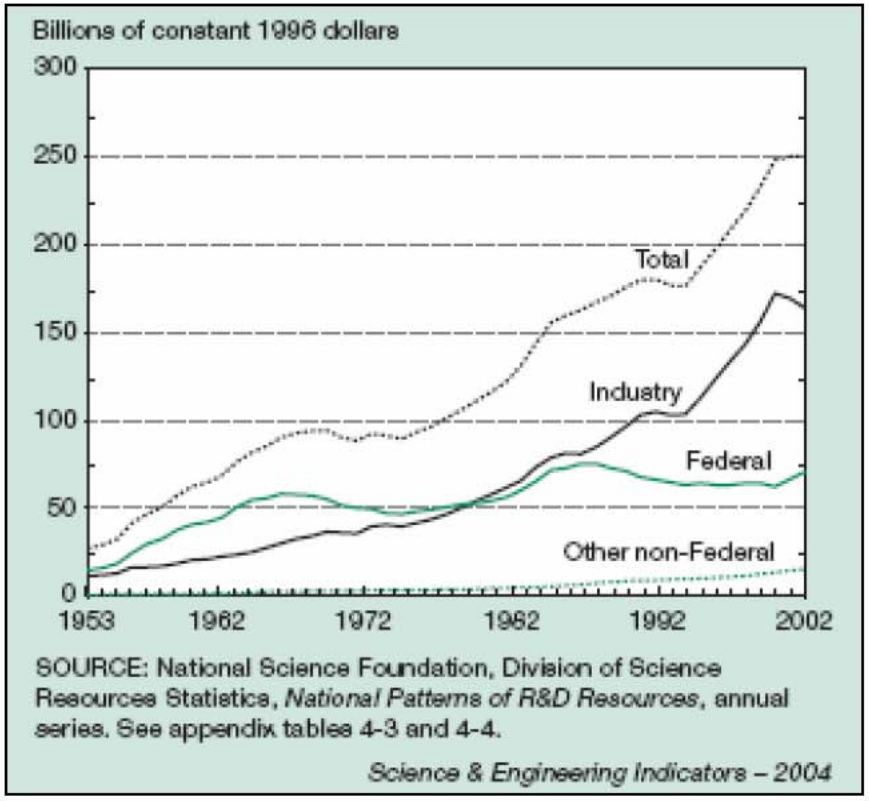
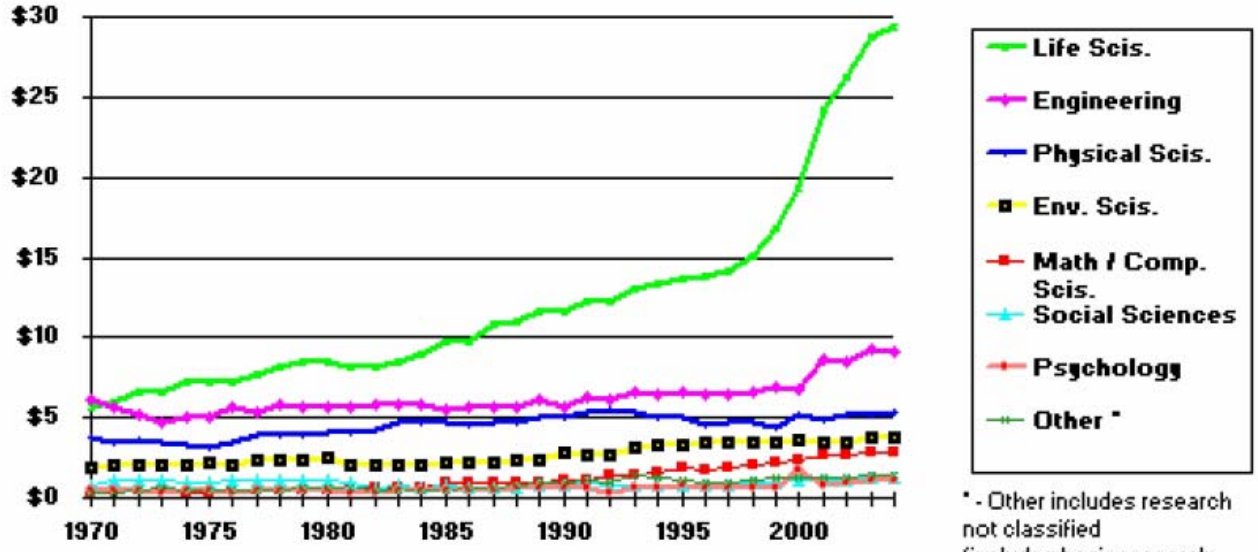


FIGURE 3-10 Federal R&D funding as a share of GDP has been declining; industry funding has decreased recently.

Trends in Federal Research by Discipline, FY 1970-2004

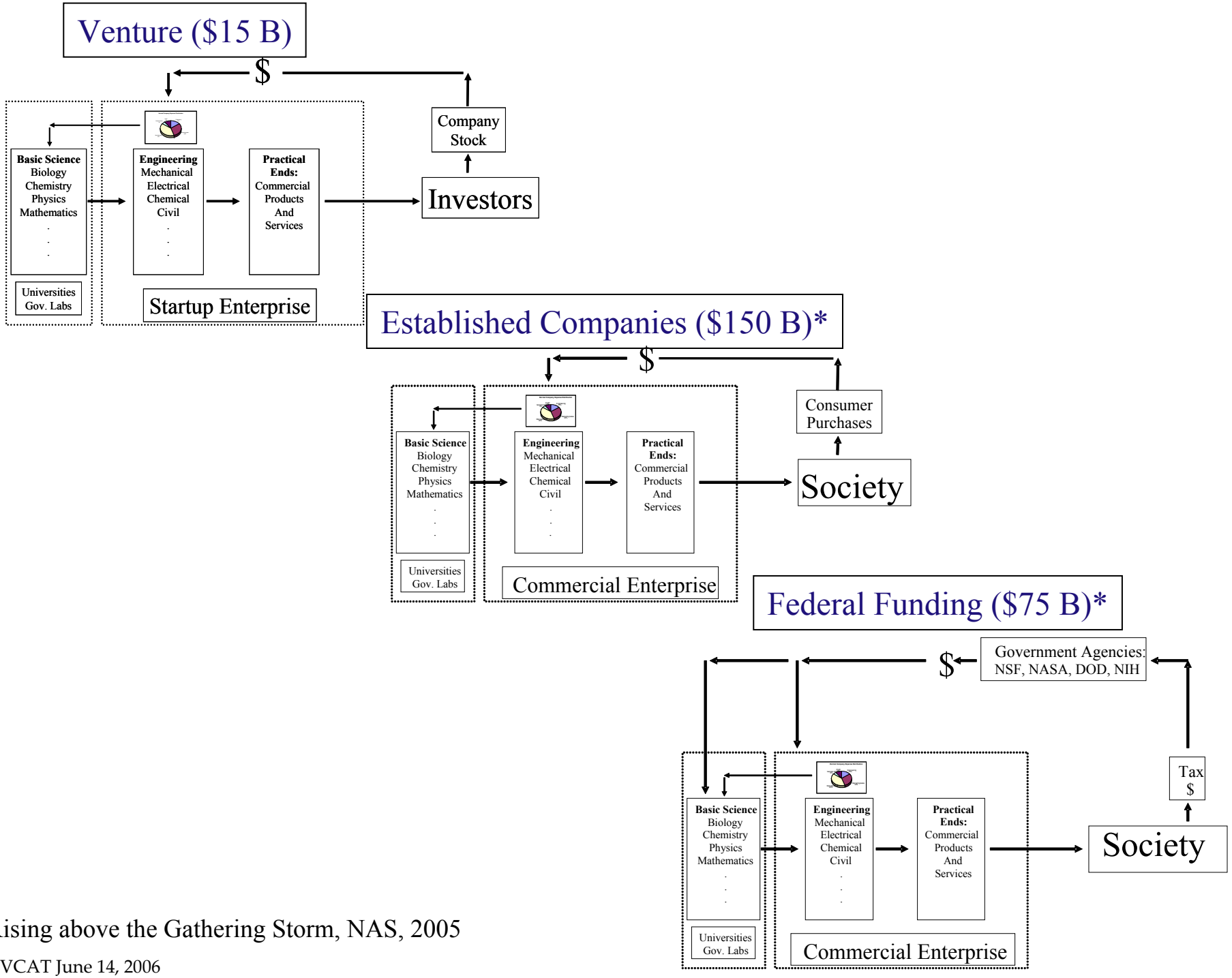
obligations in billions of constant FY 2004 dollars



* - Other includes research not classified (includes basic research and applied research; excludes development and R&D facilities)

