

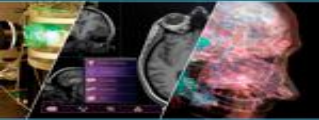
Regulatory Science in FDA's Center for Devices and Radiological Health (CDRH):

**A Vital Framework for Protecting
and Promoting Public Health**



What is Regulatory Science?

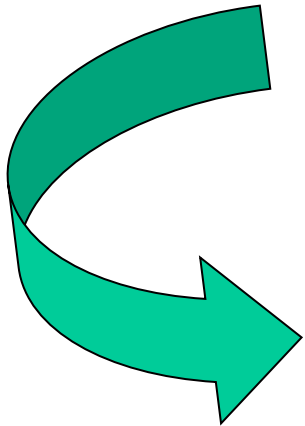
- Provides the tools, standards, and approaches needed to evaluate the safety, effectiveness, performance, and quality of medical products
- Benefits patients by speeding the rate of important technologies reaching market
- Reduces time and resources needed for device development, assessment, and review. For example:
 - Can lead to quicker, more efficient device approvals
 - Can decrease the size and duration of pre-market clinical trials



Computational Modeling

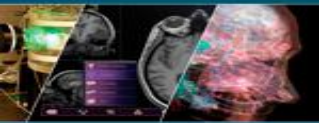
From: The Virtual Physiological Human

- Academic, hypothetical
- Catalogue of normal human anatomy
- European Union
- Constructed by: Academics



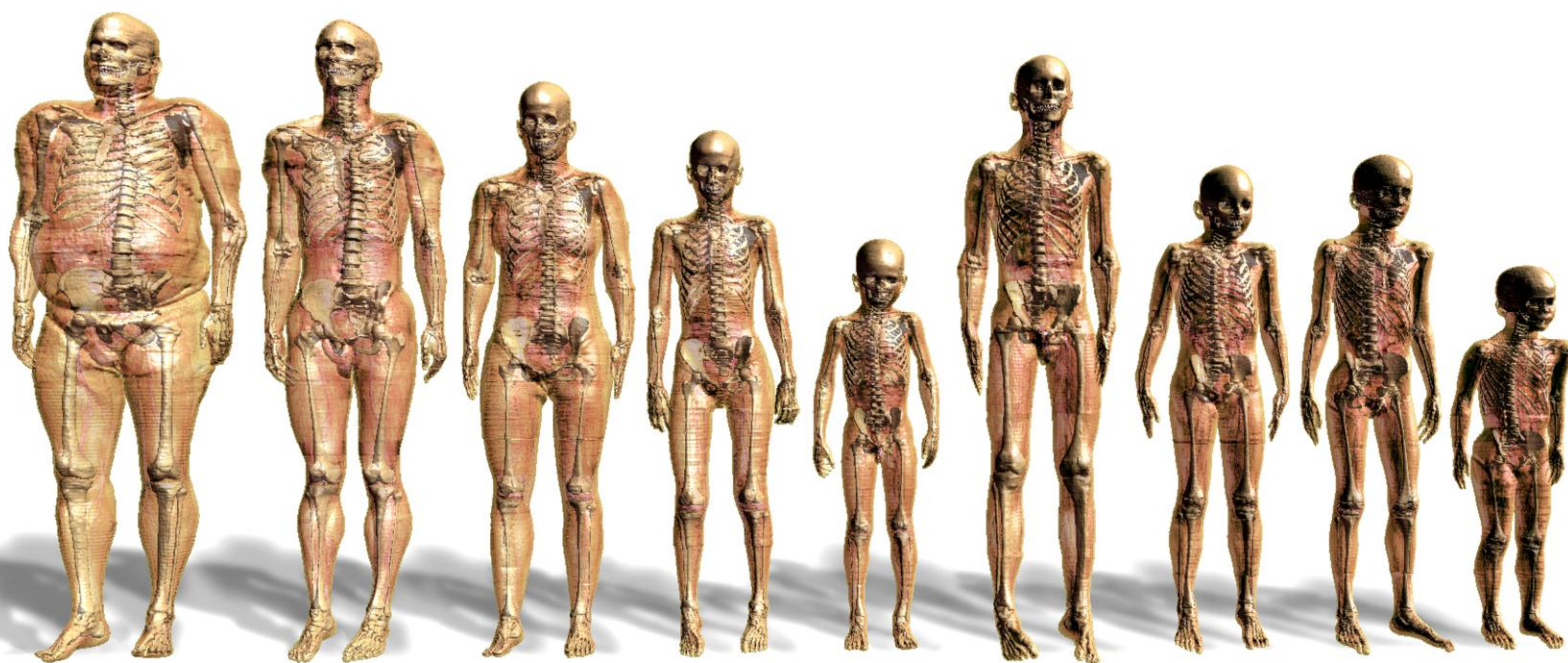
To: The Virtual Physiological Patient

- Practical, applied to device design and testing
- Catalogue of normal human variation and disease physiology/structure
- FDA
- Constructed by Academics, Industry, FDA



