National Institute of Standards and Technology

Bio-Imaging Showcase

October 6, 2009

Dr. Jason Boehm

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

Department of Commerce

Gary F. Locke
Secretary of Commerce

Dennis F. Hightower
Deputy Secretary of Commerce

Gary F. Locke confirmed as US Commerce Secretary on March 24, 2009

Dennis F. Hightower confirmed as Deputy Secretary of Commerce on August 7, 2009

- National Oceanic and Atmospheric Administration
- International Trade Administration
- US Patent and Trademark Office
- **National Institute of Standards & Technology**
- Economics and Statistics Administration
- other agencies...

The historic mission of the Department is "**to foster, promote, and develop the foreign and domestic commerce**" of the United States. This has evolved, as a result of legislative and administrative additions, to encompass broadly the responsibility **to foster, serve, and promote the Nation's economic development and technological advancement**.

Patrick D. Gallagher
Deputy Director

Secretary Locke announced President Obama's intent to nominate Dr. Gallagher to be the 14th Director of NIST on September 10, 2009

NIST Mission and Programs

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

NIST Laboratories

- Create critical measurement solutions and promote equitable standards to stimulate innovation, foster industrial competitiveness, and improve the quality of life.

Hollings Manufacturing Extension Partnership

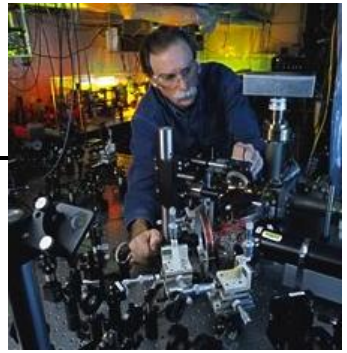
- Nationwide network of resources helping smaller manufacturers compete globally

Baldrige National Quality Program

- Promoting and recognizing performance excellence via information and Presidential awards in manufacturing, service, small business, education, health care, and the nonprofit sector

Technology Innovation Program

- Supports development of cutting edge technologies by the private sector and universities to address critical national needs and key societal challenges



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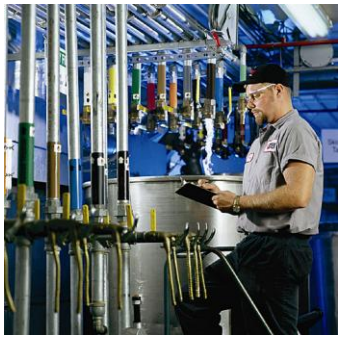


Courtesy Stoner Inc.

Courtesy Steuben

NIST Products and Services

Collaborations
- 2600 Associates and Facility Users

Measurement Research
- 2,200 publications per year
- 8,000 attendees at 69 technical conferences

Standard Reference Data
- 100 different types
- 6,000 units sold per year
- 130 million data downloads per year

Standard Reference Materials
- 1,300 products available
- 33,000 units sold per year

Patents and Inventions
- 40 in FY 07

Baldrige National Quality Program
- 67 Award recipients (71 Awards)
- 1,139 Baldrige Award applications

Manufacturing Extension Partnership
- 28,000 Clients

Calibration Tests
- 24,000 tests per year

Laboratory Accreditation
- 800 accreditations of testing and calibrations laboratories per year

Standards Committees
- 400 NIST staff serving on 1,000 national and international standards committees

Other Agency R&D
- > 300 Agreements with 80 Fed. Agencies
- $125M received in FY 2009

President's Science and Innovation Plan

President Barack Obama gives a speech at the National Academy of Sciences on April 27, 2009.

Commerce Secretary Gary Locke and Harvey V. Fineberg President of the Institute of Medicine., NAS.

The President's budget recognizes that NIST is a capable partner that is strategically positioned to help the Nation improve its innovation performance and respond effectively and efficiently to national priorities.