Source: National Science Foundation, *Federal Funds for Research and Development FY 2002, 2003, and 2004,* 2004. FY 2003 and 2004 data are preliminary. Constant-dollar conversions based on OMB's GDP deflators. OCTOBER '04 © 2004 AAAS

AAAS



*Rising above the Gathering Storm, NAS, 2005

Academy Committee recommendations for NIST:

MEP

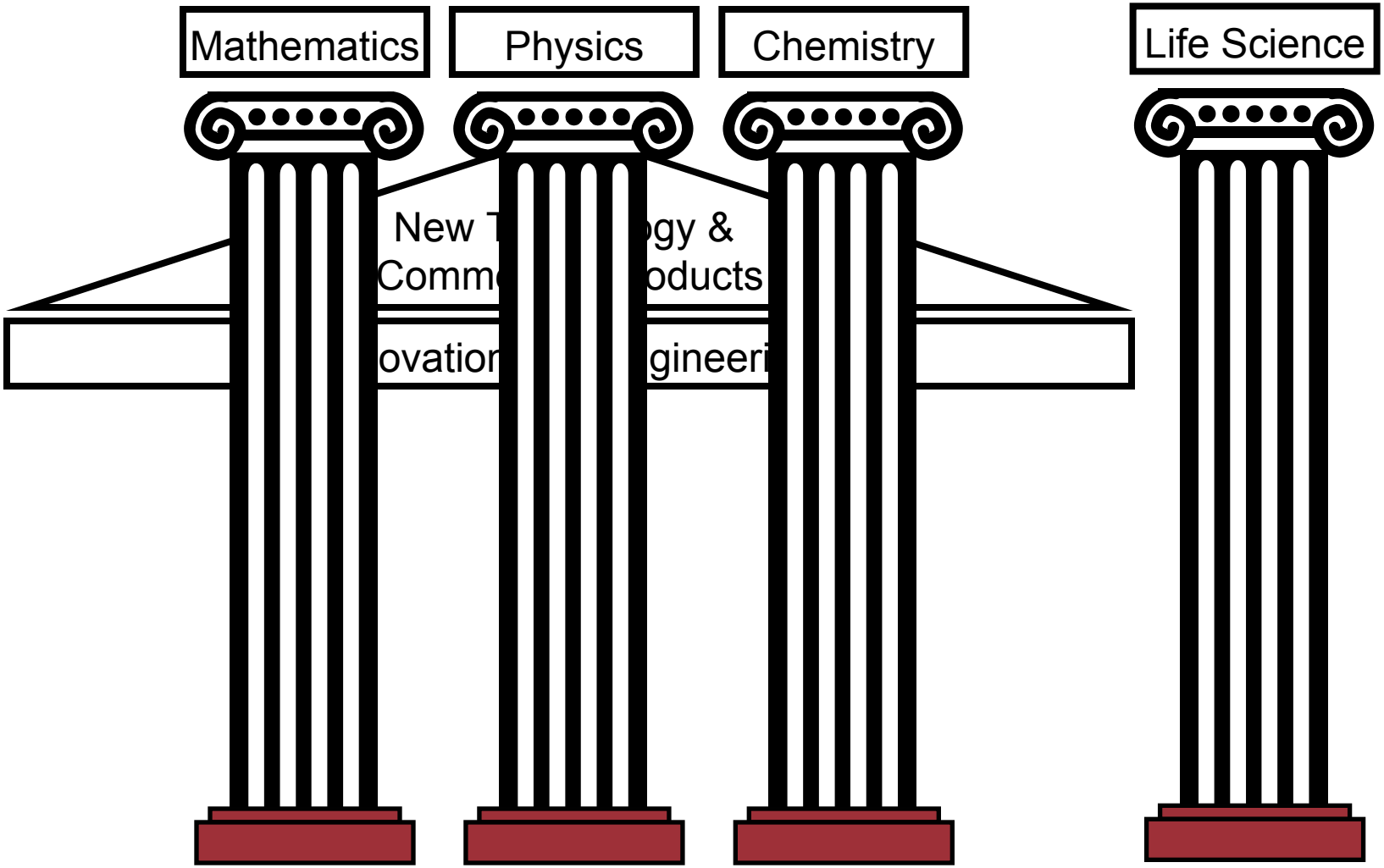
- Establish a program of Innovation Extension Centers to enable small and medium-sized enterprises to become first-tier manufacturing partners
- Create centers for production excellence that include shared facilities and consortia

ATP

- Restore the support of ATP and its ability to fund new projects to the level of recent years.
- Streamline and shorten the ATP application process and timeline.
- Give applications from single companies parity with those from joint ventures or consortia.
- Extend the window for ATP award applications, accelerate the decision-making process for awards, and extend the period in which awards can be made.
- Retain the debriefing process for unsuccessful ATP applicants.
- Concentrate a significant portion of ATP awards in selected thematic areas.
- Coordinate ATP with SBIR and national initiatives.
- Establish a regular outreach program within NIST to coordinate ATP awards with matching grants by states.

After reading The Rising Storm, my conclusions:

- We don't have an *Innovation Crisis*
  - There are plenty of financial resources supporting US innovation through investment in basic research and development
- US needs to review the process and extent of federal government supports for basic science through NSF, DoE, DoD, and NIH
  - Determine position of Federal support of basic research on the US priority list, relative to investments in basic infrastructure, education, entitlement programs and national security
- The historical role and mission of many of the DoD and DoE National labs are essentially obsolete. We need a new vision of a 21st century mission for this critical resource.
  - Should their primary role now be to support innovation in US industry?
- NIST can best support innovation by staying focused on its mission to support US industry by developing and improving the standards infrastructure for key/major US industries and by being a world leader in advancing measurement science.


Mathematics
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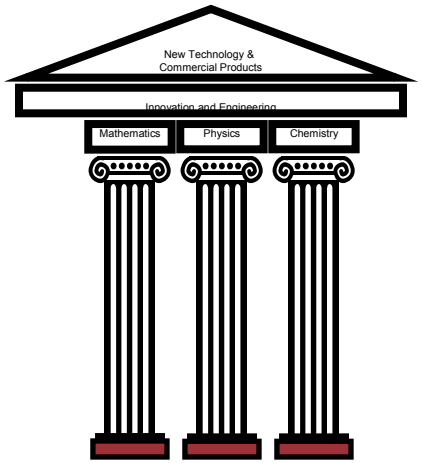
Question for NIST SMB:

- Is NIST effectively supporting innovation in the Biotechnology and Healthcare industries?
- Can NIST efficiently support innovation in this multidisciplinary industry given the current NIST laboratory structure?



- The Healthcare and Biotechnology sector is roughly $2 Trillion, the largest single industrial sector.

One Example of where NIST could have a major impact on innovation in health care through support of measurement science:

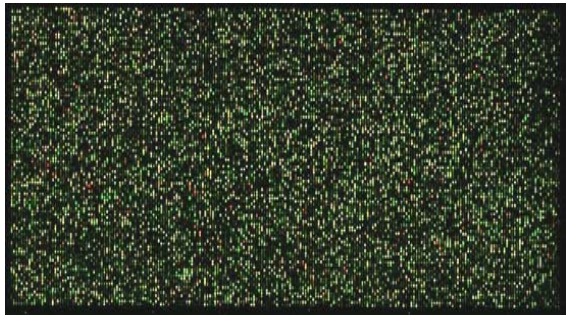
Rank	Cause of Death	No. of deaths	% of all deaths
1.	Heart Diseases	700,142	29.0
2.	Cancer	553,768	22.9
3.	Cerebrovascular diseases	163,538	6.8
4.	Chronic lower respiratory diseases	123,013	5.1
5.	Accidents (Unintentional injuries)	101,537	4.2
6.	Diabetes mellitus	71,372	3.0
7.	Influenza and Pneumonia	62,034	2.6
8.	Alzheimer's disease	53,852	2.2
9.	Nephritis	39,480	1.6
10.	Septicemia	32,238	1.3

Source: US Mortality Public Use Data Tape 2001, National Center for Health Statistics, Centers for Disease Control and Prevention, 2003.