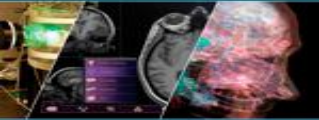
The Virtual Family

Spurring innovation through modeling device use *in silico*



Virtual Family and Virtual Classroom

http://www.itis.ethz.ch/index/index_humanmodels.html



The Virtual Physiological Patient

The Virtual Human Heart

- Valves
- Ventricular Assist Devices

The Complete Peripheral Vasculature

- Aneurysms
- Stents

The Bone Body

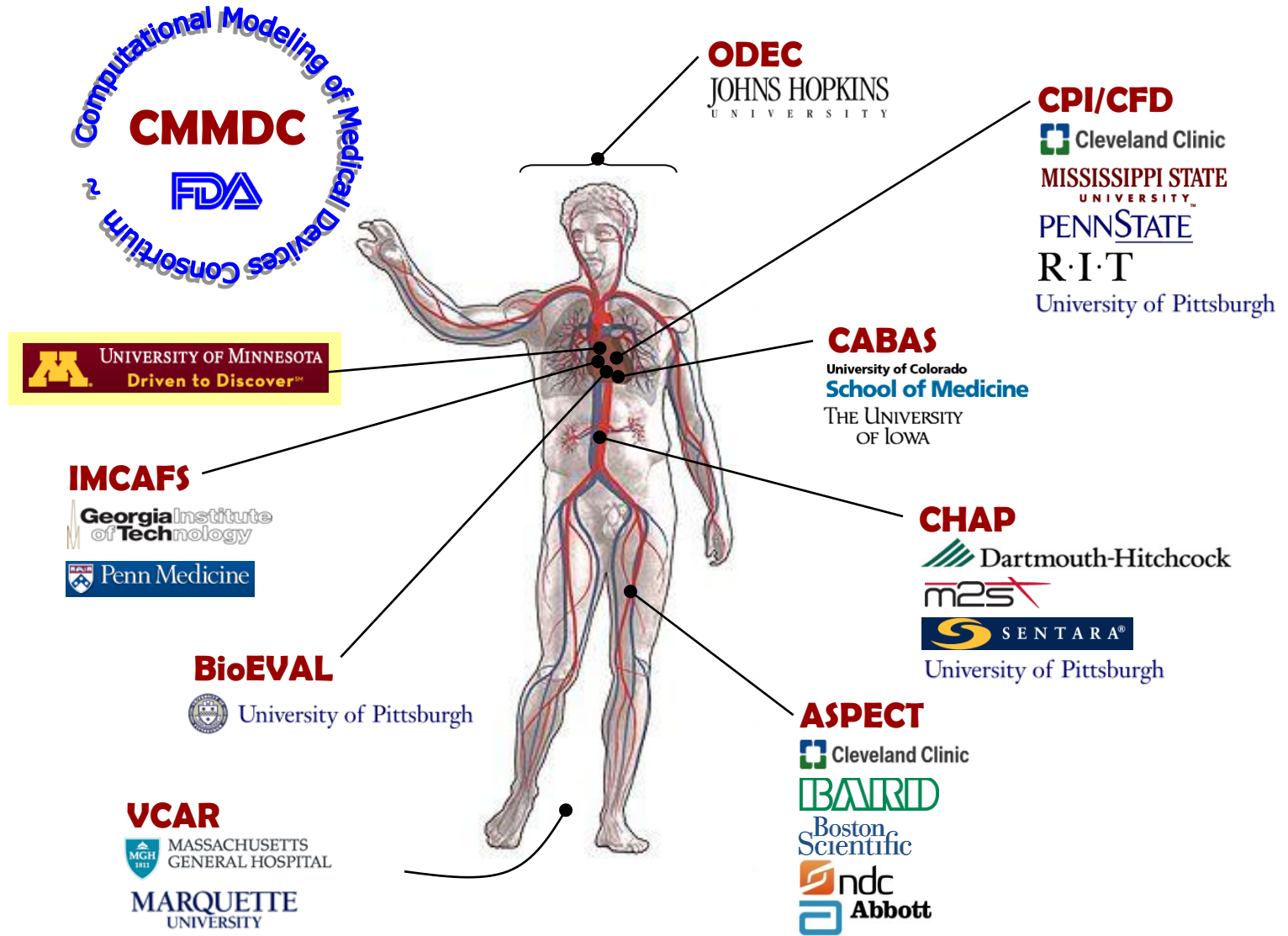
- Joint Replacements

The Model Mind

- Neurosurgical Tools
- Revascularization Post-stroke

**Components of
the Virtual
Physiological
Patient**

Our goal is the development of biomechanical computer models and simulation platforms for computational assessment of medical devices

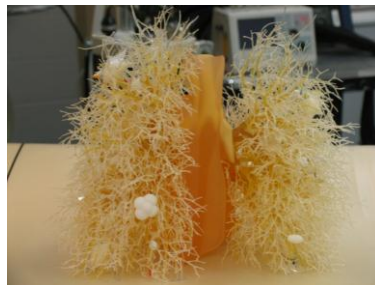


Quantifying Responses to Treatment: Anthropomorphic Phantom Studies

Develop groundwork to establish CT tumor sizing methods as imaging biomarkers for tumor response

- Streamline review for pharmaceuticals & for medical devices
- Joint effort through Quantitative Imaging Biomarker Alliance (QIBA)
 - FDA, NIST, NCI, FNIH, ACRIN, PhRMA, CT vendors, Software vendors, CROs, PIG, Academia
- Thousands of CT images made publicly available by CDRH for use in software development & testing