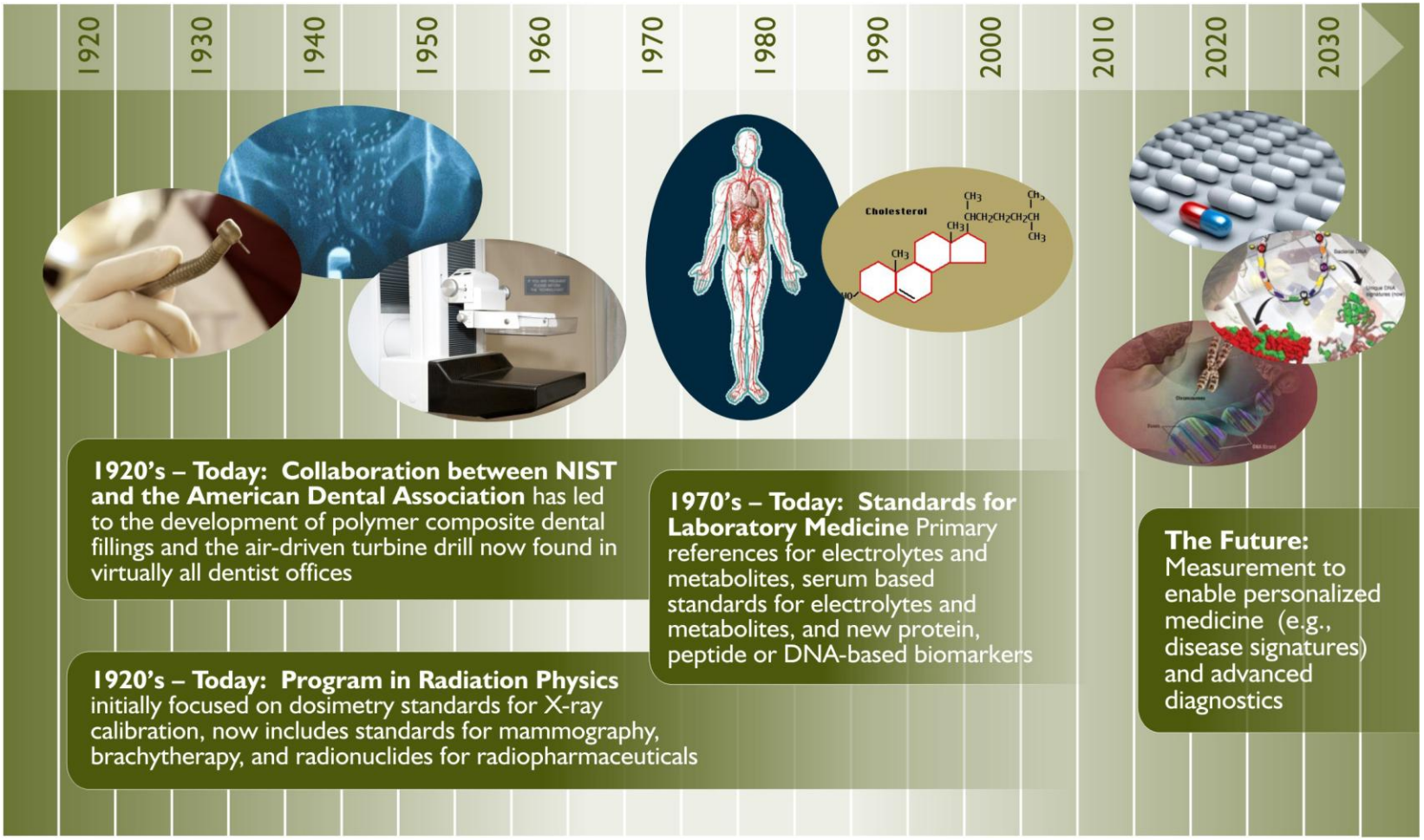
- Double NIST laboratory/construction budget
- Growth of Hollings MEP Program
- Growth of Technology Innovation Program

NIST programs directly impact Presidential priorities:

- Smart Grid
- Health IT
- Cyber-security
- Manufacturing
- Innovation and competiveness