Two measurement technologies that are revolutionizing cancer diagnosis

CT, PET, MRI, US

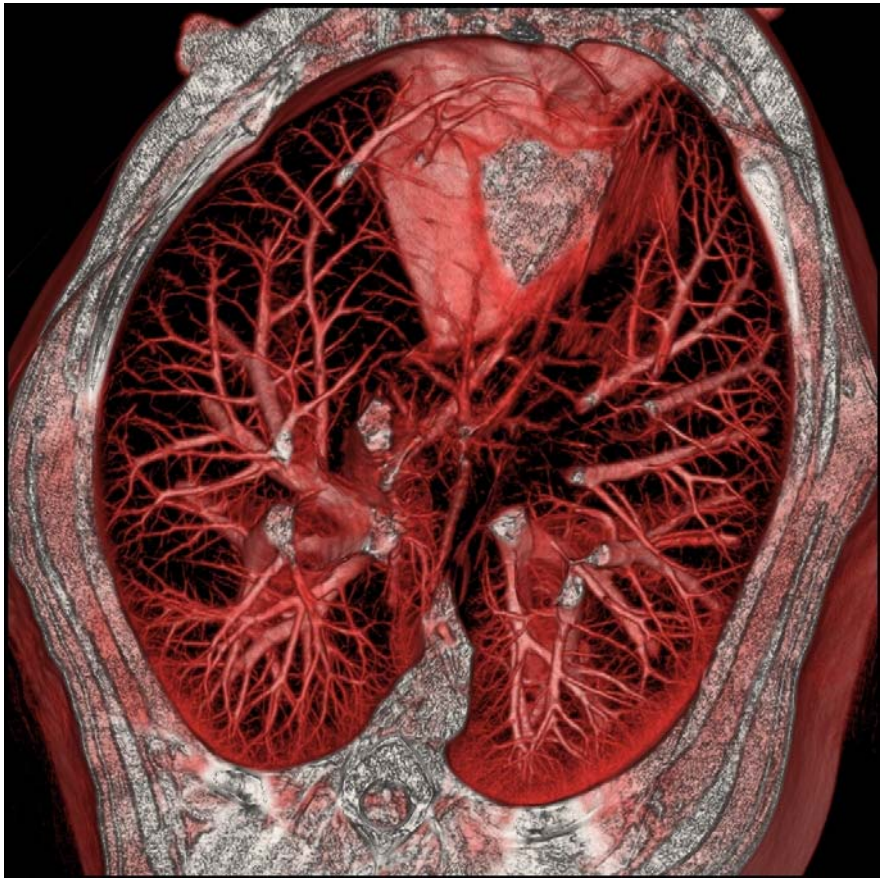
→ Early Detection and Intervention



RNA, DNA, Protein Analysis

→ Personalized Medicine
Patient Customized Therapy

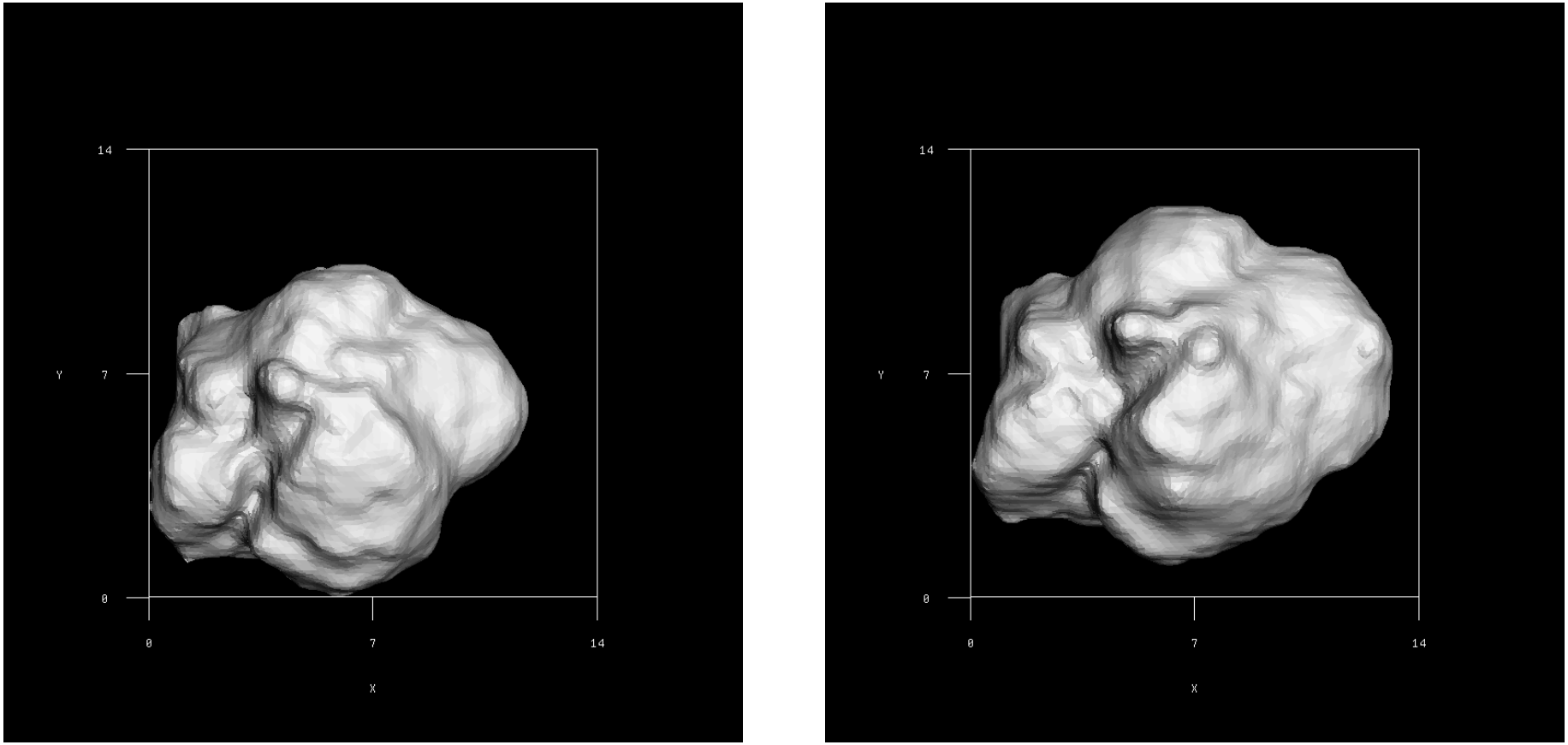
What is the Current State of the Art for CT Imaging?



MD Anderson & GE Health Care, courtesy of Bob Becket

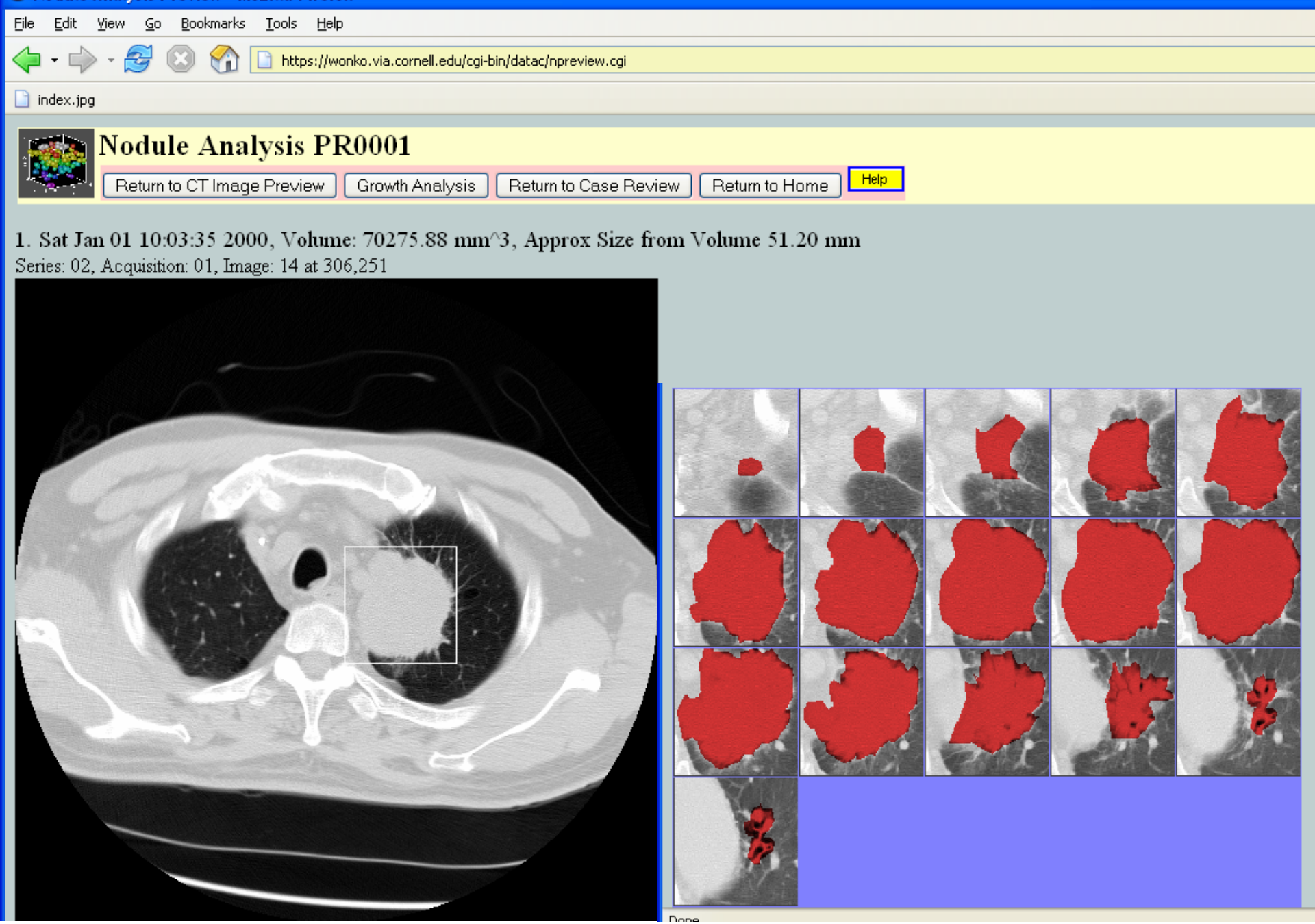
High resolution makes possible solid nodule differentiation from other tissue