Anthropomorphic Thorax Phantom



Synthetic Nodules designed by CDRH



Spherical



Ellipsoid

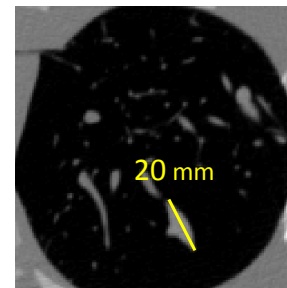


Lobulated

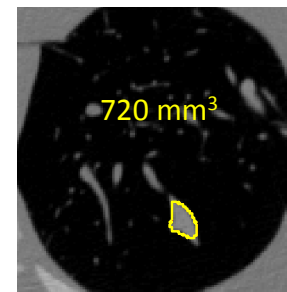


Spiculated

Sizing Methods

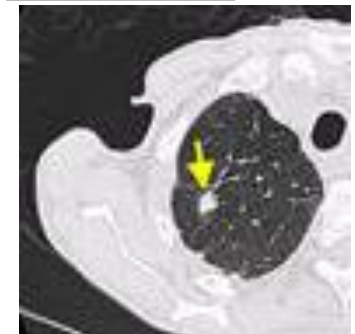


Current 1D Sizing

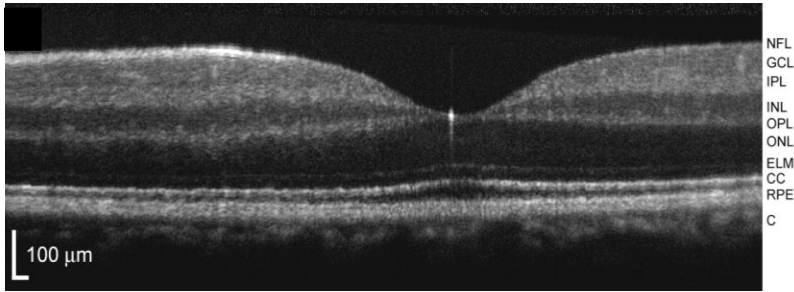


3D Volumetric In-slice Sizing

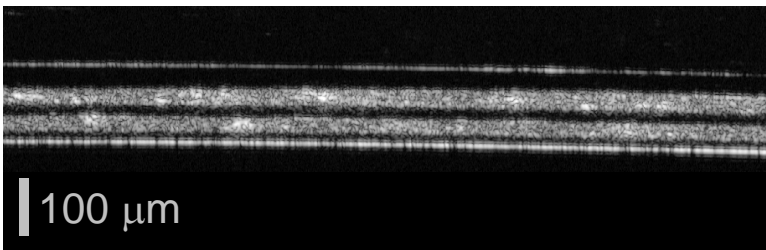
Clinical Cases



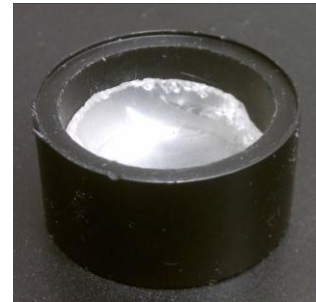
Phantom-based Test Methods for Optical Coherence Tomography



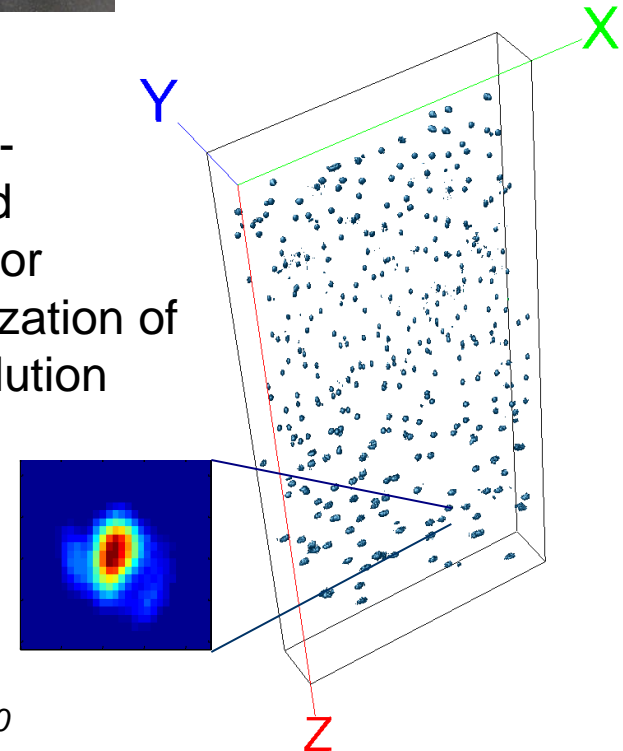
- Clinical OCT image of human retina
- 37,000 retinal scans per day in US



- Novel silicone phantom mimicking retinal layers to assess OCT accuracy



Nanoshell-embedded phantom for characterization of OCT resolution

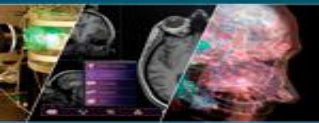




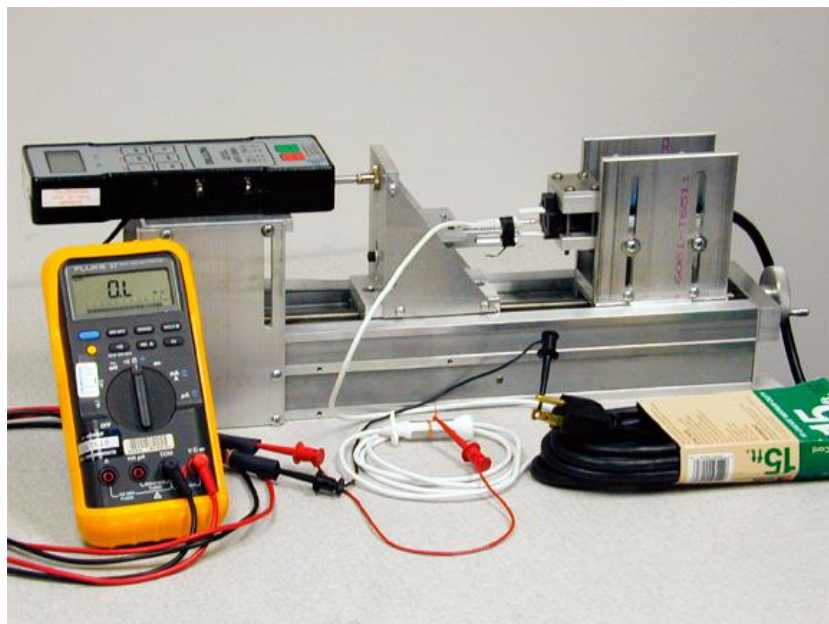
Minimally Invasive Ultrasonic Surgery

- Minimally invasive ultrasonic surgery is a leading-edge technology to perform surgery without incisions
- Applications include destroying diseased tissue and controlling internal bleeding
- CDRH developed improved test methods for these products and evaluated tests developed by others
- Help to reduce the number of invasive surgeries that patients need