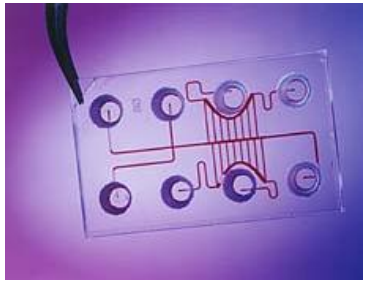
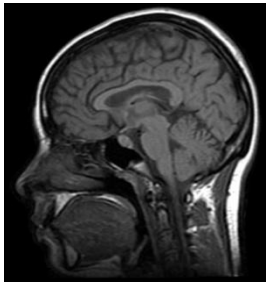
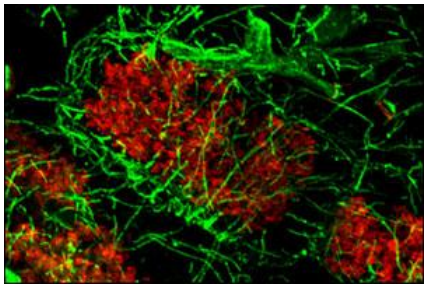
Photos by Patricia Pooladi courtesy National Academy of Sciences.

NIST and Healthcare

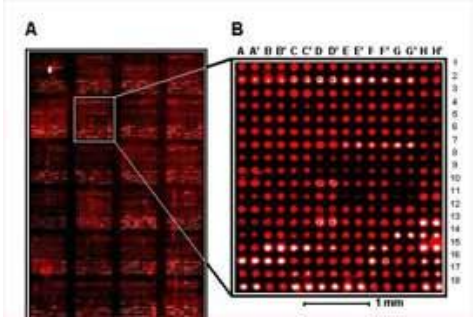


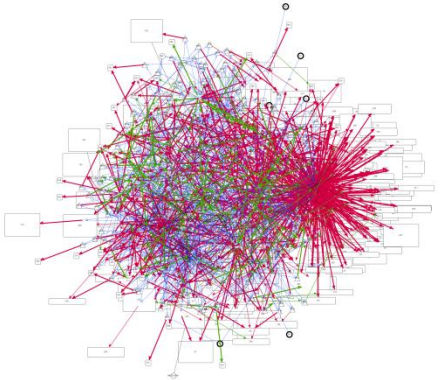
Measurement Infrastructure for Healthcare Innovation

1. **Standards and Technology for Increased Quality in Current-Generation Biomedical Measurements for Diagnostics And Therapeutics**
   - ***Laboratory Medicine***
   - ***Medical Imaging***

2. **Standards to Support Next-Generation Healthcare Measurements in Human Cells, Fluids and Tissues**
   - ***Tools to support discovery and utilization of "Disease Signatures"***





Advanced Imaging Technologies: Molecules to Man

1)Whole body imaging: New therapies for cancer, quantitative and reproducible imaging of biomarkers, and software for image registration

2) 3D compositional mapping of cells: development of robust, automated technologies for the mapping of cellular architecture at molecular resolution aimed at detection of 3D distribution of ions, metabolites, drugs and proteins.

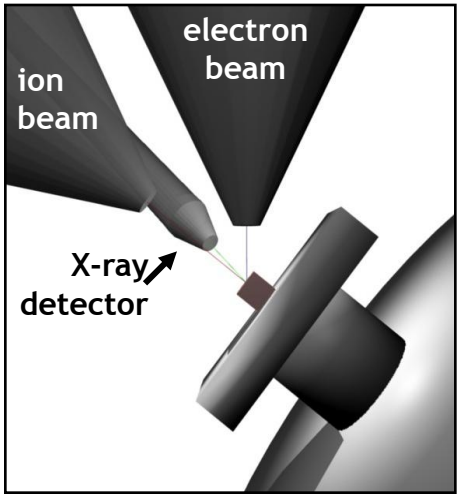
3) Cellular imaging: Super-resolution light microscopy, localization studies in the nucleus and cytoplasm, and software platforms for pattern recognition