Volumetric Growth Rate Analysis



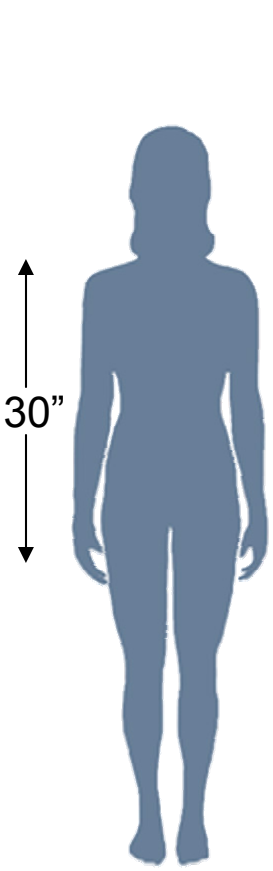
10 mm malignant pulmonary nodule at baseline and 32 days later

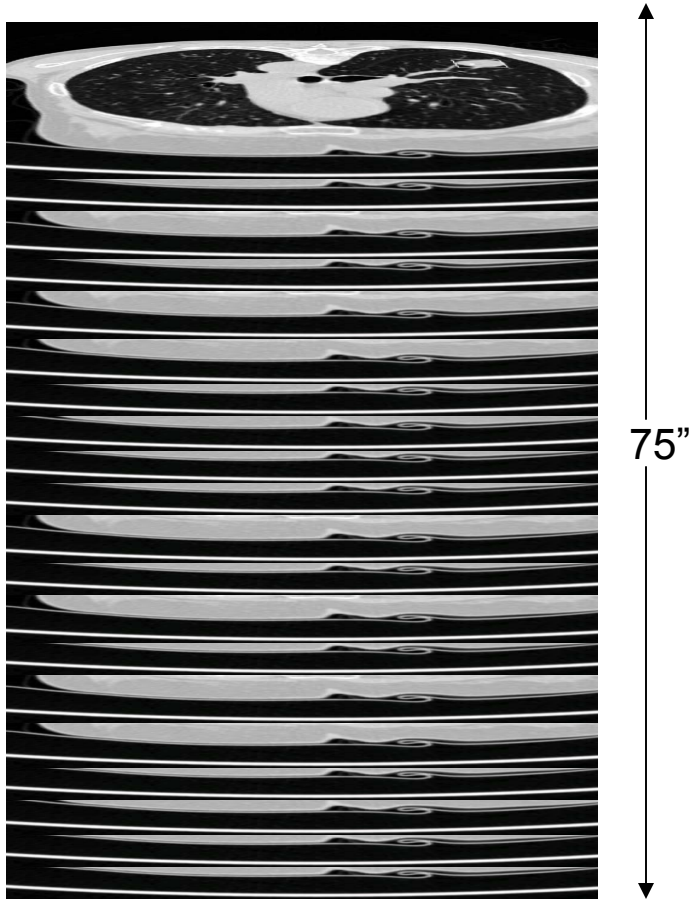
MVGI = 22.0% -- Squamous Cell Carcinoma



How much data from high resolution CT scan?

- 0.1 mm resolution
- 20″ by 20″ by 30″ volume
- Data file size:
  - 10,000, 20 MByte images
  - 200 GBytes
- Stack of x-ray films
  - 75″ tall
  - ~400 pounds

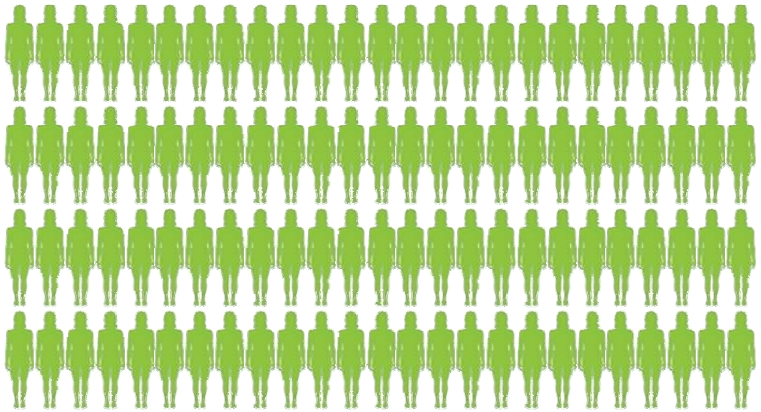




Screening of at risk patients generates lots of data!
How do we build the scientific infrastructure to access and analyze this data?