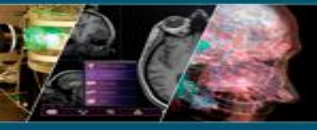




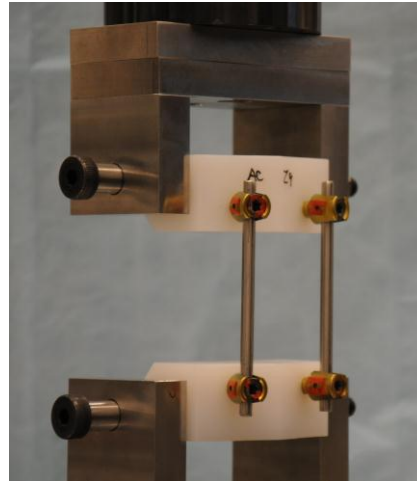
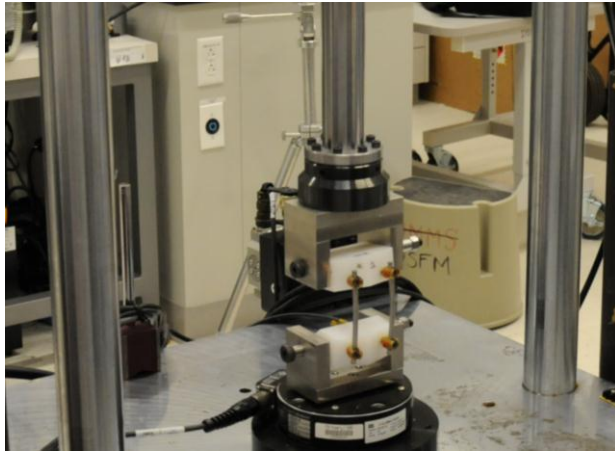
ICD Leads



- ICD lead failure can lead to loss of pacing, loss of shocks, or even painful, inappropriate shocks
- CDRH is working with the VA on an epidemiology study to determine lead failure rates and cause of failure
- Help us work together with manufacturers to produce more reliable leads

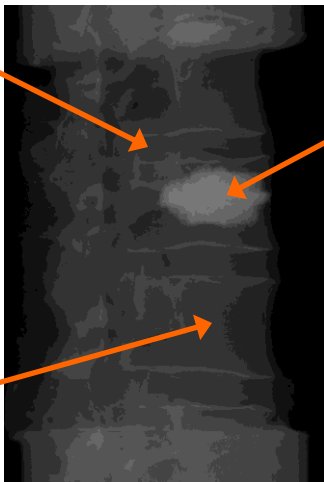


Spinal Device Testing ASTM Interlaboratory Study & Vertebroplasty Effects on Tissue Damage



- Interlaboratory study of most common mechanical testing standard for spine fusion devices
- FDA participation aids clarity and ease of review

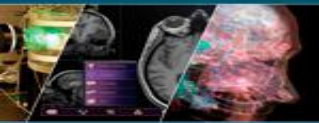
Disc



Injected bone cement

vertebra

- Research study to determine how vertebroplasty affects damage in adjacent level discs and vertebra
- Identified increased strain in superior disc and vertebra for vertebroplasty treated spine segments
- **Resulted in a new preclinical method to evaluate safety of novel bone cements**



Radiation Exposure from Medical Imaging

- **Medical x-rays, including CT scans, are indispensable in diagnosing illness**
- **Important to keep patients' radiation exposures as low as possible**
- **Working with manufacturers to improve operator information about the radiation dose being delivered**
- **Tools will allow medical imaging system designers to evaluate innovations in the design phase to quickly assess tradeoffs between image quality and radiation dose**

Point-of-Care Diagnostics

Goal: Assess the many aspects of emerging technologies incorporated into point-of-care diagnostic sensing devices to assist in regulatory review