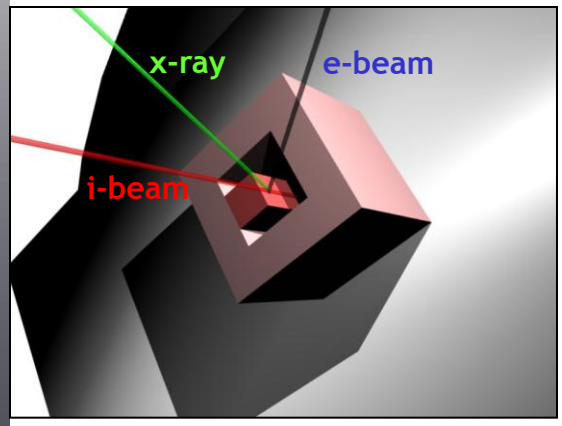
NIST NATIONAL CANCER INSTITUTE

3D Chemical Imaging

Experiment

serial slicing with ion beam + chemical mapping w/ X-rays



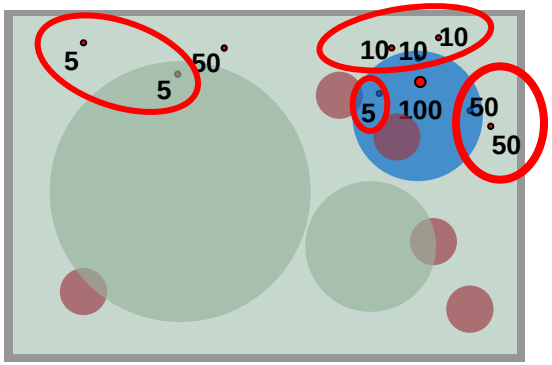


Monte Carlo Simulation

simulate organelles, cytosol, and nanoparticles in realistic geometry to predict detection limits and 3D artifacts

6 micrometers

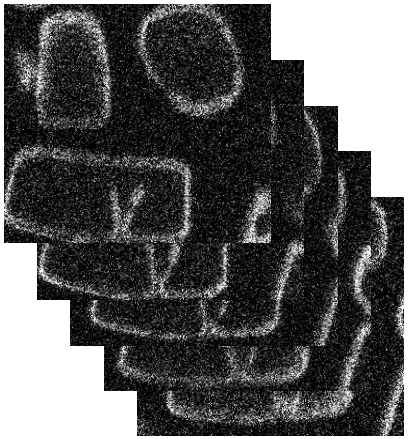
Quantum dot sizes in nm



Experimental Maps

3D maps of diatom silica skeleton

~ 200 serial X-ray maps



visualization of 3D silicon distribution

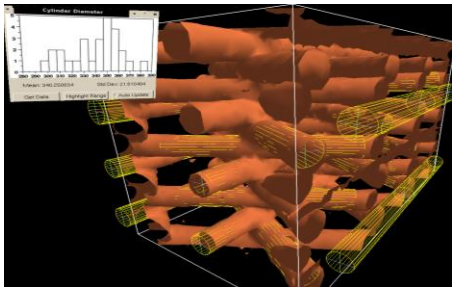
Cellular and Tissue Imaging Methods

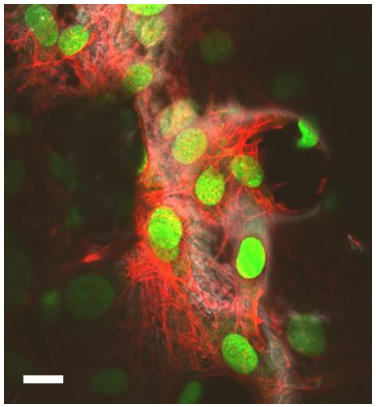
Cellular Imaging

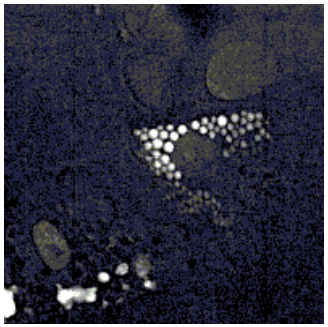
- Confocal, Fluorescence, etc.
  Heavily used, image analysis development
- Optical Coherence
  Noninvasive, Label-free, Excellent penetration
- CARS
  Noninvasive, Label-free, Molecular contrast
- Conjugated Quantum Dots
  Quantitative, Molecular contrast

