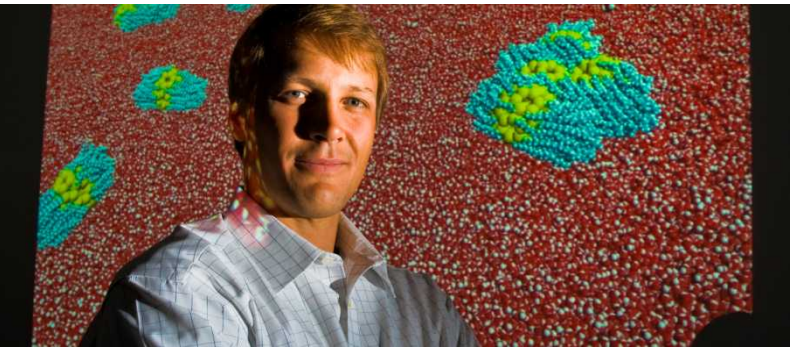
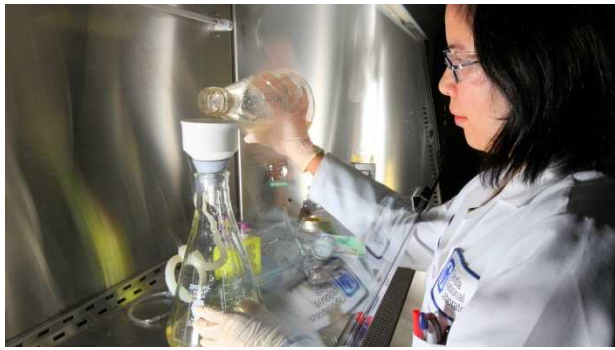
SAND2012-7941P

Exceptional service in the national interest

Sandia National Laboratories





Laboratory Directed Research and Development Program Overview

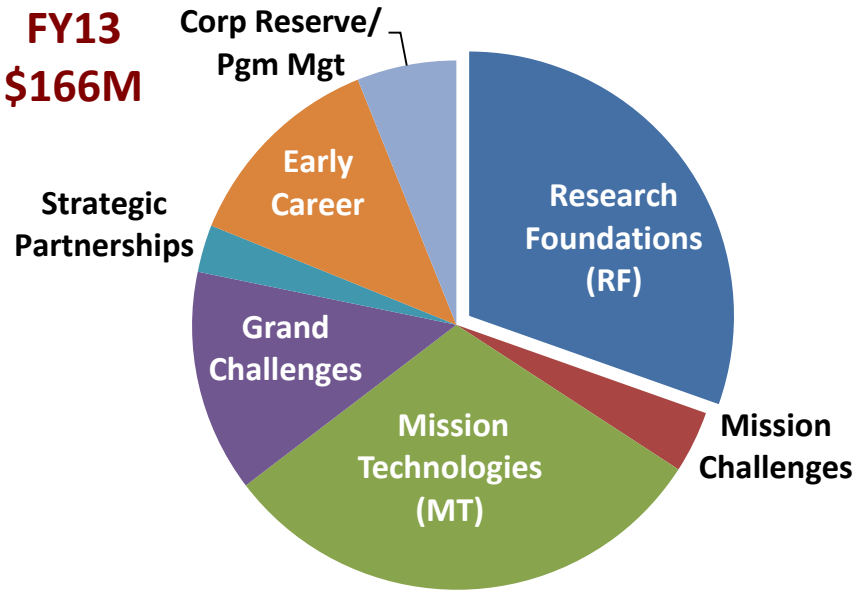
Julia M. Phillips, PhD
Deputy Chief Technology Officer

U.S. DEPARTMENT OF ENERGY | National Nuclear Security Administration | LDRD Laboratory Directed Research & Development

Sandia National Laboratories is a multi-program laboratory managed and operated by Sandia Corporation, a wholly owned subsidiary of Lockheed Martin Corporation, for the U.S. Department of Energy's National Nuclear Security Administration under contract DE-AC04-94AL85000.