200 Gbytes X 10,000 Patients/day = 2 PetaBytes/day (2000 TeraBytes)

X



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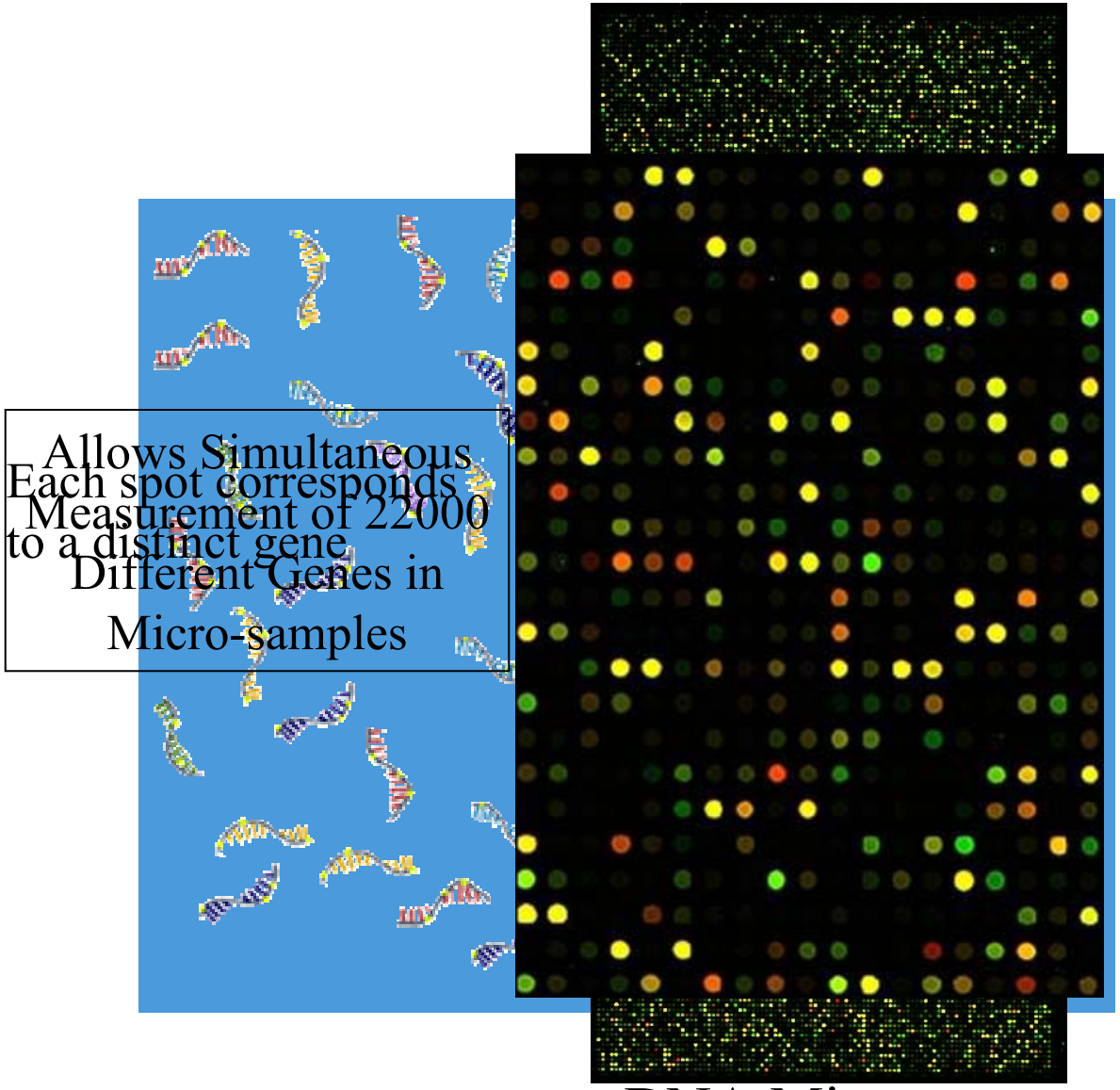
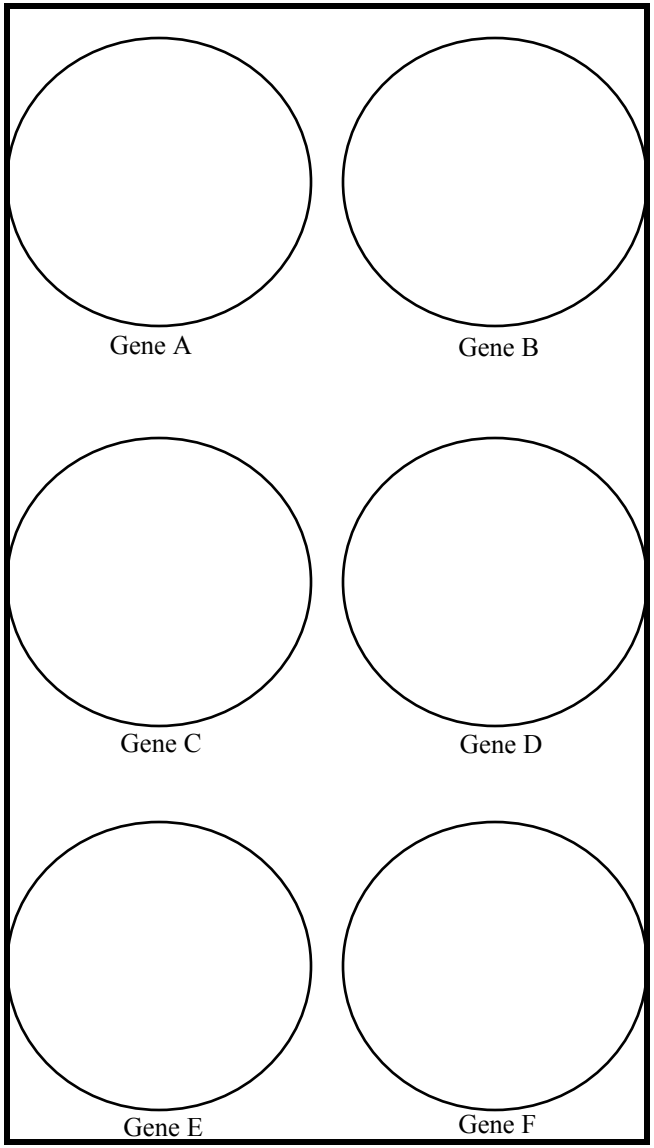
Separate and Measure RNA Population:



Allows Simultaneous Measurement of 22000 Different Genes in Micro-samples

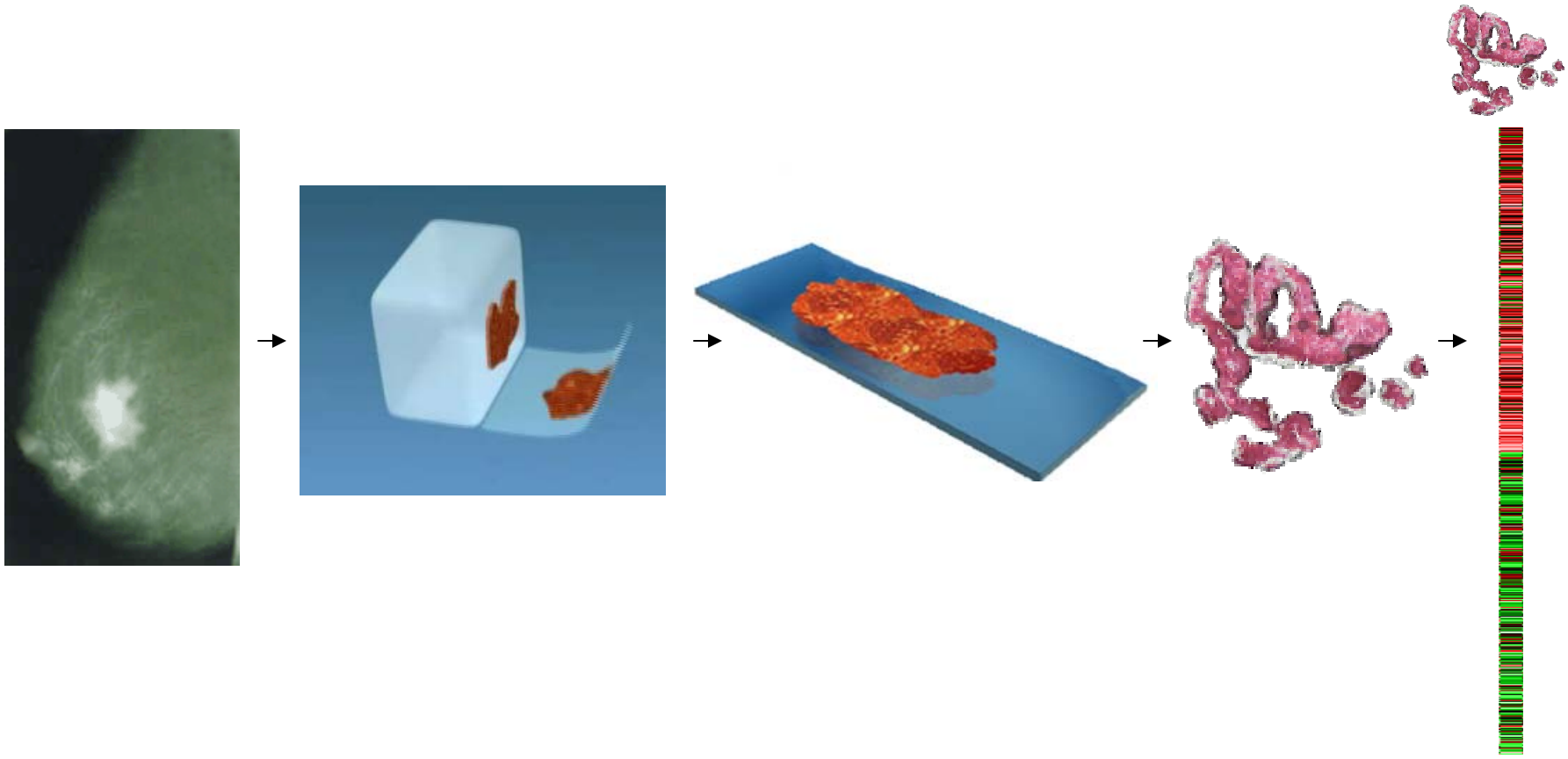
Each spot corresponds to a distinct gene

