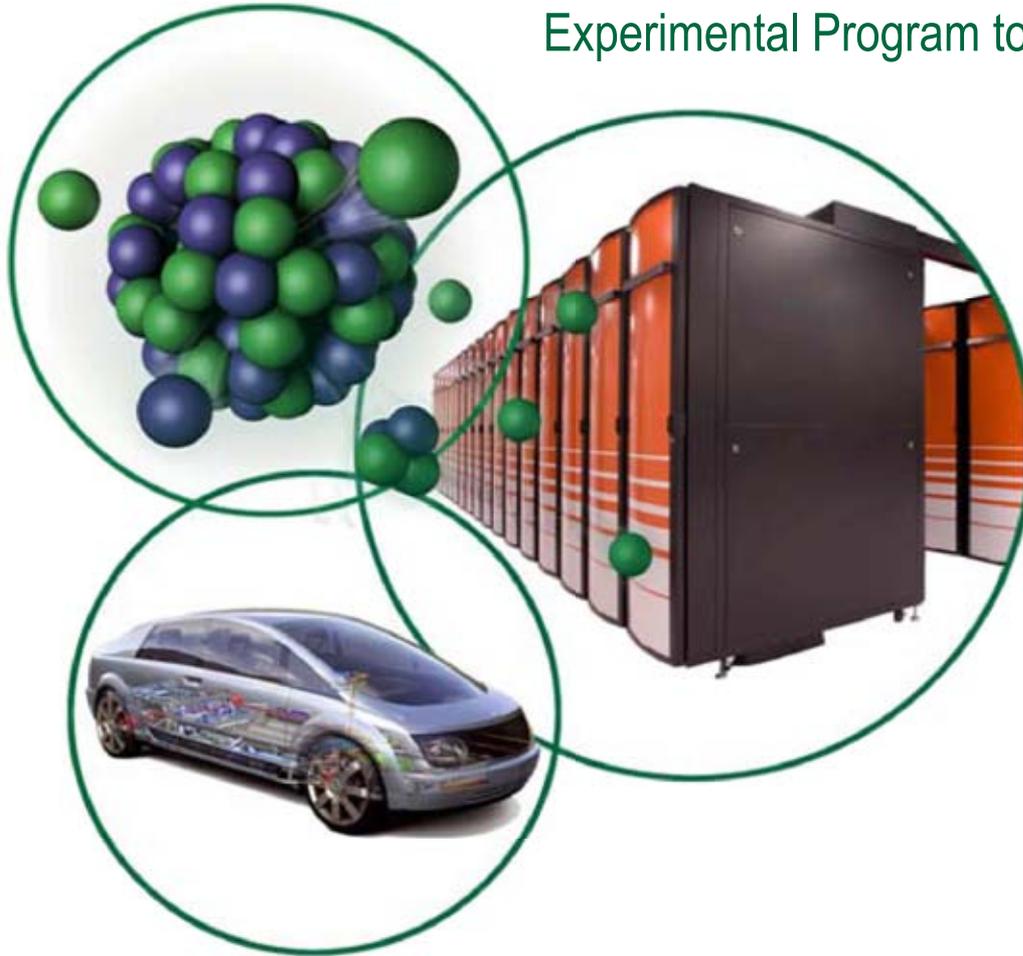


DOE Technology Programs at ORNL

Experimental Program to Stimulate Competitive Research (EPSCoR)
Program Review

July 22-24, 2008
Oak Ridge, Tennessee



Kenneth W. Tobin

Director

Corporate Research Fellow

*Measurement Science and
Systems Engineering Division*

Outline

- **The Oak Ridge National Laboratory**
- **Overview of Energy Technology Research at ORNL**
- **Measurement Science Research**



Kenneth W. Tobin, Director, Measurement Science and Systems Engineering Division,
Ph: (865) 574-0355, E-mail: tobinkwjr@ornl.gov