LDRD is a vital program to Sandia

- Background
  - LDRD Program was authorized by Congress*, with oversight by DOE/NNSA, and strategic guidance by the Labs' Director and CTO
  - LDRD is the Labs' sole source of discretionary R&D funds for staff-generated, innovative ST&E**
- LDRD creates the future of the Labs
  - Enables and supports Labs' national security missions
  - Advances the frontiers of science and engineering



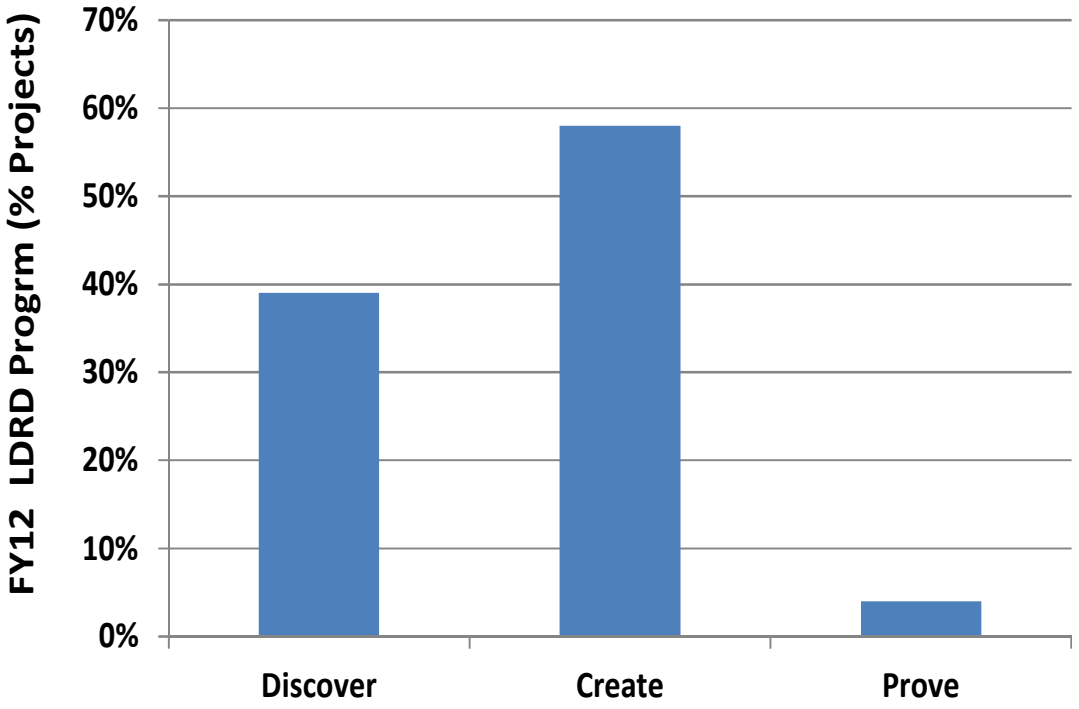
Investment Area Evaluation Criteria:
- Strategy
- Relevance
- Quality
- Workforce / Capabilities
- Impact

*National Defense Authorization Act for FY 1991 (P.L. 101-510, Section 3132)
** Energy Research and Development Administration Authorization Act for FY 1977 (P.L. 95-39, Section 303)