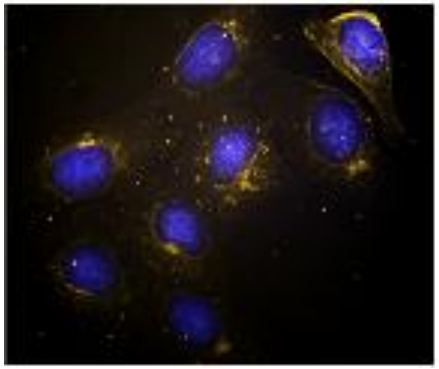
Tissue Imaging

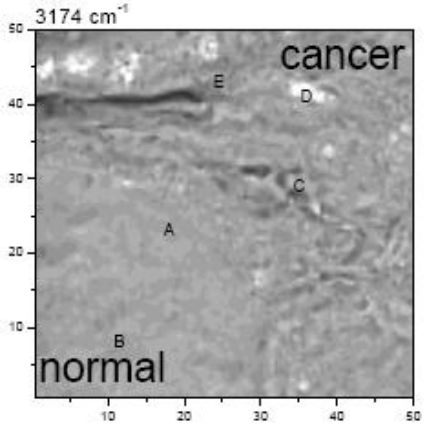
- All of above, plus…
- μCT
  Label-free, 3D structure
- Ultrasound
  Noninvasive, Label-free
- Photo-Acoustic
  Excellent penetration, Molecular contrast











Contact: Marcus Cicerone

Quantitative MRI Standards Research at NIST

New system phantom for determining

- geometric accuracy of MRI scanners
- B0 and B1 non-uniformity
- T1, T2, and protein density measurement accuracy
- Resolution
- signal to noise
- system stability

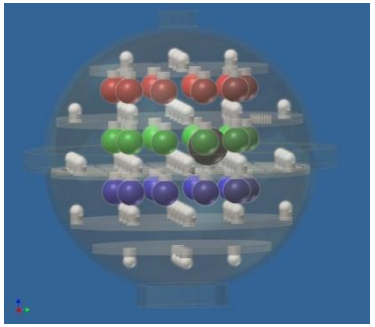


Figure 1 Solid model of MRI system phantom

First MRI phantom with NIST traceability

- open source 3-d models
- associated numerical imaging phantom
- materials properties database
- http://wiki.ismrm.org/twiki/bin/view/QuantitativeMR/QuantitativeMRWhitePaper2007

Figure 2 Microfabricated particles

Developing measurement systems to

- characterize advanced MRI nanoagents
- detect NMR relaxivity around a single nano-contrast agent
- measure the activation of individual nanoagents
- measure magnetic-nanoparticle viral-surrogate concentrations < 104/liter

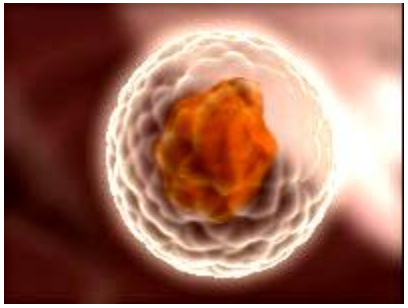
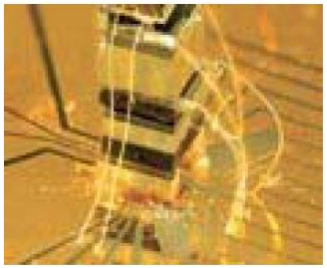


Figure 2 Schematic image of protein cage filled with an iron oxide nanoparticle being investigated for MRI contrast and viral surrogate applications.

Chip-Scale Atomic Magnetometers at NIST



Technology Review
PUBLISHED BY MIT

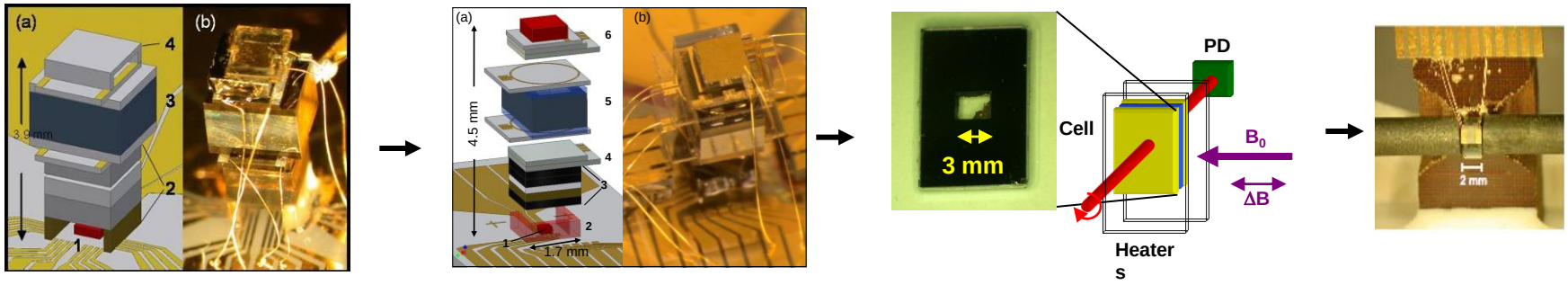
Special Reports 10 Emerging Technologies 2008 See All Special Reports »