Oak Ridge National Laboratory

ORNL campus

- U.S. Department of Energy's *largest science and energy laboratory*
- ORNL was established in 1943 as part of the Manhattan Project to pioneer a method for producing and separating Plutonium
- Today the laboratory supports the nation with a peacetime mission of scientific competencies including *neutron science, energy research, high performance computing, complex biological systems, advanced materials, and national security*
- **Statistics**
 - More than 4,200 staff members
 - 3,000 guest researchers annually
 - \$1B annual budget



Graphite
Reactor
(1946)
Spallation
Neutron
Source (2006)



ORNL Energy Technology Research Cuts Across the Entire Energy Spectrum



Generation	Storage and Distribution	Consumption
<p>Fossil Fission Renewables Fusion</p> 	<p>Transmission technology Hydrogen Distributed energy resources</p> 	<p>Buildings Industry Transportation Efficiency</p> 

Supporting the nation's strategic goals for energy security, reliability, and assurance through industrial partnerships and technology demonstration



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Energy Efficiency and Renewable Energy

Demonstrating the reliability of advanced technologies

High-Temperature Superconducting Cable Test Facility

- HTS cables and components
 - Cryogenic systems
 - Terminations
 - Joints
- Partnership with Southwire
- Used to test AEP Columbus Bixby HTS cable (2006) and Entergy HTS cable (2011)



Distributed Energy Communication and Controls

- Demonstrate reactive power compensation from distributed energy
- Develop controls for voltage regulation to improve system reliability



Power Electronics Test Facility

- Demonstrate reliable operation of power electronics components
- Next to new ORNL substation
- TVA/ORNL/EPRI partnership



Conductor Accelerated Test Facility

- Advanced conductor testing to ensure operation over life of system
- High-current, low-voltage dc power induces thermal cycles on conductor



ORNL: DOE's Largest and Most Diverse Transportation Research Program

Developing energy-efficient, low-emissions transportation technologies that enable America to use less petroleum

Low-cost, high-efficiency motors and invertors/converters for electric hybrid vehicles



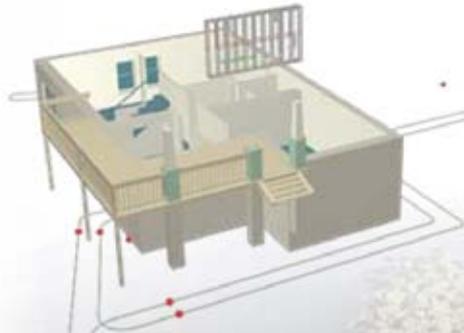
Lighter-weight structural materials and propulsion materials



Technology for advanced combustion regimes with reduced emissions without fuel efficiency penalty



Developing net-zero-energy houses for more efficient energy use



- Integrated on-site energy supply and use systems
- Use of solar and geothermal resources
- On-demand lighting and heating/ventilation/air conditioning
- Superior building envelope
 - Structural insulated panels
 - Reflective roofing
 - High-thermal-mass basement walls

**Energy cost for
a 2,600-ft² home:
~\$1 per day**



USEC-ORNL CRADA:

Develop, demonstrate, and deploy The American Centrifuge

>\$75M to ORNL
(2002–2012)

- Largest DOE CRADA (100% funds-in)
- \$35M to date; recently renewed for another 5 years
- ~150 ORNL staff

Key IPTs
(ORNL leads)

- Thermal management
- Balancing
- Data acquisition/control

Modeling and simulation

- Components, subsystems and systems

Design and manufacturing

- Components, instrumentation and controls

Testing

- Components, complete machines
- 5 test stands (>\$100M asset) at ETTP site on Oak Ridge Reservation
- Instrumentation and diagnostics



Objective: Design, fabricate, assemble, and test advanced gas centrifuges for uranium enrichment (key nuclear fuel cycle step)