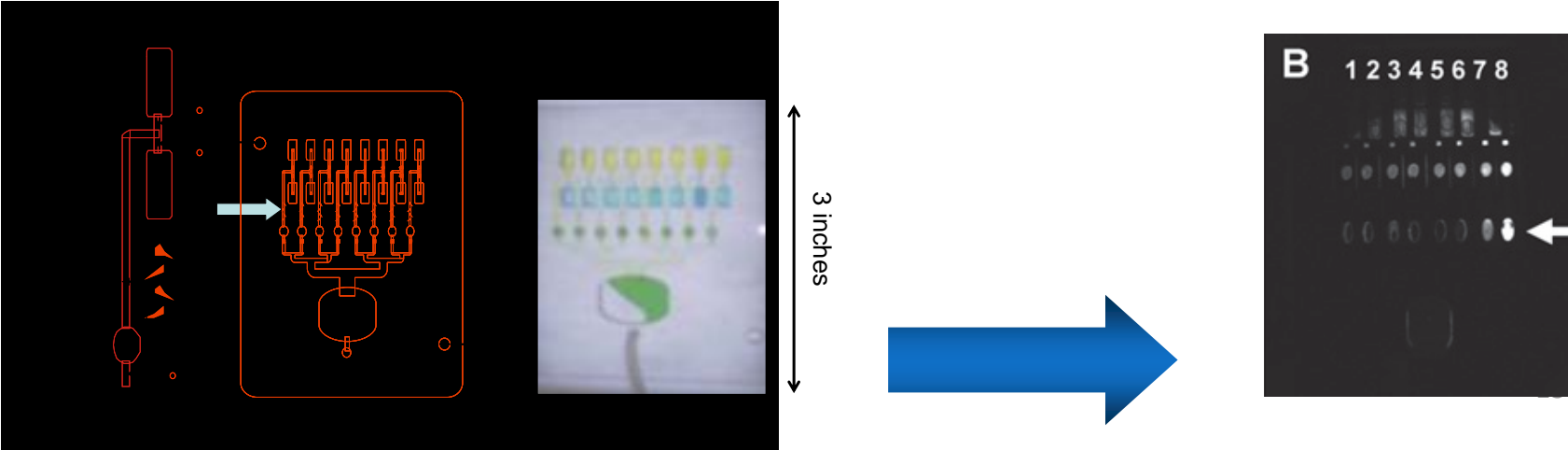
NRL
 NCI
 eBioscience
 U. Md

Excitation Source

Microfluidics/ Lab-on-a-Chip

Signal Transduction

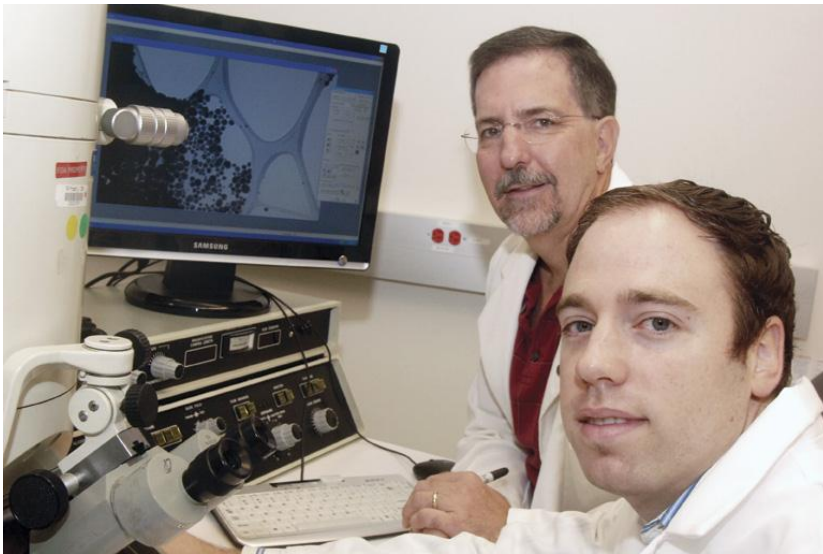
Nanoparticles





Nanomaterials

- Nanotech has the potential to revolutionize medical devices
- CDRH is developing methods to measure size, uniformity, and toxicity
- Methods will help developers understand safety questions regarding nanotech devices



Human Factors

- Human factors can help reduce user error, enhance patient and user safety, improve product usability and efficiency, and enhance user satisfaction
- CDRH has established a Human Device Performance Laboratory to measure the performance and interactions of medical devices
- Created toolbox of generic device user interfaces for human factors usability testing

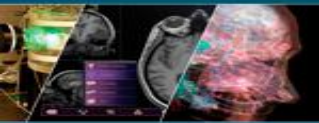
Multi touch overlay and monitor
for touch screen interfaces