DNA Microarray Example

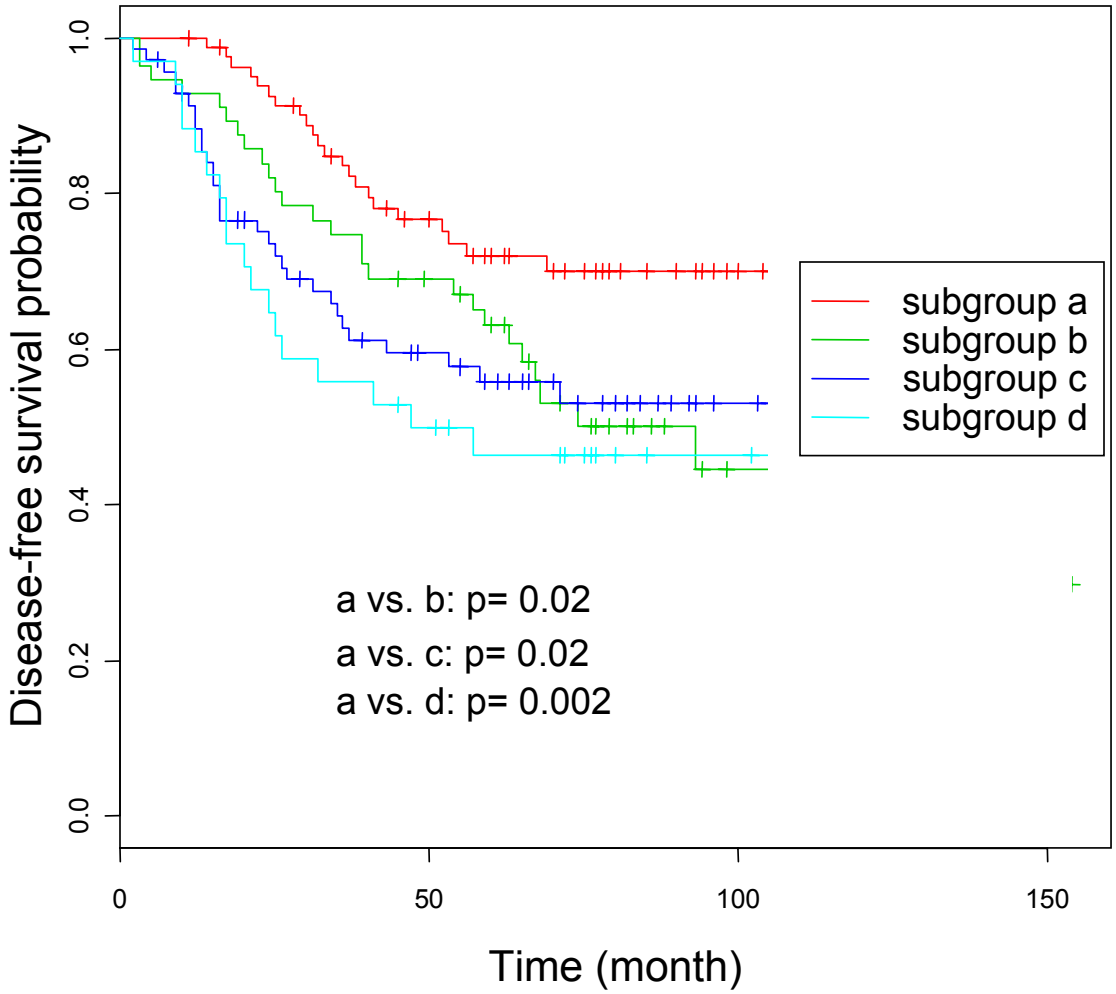


DNA Microarray

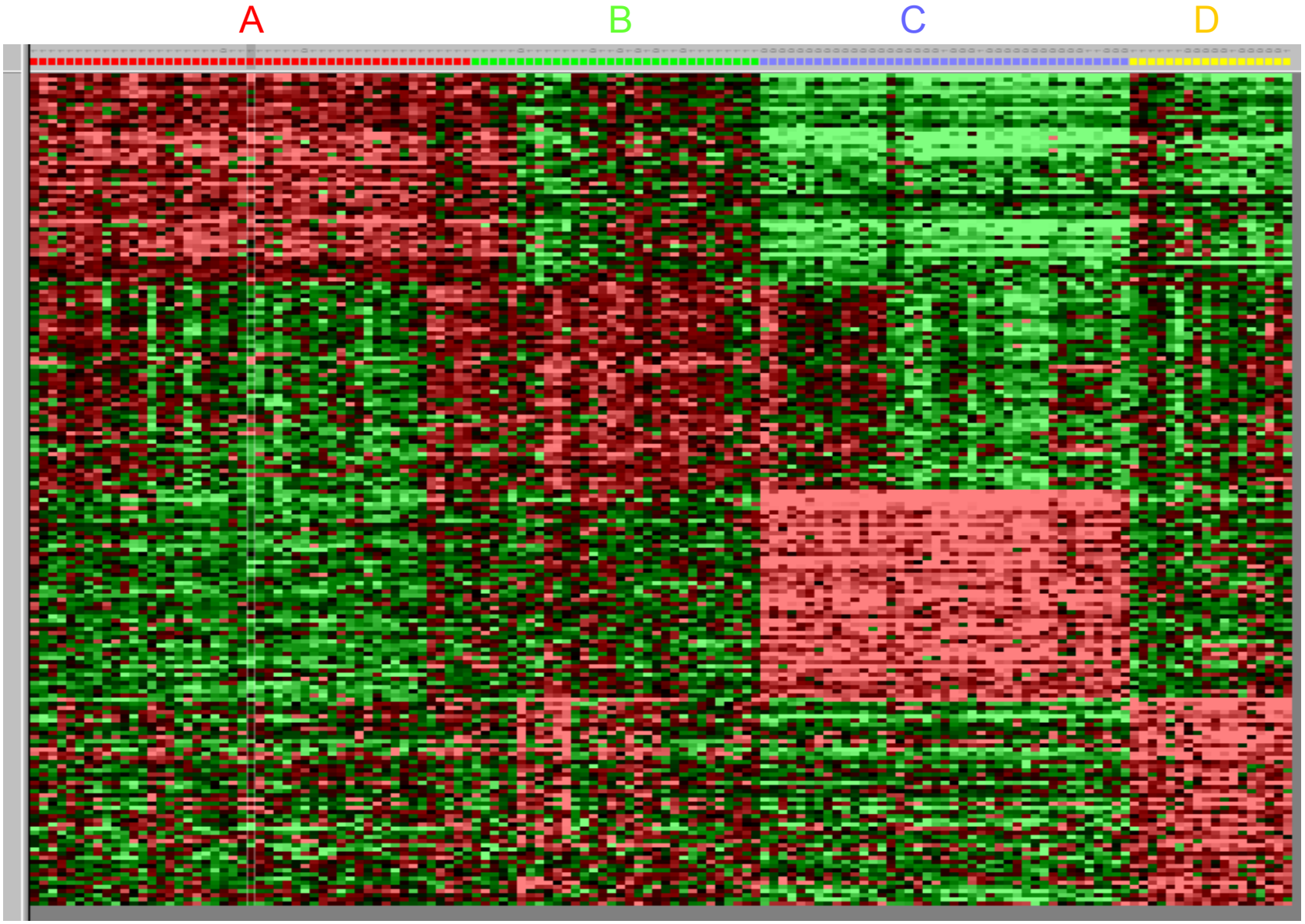
Measuring a gene expression signature:



Four Subgroups Have Distinct Disease-Free Survival Curves



Breast Cancer Subtype Signature



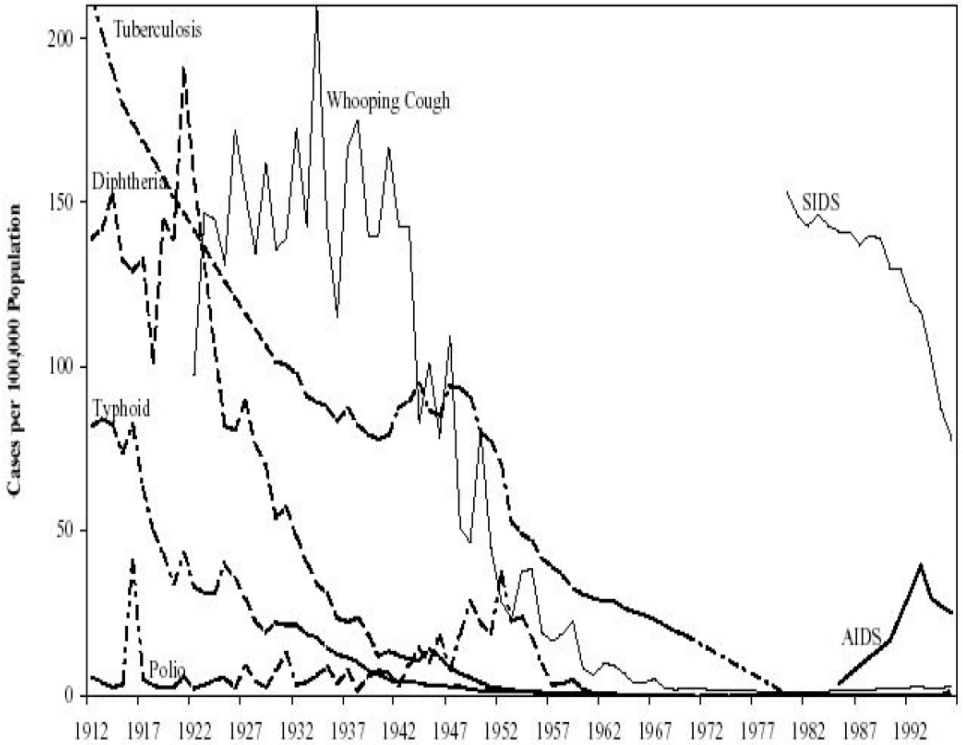
Barriers to Innovation in cancer screening and diagnosis which NIST could help overcome:

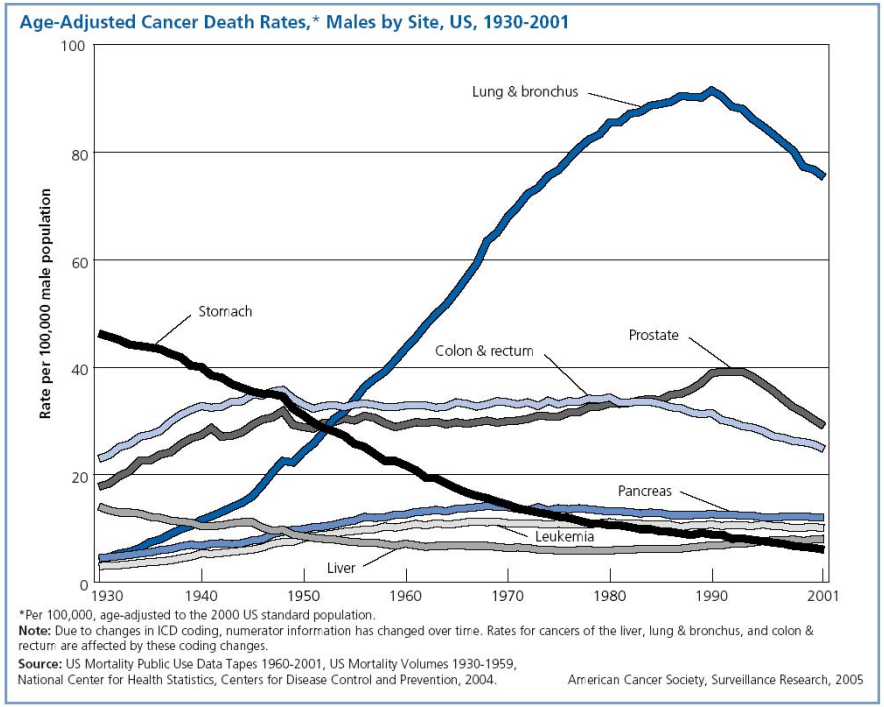
- Measurement methods to distinguish benign from malignant tissue and determine appropriate therapies
- Automated software algorithms to measure tumor size accurately
- Calibration procedures to assure instrument reproducibility over time
- CT and molecular analysis platform interoperability
- Methods to validate, analyze, and share huge 3-dimensional datasets

How can NIST best support US innovation?

- Continue to implement its mission
- Review the National Academy recommendations for changes to ATP and MEP
- Consider radical changes to how it supports the biotechnology and health care industries

Infectious Disease and Cancer Death Rates vs. Time

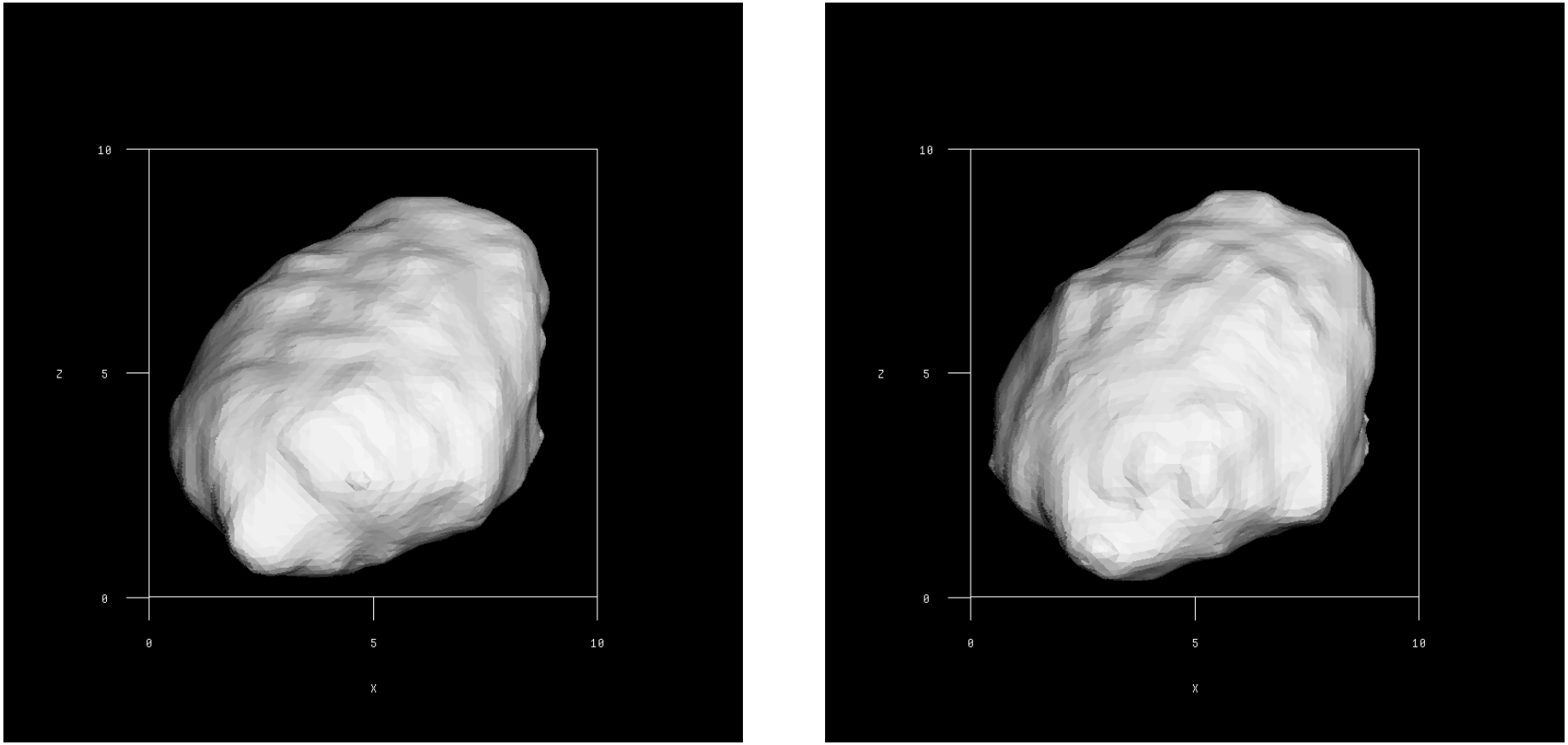




CT screening example: Lung Cancer

- Lung cancer results in more deaths than any other cancer (~160,00/year in the US)
- 85% lung cancer patients have a history of smoking
- Current chest x-ray screening methods detect tumors greater than 2 cm
- With tumors this large 4 year post-surgery survival rate is only 15%
- Current generation of CT scanners appears to detect tumors as small as 0.5 cm
- Initial results indicate post-surgery survival rates greater than 90%
- Currently CT screening is complicated by a large number of false positives leading to unnecessary and hazardous surgical procedures

Volumetric Growth Rate Analysis

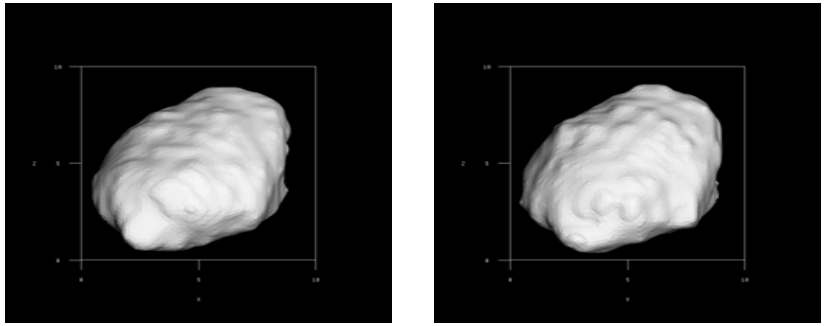


8 mm stable pulmonary nodule at baseline and 181 days later

MVGI = 0.57%

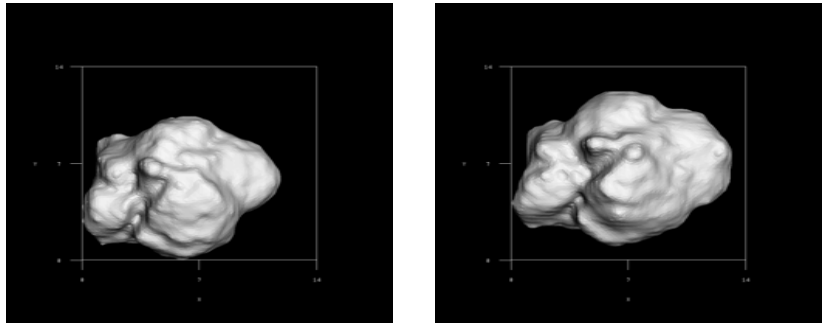
Volumetric analysis drives critical therapeutic decisions:

Stable Nodule



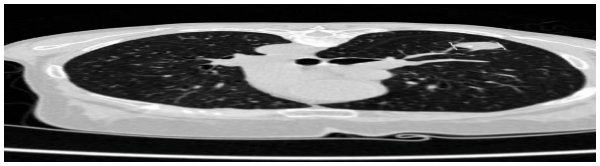
"Watchful Waiting"

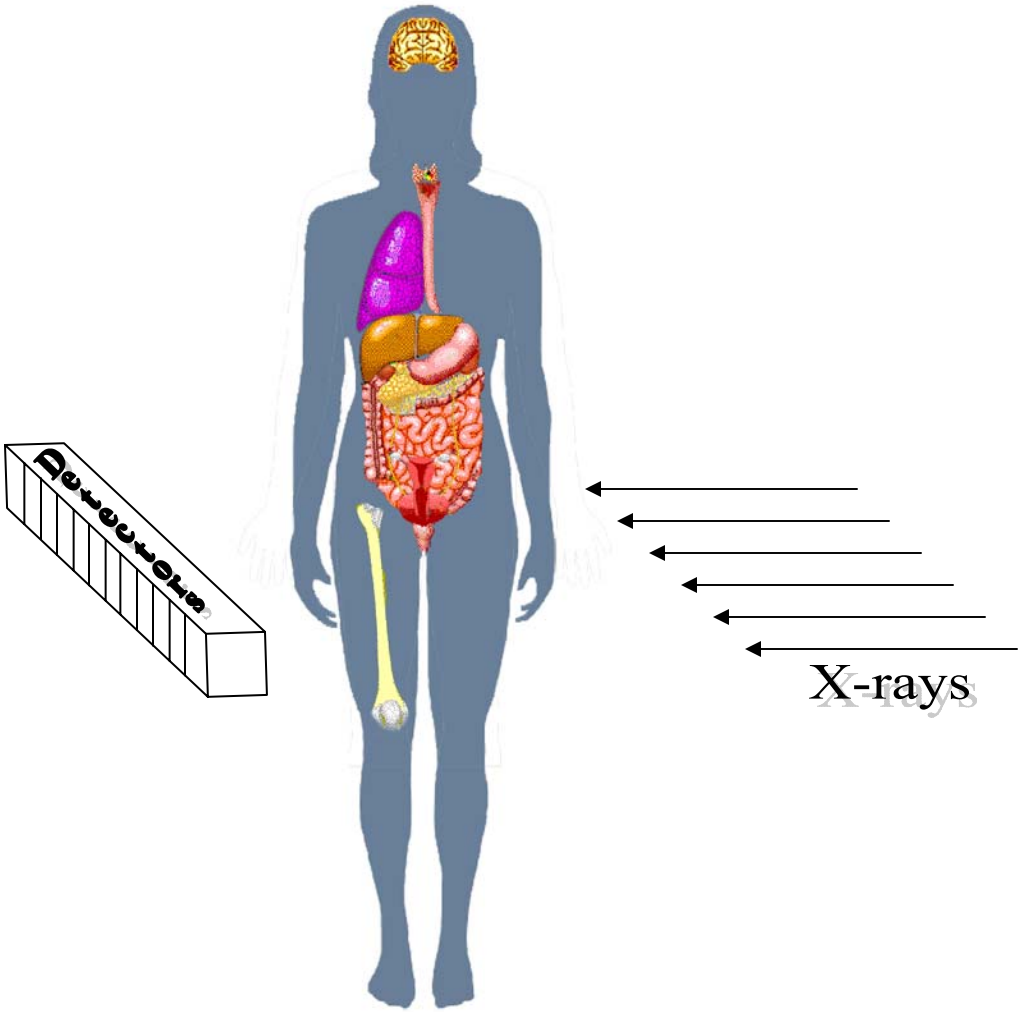
Malignant Nodule



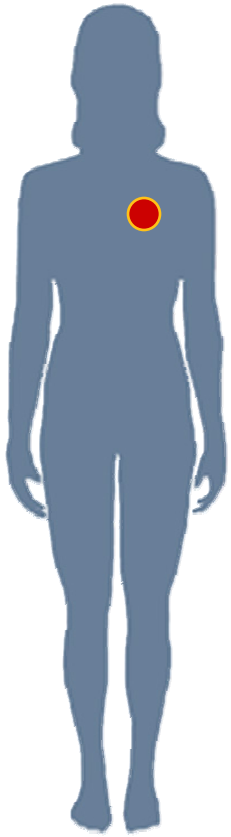
Surgery/Chemotherapy

Building a 3 dimensional image





Molecular technology analyzes the molecular basis of disease: The RNA, DNA, and protein components of tissues.



Modern molecular technologies can provide new answers to these critical questions:

- What is the best drug to use for treatment?
- What is the likelihood of recurrence?
- How fast is the tumor growing?
- How many different types/subtypes of cancer?
- Where is the primary site of the cancer?

Researchers anticipate advances in two technologies will revolutionize cancer diagnosis

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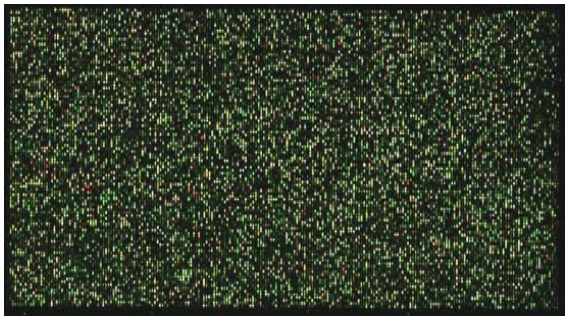

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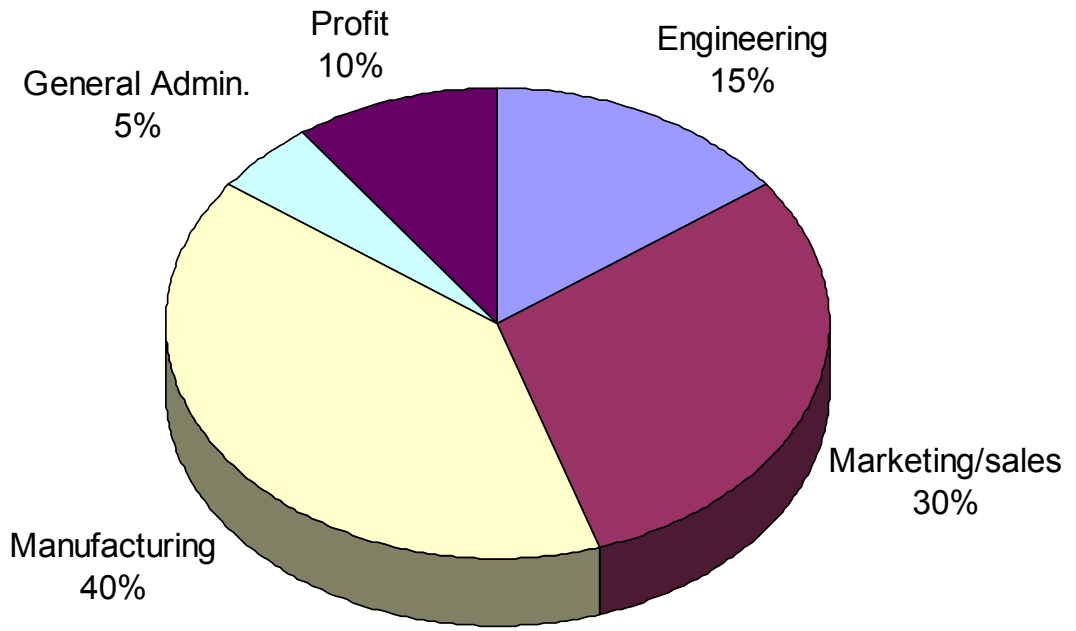
Early Detection
&
Most Effective Treatment

Imaging + Molecular Analysis = (?)

Eliminate Suffering and Death Due to Cancer by 2015

Normal Company Expense Distribution



Consumer Purchases

Society

Universities
Gov. Labs

Commercial Enterprise

Why has there been so little progress compared to other disease areas?

Infectious Diseases

- Invasion by non-human organism
- Stimulates immune response
- Cure possible after symptoms
- Systemic disease

Cancer

- Slight modification of normal cells
- Usually no immune response
- Often fatal when symptoms present
- Usually localized in early stages
- Many different types of Cancer