- Demonstrate centrifuge machine technology in Oak Ridge (2000–2012)
- Support construction of lead cascade in Piketon, Ohio (2006–2010)
- Full-scale plant (3.5 MSWU/year) (2012)



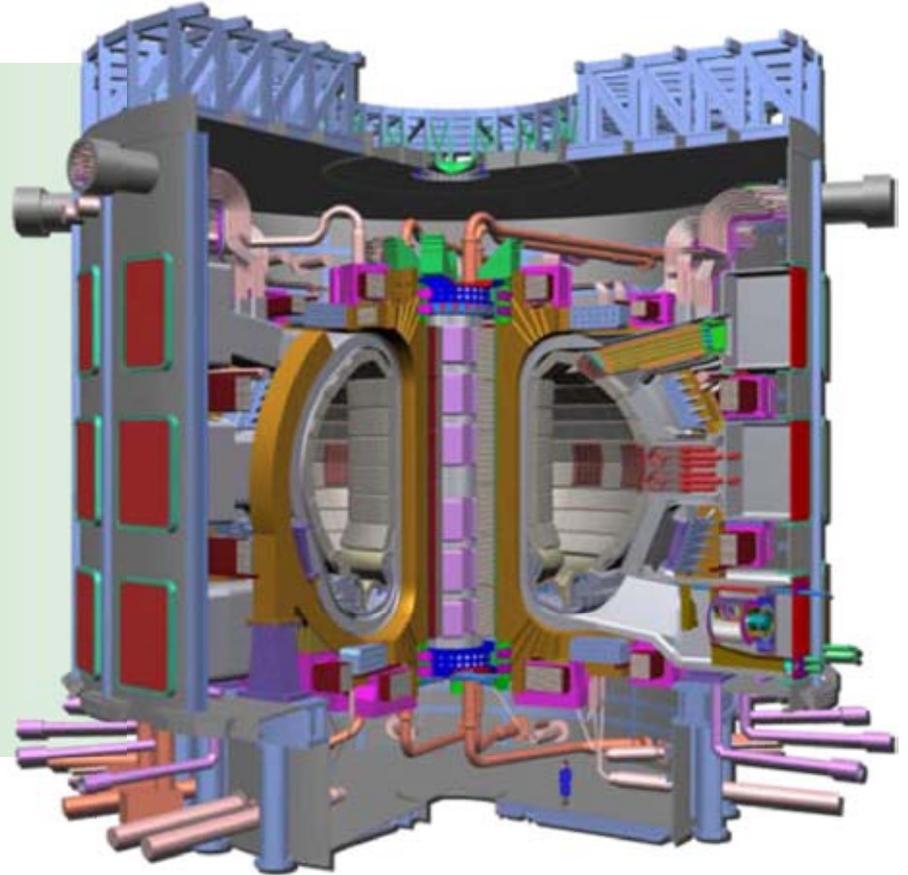
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Abundant, affordable energy supplies

Harnessing fusion energy: ITER

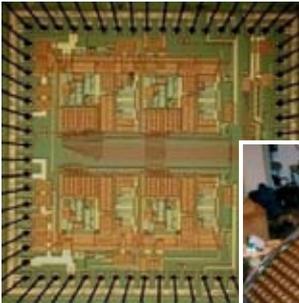
- Joint international R&D project aimed at demonstrating the scientific and technical feasibility of fusion power
- To be built in Cadarache, France, with operation set to begin at the end of the next decade
- First burning plasma experiment
 - Plasma current = 15 MA
 - Magnetic field = 5 T
 - Fusion power ~ 500 MW



Measurement Science and Systems Engineering (MSSE)

- MSSE performs applied R&D in measurement science associated with ...