Monitor with multitouch overlay

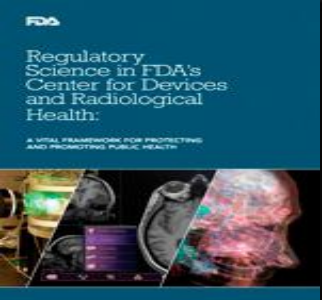


Sample interfaces

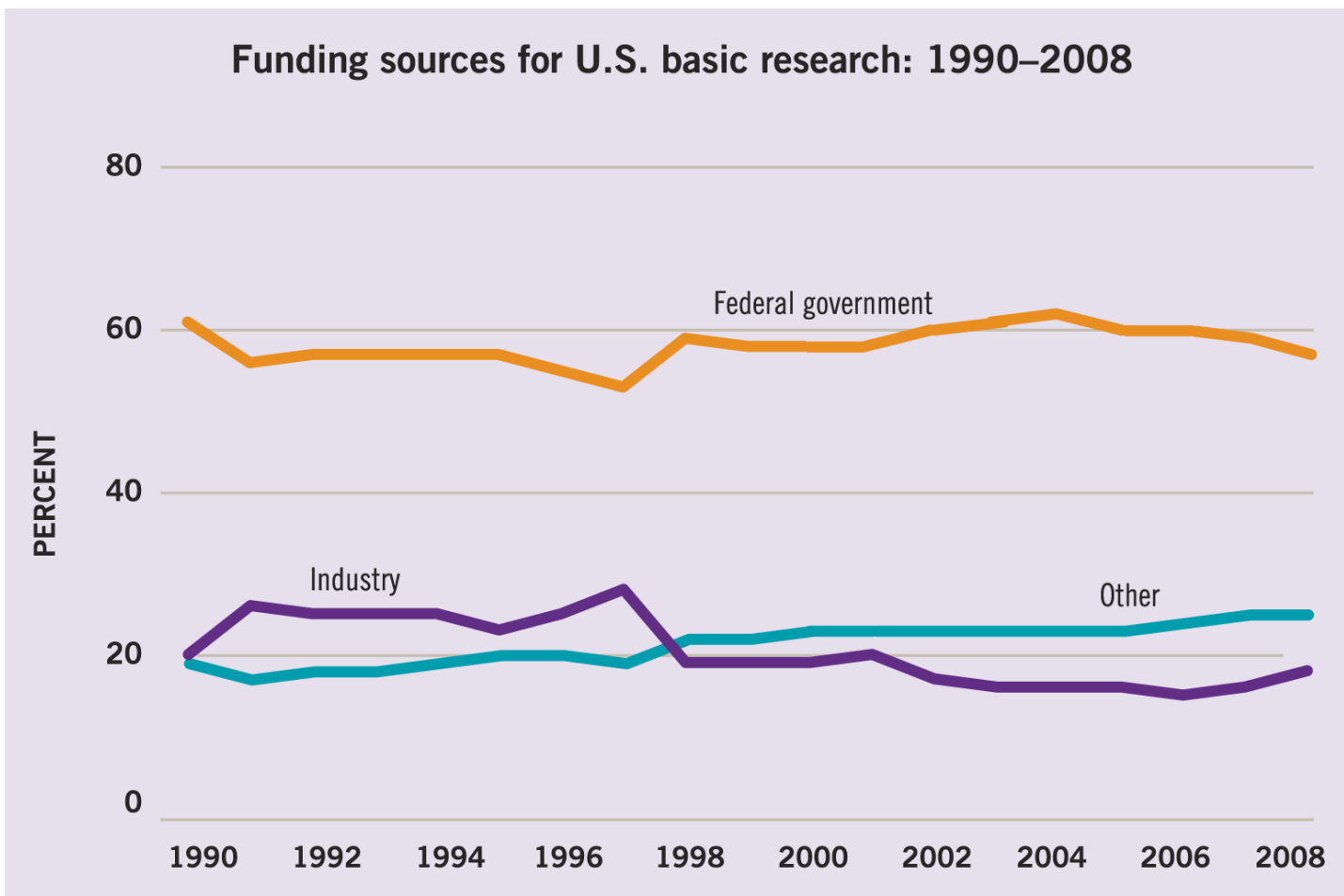


Medical Device Epidemiology Network

- **Device clinical studies may not always detect long-term outcomes and rare adverse events**
- **Often takes many years to fully define the benefit-risk profile of devices in use to support reduction in pre-market evidence requirements or down-classification**
- **Challenges exist for using data collected post-market outside of a clinical trial to support pre-market approval or clearance**
- **Collaborating with a professional organization, academic centers, and industry to establish the Medical Device Epidemiology Network (MDEpiNet) to develop new methods to evaluate clinical evidence**
- **Help to more accurately and quickly determine the benefit-risk profile of devices once marketed and used in patients**



While the US Government Maintains a Strong Investment in Basic Research...