TR10 *Technology Review* presents 10 technologies that we think are most likely to change the way we live.

Atomic Magnetometers

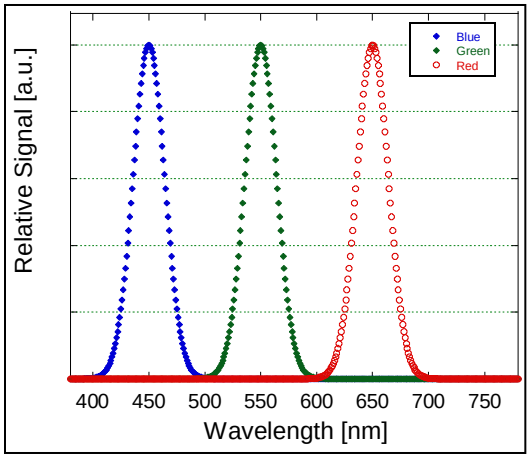
John Kitching's tiny magnetic-field sensors will take MRI where it's never gone before.

2004: 40 pT/√Hz **2006: 5 pT/√Hz** **2007: 70 fT/√Hz** **2008: 15 fT/√Hz**



500 X sensitivity improvement in 3 years

Medical Optical Imaging



Medical Applications:

Burns

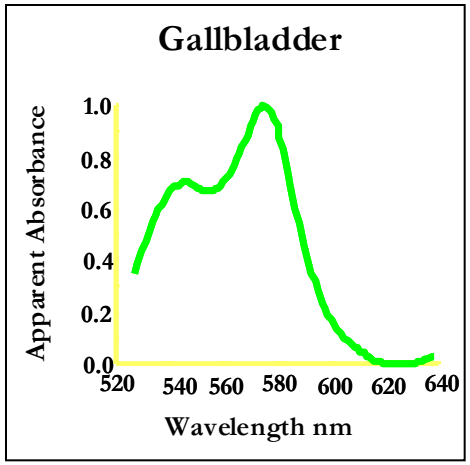
Gall Bladder

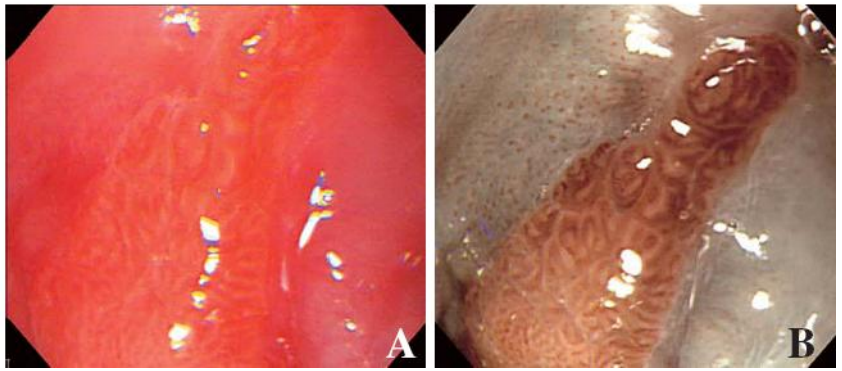
Cancer

Diabetes

Infections

Organ Transplants





NIST Technology Transfer and Collaboration

- A wide variety of tools
  - Patents and licenses
  - Collaborations – formal and informal
  - Guest researchers
  - Facility Use Agreements
  - Publications
  - Standards

NIST Technology Transfer and Collaboration

- www.nist.gov look for “Work with us”
- http://patapsco.nist.gov/ts/220/external/index.htm

- Contact: Office of Technology Partnerships

  otp.nist.gov

  301-975-3084