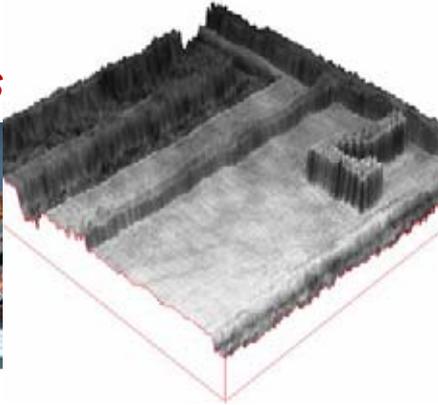
Electronics



Sensors



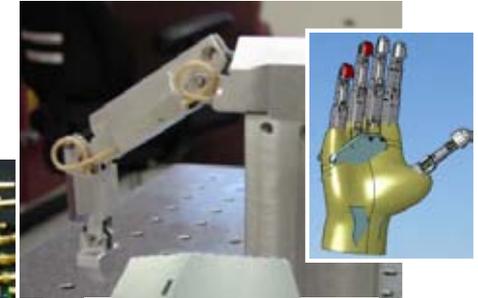
Signals / Patterns



Communications



Systems



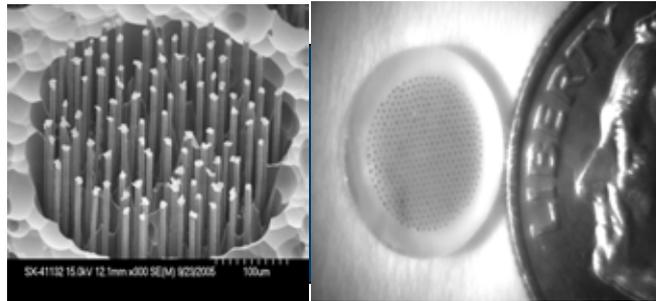
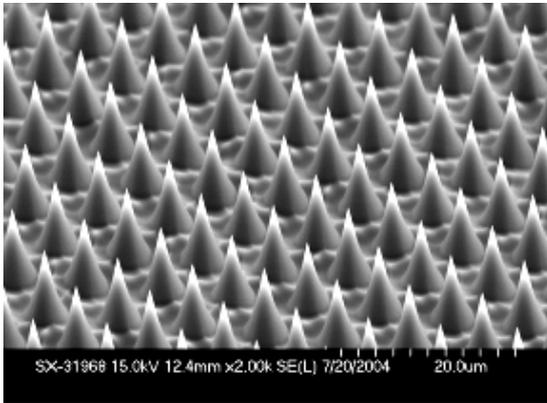
- We perform and support research in
 - Energy
 - National security and defense
 - Human health

Energy Research

Nanostructured Materials

- Large area nanostructured material enables
 - Superhydrophobics (drag reduction, anti-icing, anti-fouling)
 - Increased surface areas (enhanced cooling, bonding, chemical sensing)
 - Microelectronics (emitter arrays, nano-wire interconnects)