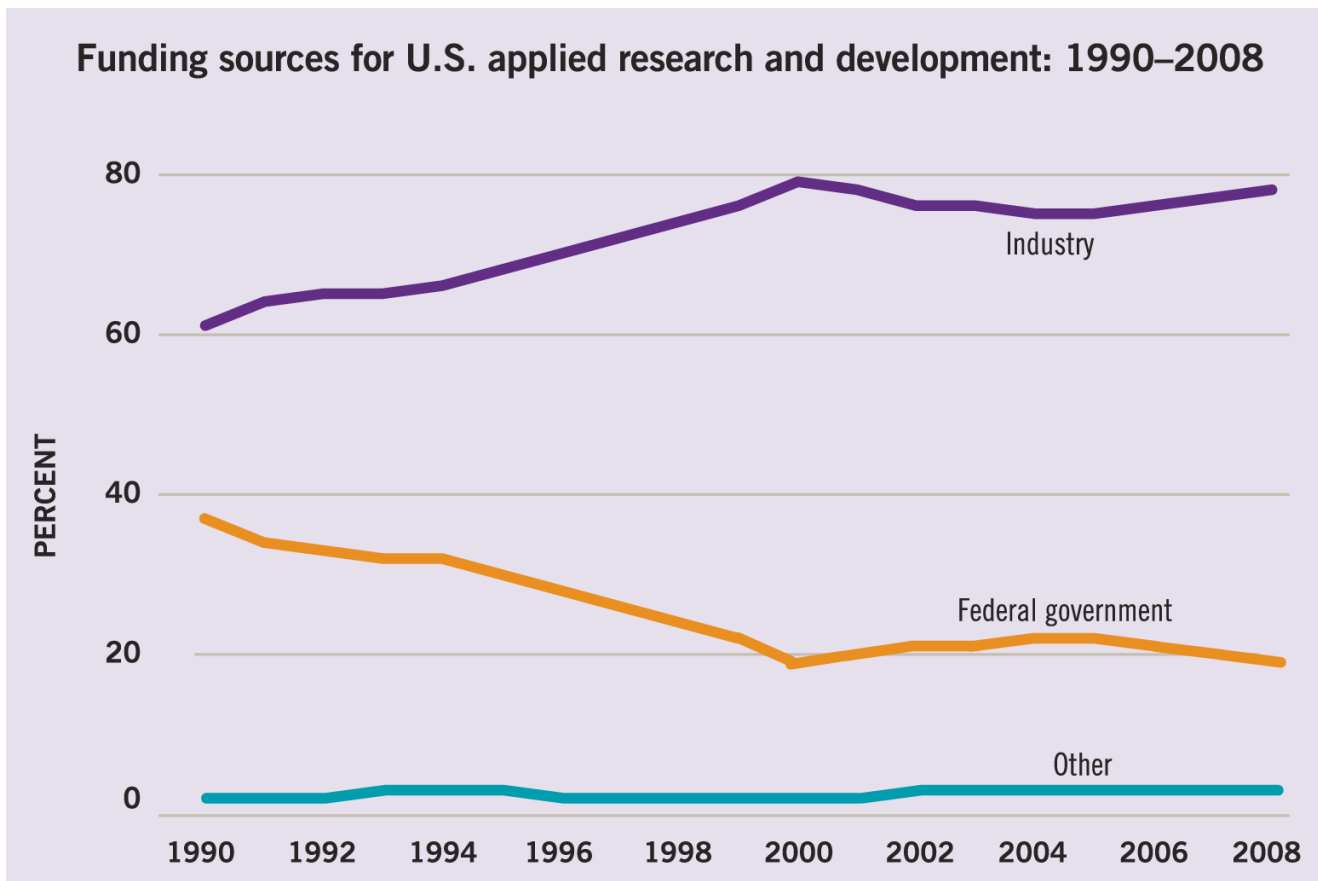


SEI 2010: Sources of R&D Funding and R&D by Character of Work, Chapter 4.

Source: The National Science Board, Science and Engineering Indicators, 2010 (The National Science Foundation)

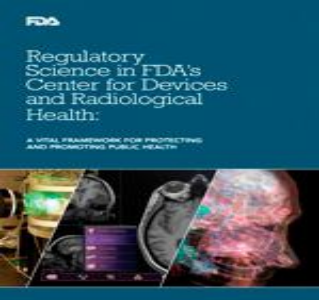


...US Federal Investments in Applied Research Represents a Smaller and Smaller Piece of the R&D Pie

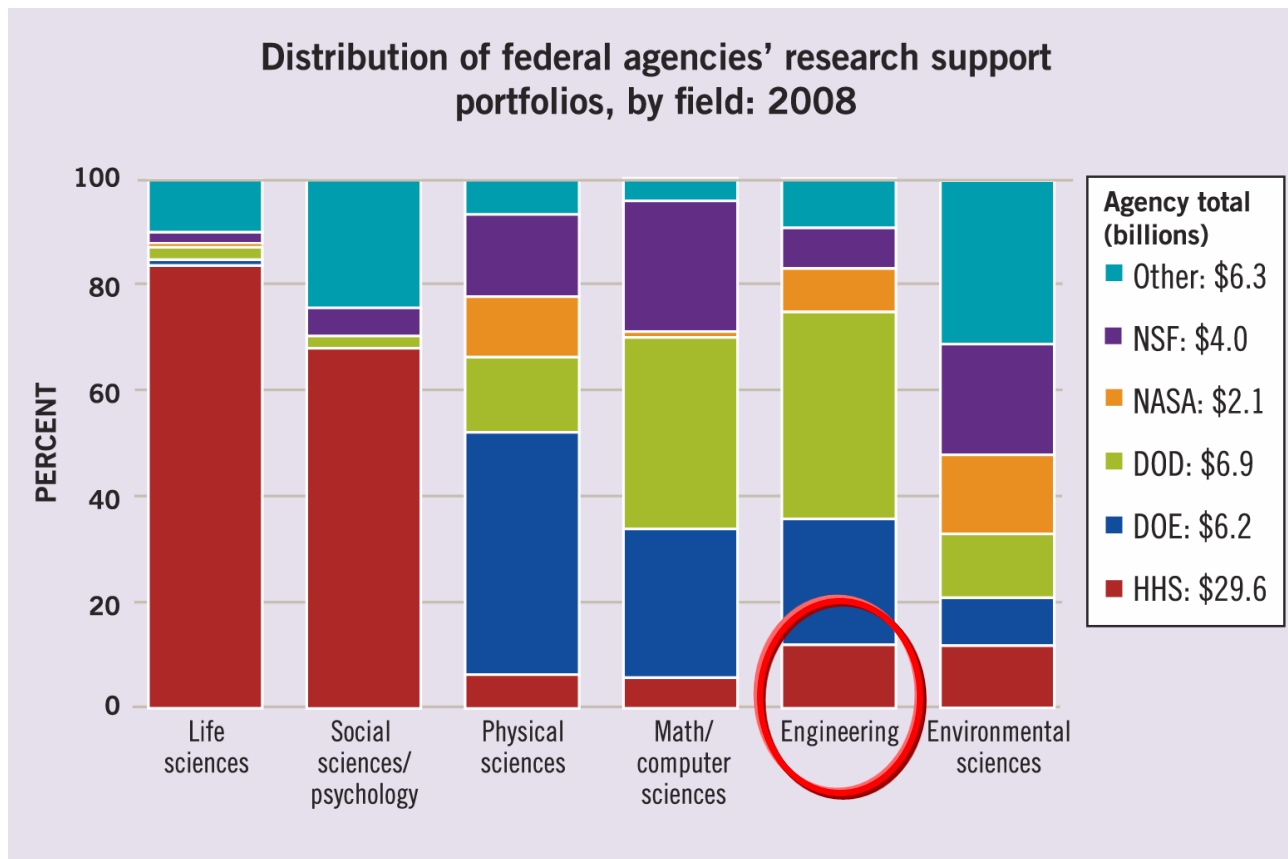


SEI 2010: Sources of R&D Funding and R&D by Character of Work, Chapter 4.

