Sandia Research

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Sandia National Laboratories

Exceptional service in the national interest

Chief Technology Officer Responsibilities

- S&T Strategy and Governance

- Capability Management and Assessment

- Laboratory Directed Research and Development Program Management

- Partnerships Management

Julia M. Phillips, PhD
Chief Technology Officer

Fellowships

- President Harry S. Truman Fellowship in National Security Science and Engineering
  - New PhD scientists and engineers pursue independent research of their own choosing that supports Sandia's national security mission.
  - Candidates are expected to have solved a major scientific or engineering problem in their thesis work or have provided a new approach or insight to a major problem, as evidenced by a recognized impact in their field.
  - Three year appointment

- John Von Neumann Post-Doctoral Research Fellowship in Computational Science
  - New PhD in applied/computational mathematics or related computational science and engineering disciplines.
  - One year appointment, with possible renewal for a second year

2012 Truman Fellows
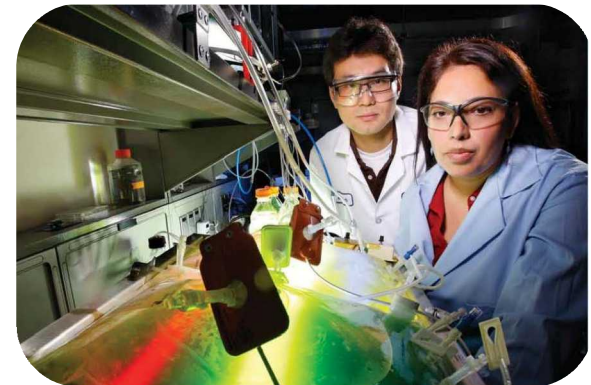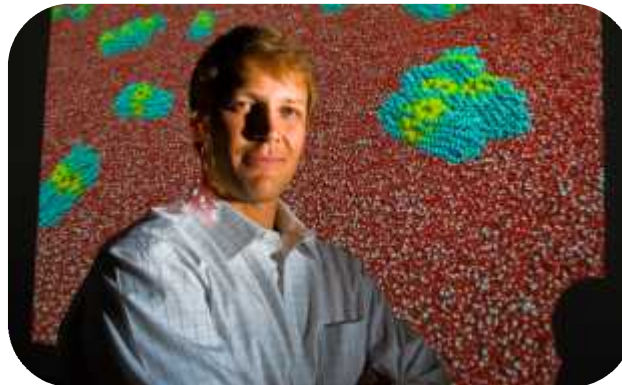
Nanoscale ultrasound – imaging the structure inside a single cell

Matt Eichenfield, PhD
Physics
California Institute of Technology

Moving high fidelity modeling from the HPC realm to the desktop

Kevin Carlberg, PhD
Aeronautics and Astronautics
Stanford University

Research Objective

Research conducted at SNL shall
enable mission delivery now and in the future and
advance the frontiers of science and engineering.

Research Challenge Characteristics

Area	Research Challenge A science or engineering obstacle to solving a mission challenge that must be addressed by a national security laboratory
Impact	Creates transformational opportunities.
Difficulty	Advances the state of the art in S&E.
Alignment	Enables customers and Laboratory to address strategic priorities in fundamentally new ways.
Breadth	Involves interdisciplinary approach and active engagement of expertise ranging from fundamental science to technology application.
Legacy	Spurs development of unique and differentiating technical capabilities that transcend the challenge.
Relevance	Covers the whole spectrum from near to long-term.

Draft Research Challenges

- **Quantum Limited Detection** – Detect the minimum unit of information carried by the phenomenon of interest (photon, RF emanation, molecule, single nuclear particle, etc.) and develop deployable systems to detect at this level

- **Beyond Moore Computing** – Invent the next computing architecture, from device through architecture, system software, and on to application codes

- **Cyber Resiliency** – Create cyber environments that maintain critical functions during and after an inadvertent disruption or malicious attack.

- **Multi-Physics & Multi-Scale Materials Knowledge to Create Engineered Solutions** – Predict with high confidence the behavior of complex materials in multi-physics processes and at multi-length time scales.

- **Data Science** – Develop the understanding that leads to techniques for large-scale data analysis for identification and characterization of key signatures buried in massive amounts of heterogeneous data to enable decision-making.

- **Trusted Systems and Communications** – Identify and nullify component and system subversions in order to create trusted systems and communications that are free from adversarial influence.

Draft Research Challenges (cont.)

- **Power on Demand** – Provide ubiquitous power through (1) grid-independent on-site power harvesting/generation; (2) a new generation of power electronics and wireless power transmission; and (3) high energy-density and power-density energy storage.

- **Embedded Annual Assessment** – Determine *a priori* sensory signatures that are precursors to material/component/system failure and embed sensors that will warn of degradation before significant issues arise.

- **First to High Yield Fusion** – Achieve controlled fusion ignition and high yield in the laboratory. [Creation of consolidated full-spectrum environments for system performance assurance is an intermediate goal of this Research Challenge.]

- **Integrative Biological Systems Analysis and Engineering** – Develop the foundational biological data and associated models to predict the performance of mission relevant biological systems.

- **Resiliency in Complex Systems** – Analyze, classify, and understand with certainty the resiliency of multiple interconnected systems in the face of multiple threats.

More on Resiliency in Complex Systems

- **Resiliency in Complex Systems** – Analyze, classify, and understand with certainty the resiliency of multiple interconnected systems in the face of multiple threats.

  - Understanding the system, then modeling and analyses that explicitly represent system (natural, infrastructure, regulatory and combined) resilience in highly uncertain decision environments

  - First-principles based modeling/engineering for human decision making

You'll be hearing more specifics on the other research challenges from the other presenters.