*Drawn glass nanostructured cones
(nanometers to micron scale)*

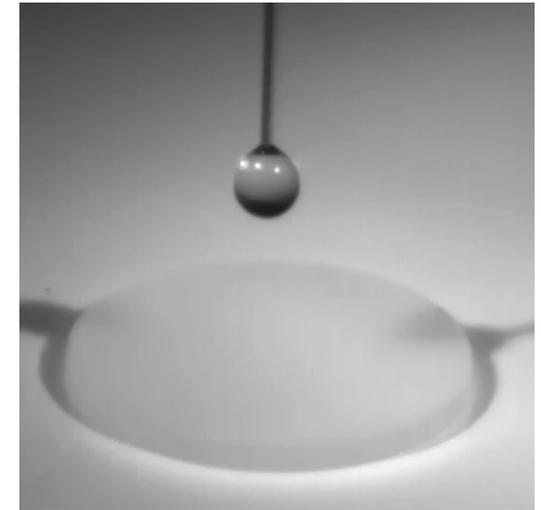


*Micro wire arrays composed
of isolated conductors*

*Demonstration of nano-textured
superhydrophobic powders*



*Example of water interacting with
superhydrophobic surface*

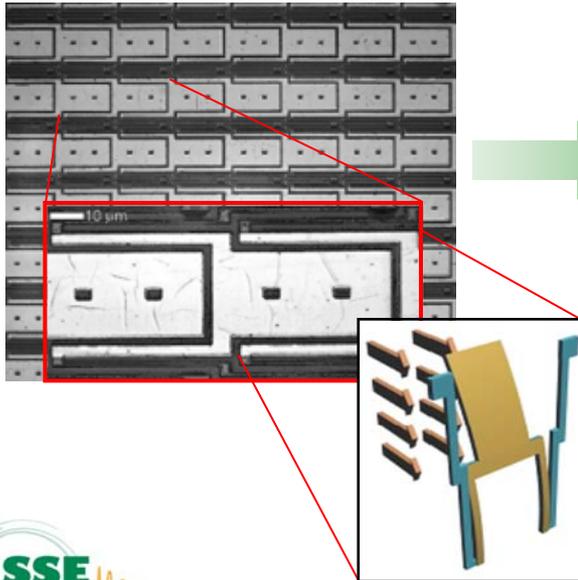


National Security

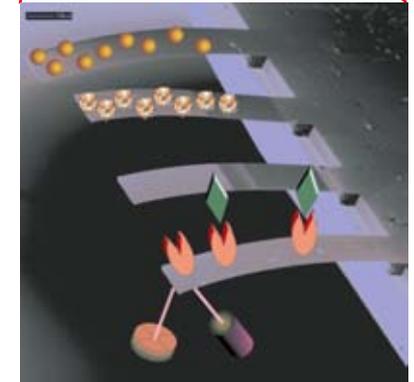
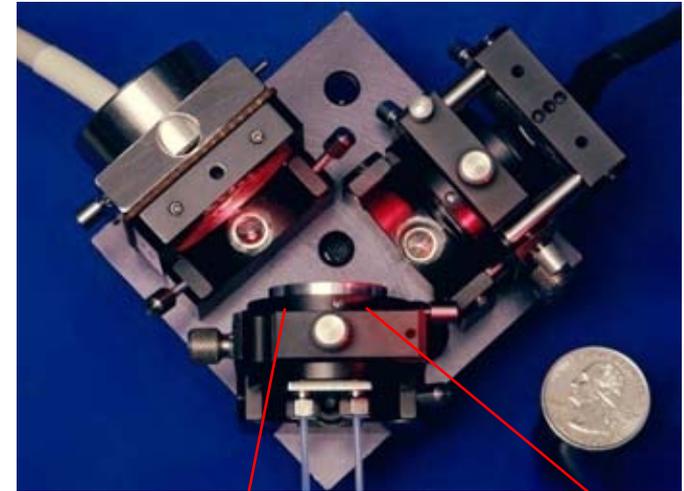
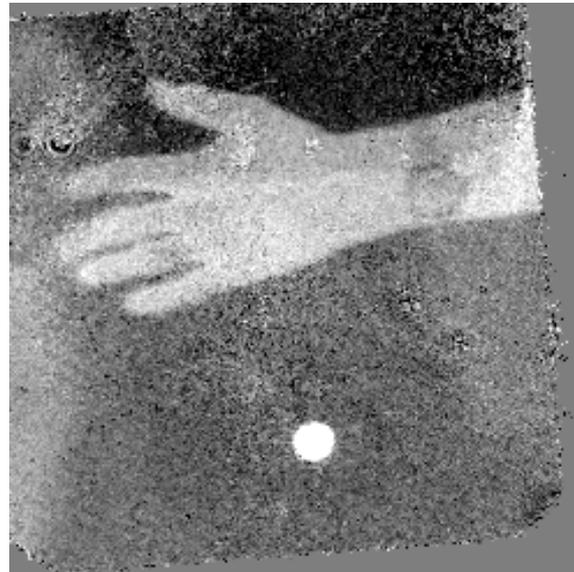
Defense Applications