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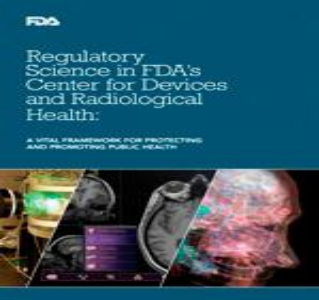
And these Investments are Particularly Low in Health Related Engineering



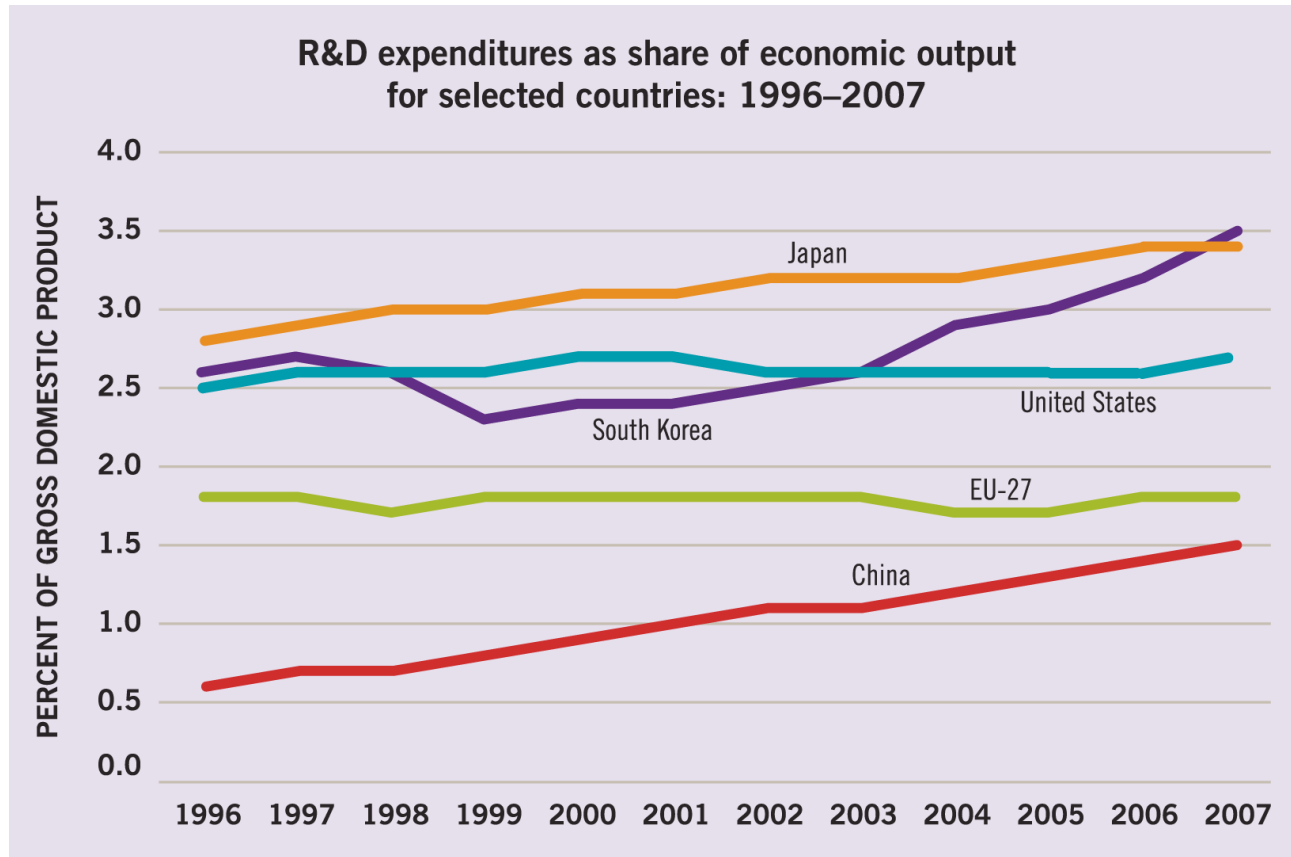
NOTE: 2008 data are preliminary; excludes ARRA stimulus funds.

SEI 2010: Federal Spending on Research by Field, Chapter 4.

Source: The National Science Board, Science and Engineering Indicators, 2010 (The National Science Foundation)



And While Our R&D investments Hold Steady Other Countries are Increasing their Investments in R&D



SEI 2010: Comparison of Country R&D Intensities, Chapter 4.

Source: The National Science Board, Science and Engineering Indicators, 2010 (The National Science Foundation)



Europe's Innovative Medicines Initiative (IMI)

- Europe launched the Innovative Medicines Initiative (IMI) modeled after FDA's Critical Path Initiative
- Aim is to support the discovery and development of better and safer medicines for patients
- IMI is a public-private partnership between the European Union and European Federation of Pharmaceutical Industries and Associations (EFPIA)
 - European Commission's Seventh Framework Programme contributes €1 billion
 - Matched with in kind contributions of at least €1 billion from member companies



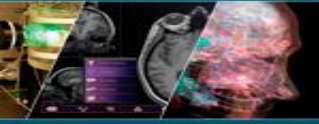
Investments in Bench and Applied Sciences versus Regulatory Science

- In FY 2011, NIH's budget for research was over \$30 billion
- In FY 2011, the FDA's budget for medical device regulatory science was about \$15 million



Regulatory Science

So Any Substantial Investments in Medical Device-Related Regulatory Science is Going to Require Collaboration Between Government and Industry Sources



What Do We Do?

- **We need a continuing, self-sustaining forum in which industry, the FDA, and academia can work together in the pre-competitive space to advance regulatory science**
- **Establish a public-private partnership between industry, the FDA , and academia**
 - Work on projects where there is shared interest
 - Implement a governance structure
 - Share human and financial resources
 - Validate tools, standards, approaches developed



Next Steps

Today the FDA is signing an MOU with LifeScience Alley to allow for scientific and intellectual collaborations, including regulatory science research, as well as outreach and educational initiatives related to medical devices