- MEMS / NEMS physical and chemical sensors
 - Infrared imaging with uncooled micro-cantilever array
 - Chemical sensing with functionalized cantilever arrays

Portion of a 256x256 microcantilever imaging array (40 μ m x 70 μ m pixels)



Real-time video of thermal imaging (8-14 μ m)



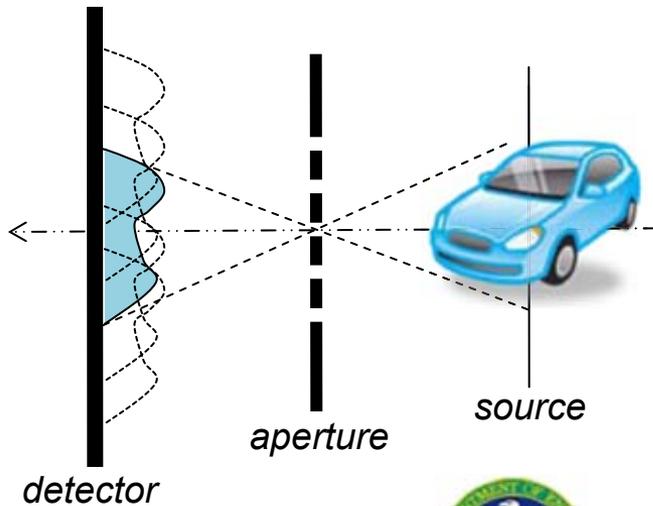
Linear cantilever array functionalized for chemical sensing (400 μ m x 100 μ m x 0.5 μ m)



National Security

Homeland Security Applications

- Wide area gamma imaging for detection of nuclear materials
- Applies integration of coded aperture gamma camera and optical video analysis



Gamma system uses linear coded aperture and CsI detector "pixels"

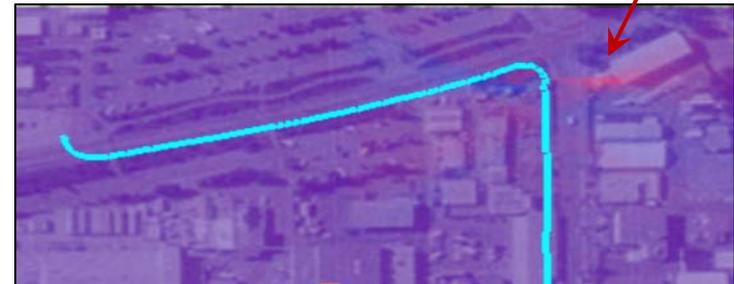


Images of traffic are acquired by a camera positioned 24' above the road



Lucas-Kanade algorithm to detect and track vehicle motion points

Detection of stationary Cobalt source from moving vehicle detector system

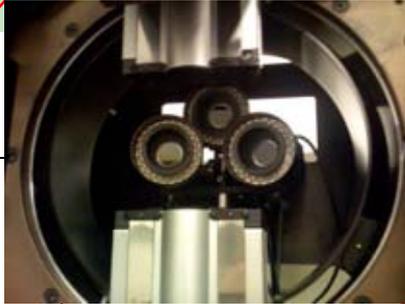
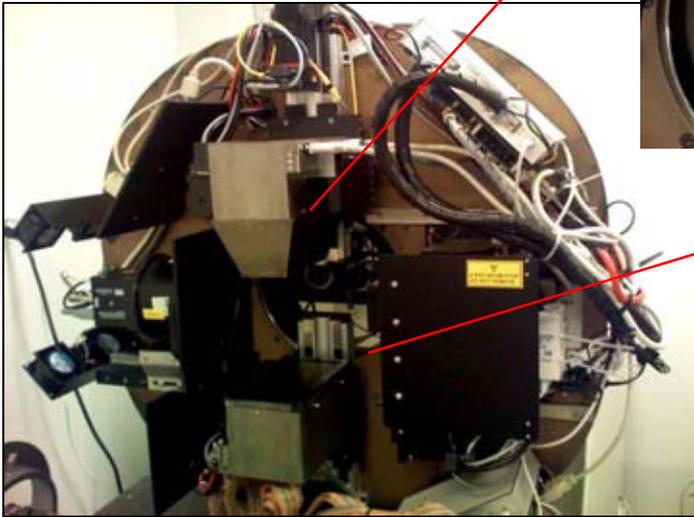


Human Health

Preclinical Animal Imaging

- SPECT imaging for functional analysis
- Dual-mode MicroCT / SPECT Imaging (NIH)
- Unrestrained Animal SPECT Imaging (DOE OBER)

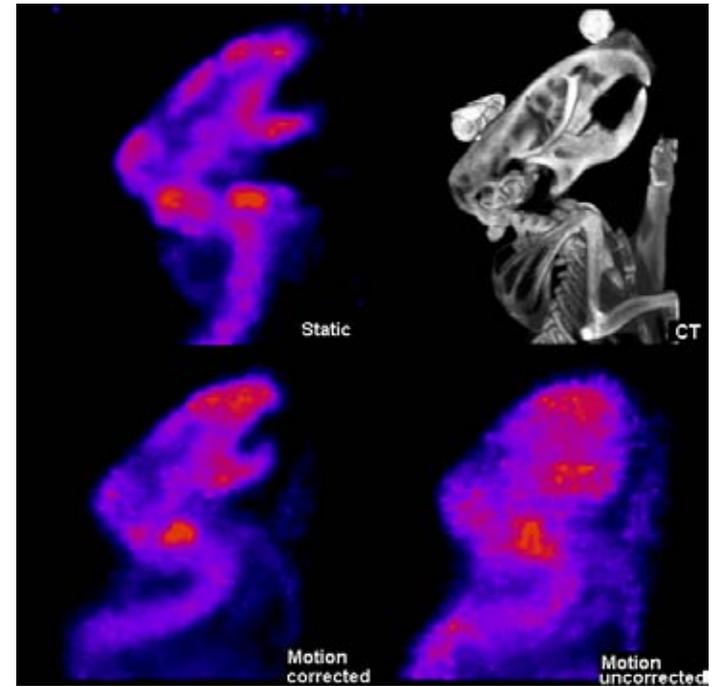
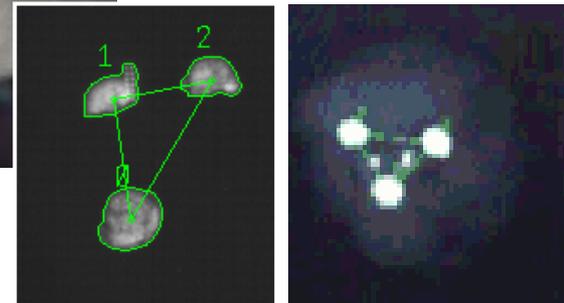
SPECT animal tracking system



Mouse in burrow



Real-time tracking



Results approach static scan in quality



ORNL is Focusing on Energy Science and Technology that Impacts the National Economy and U.S. Industry

- **Establishing relationships through EPSCoR provides strategic, innovative partnerships that are of benefit to ORNL and the nation**
- **Our Energy Technology Programs offer ample opportunities for partnerships and collaboration**
- **We have a track record of “discovery S&T” that is of interest to universities and industry**
- **Most diverse energy portfolio of all national laboratories**
 - **18 user facilities**
 - **134 R&D 100 awards, many with industry partners**
 - **20 FLC awards for excellence in technology transfer in the past decade**

Our multiprogram nature allows us to attract bright staff, acquire and apply cutting-edge facilities and equipment, and interface external partners to achieve our goal: Moving energy technology into the marketplace