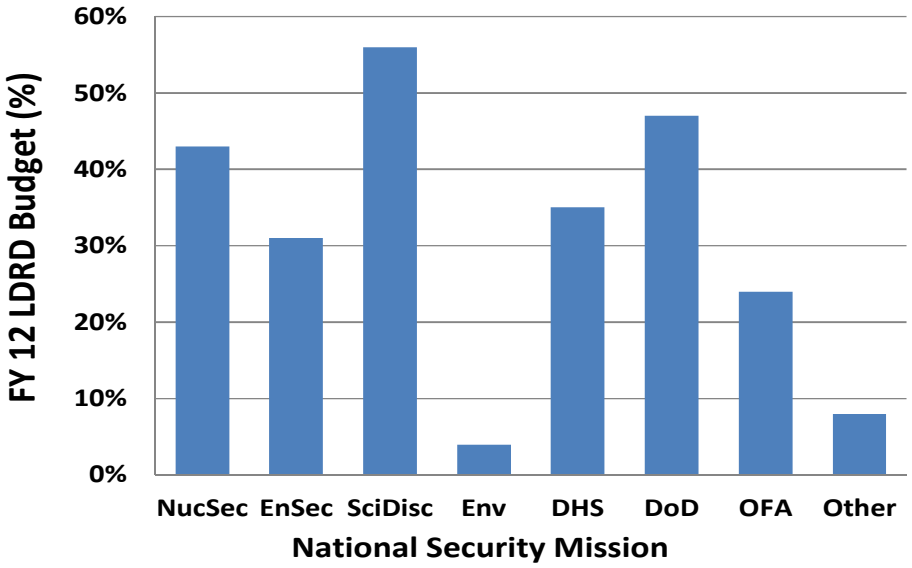
Metrics

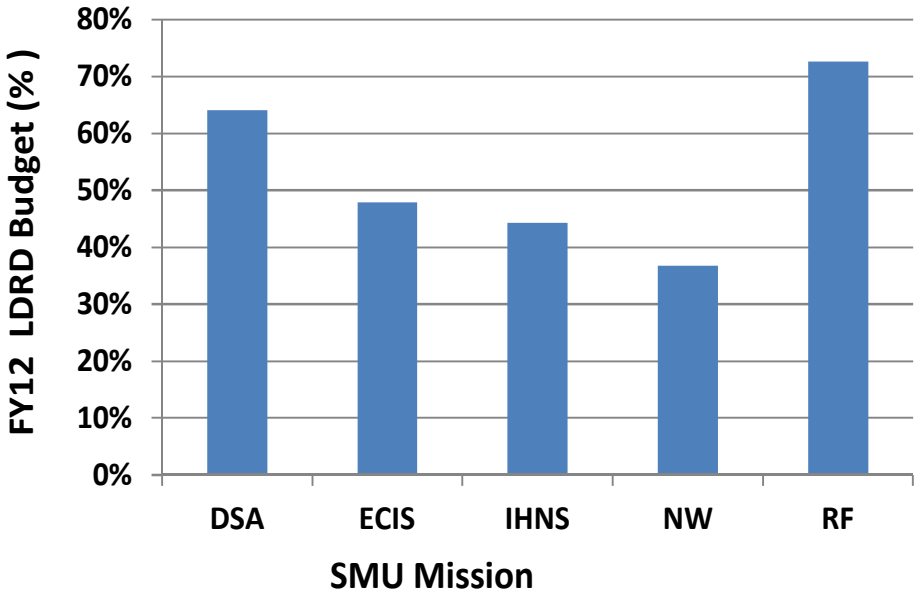
Portfolio is weighted toward discovery and creation

- **Discover** – create new understanding or knowledge
- **Create** – produce a novel solution or application, or revolutionize a critical ST&E area
- **Prove** – test an innovation or concept in a real-world environment



Relevance

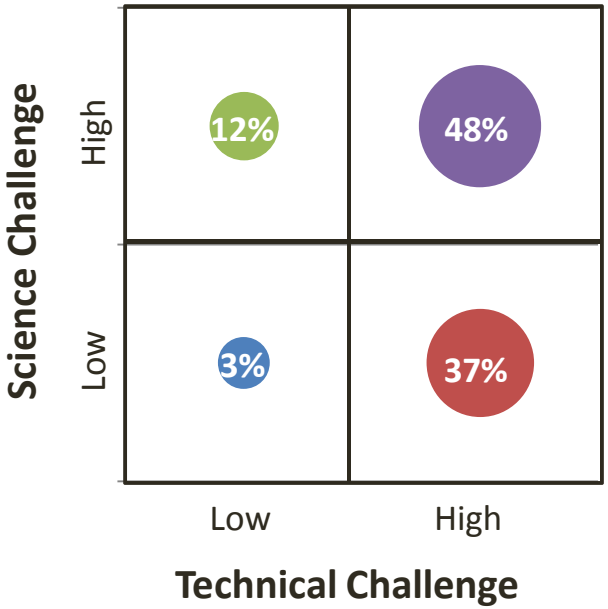




Most LDRD projects provide multiple benefits to Sandia's national security missions

Quality

- Technical and science challenge



Science Challenge
4: Creation of a new scientific framework or field
3: Significant advance in an existing scientific framework or field
2: Incremental increase within existing scientific framework or field
1: No change in existing scientific framework or field

Technology Challenge
4: First ever product/technology of its kind
3: Significant improvement of a product/technology
2: Incremental refinement/customization of existing product/technology
1: No change to existing product/technology

Quality

- Awards, Invited Talks, Collaborations

Measure	FY08	FY09	FY10	FY11
Refereed Publications	176	152	155	n/a
Invited Presentations	n/a	54	48	81
Technical Advances	114	109	123	n/a
University Collaborations	96	141	145	189
Industry & Govt. Lab Collaborations	44	65	79	85
Awards - R&D 100 *	3	4	3	2

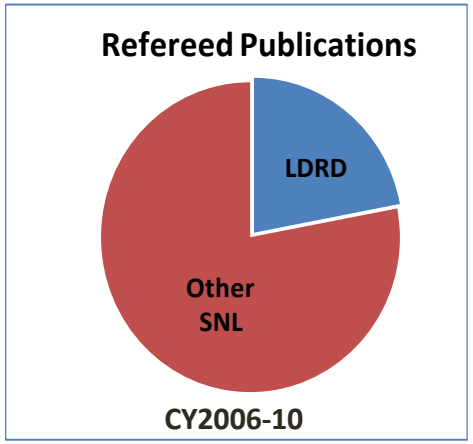
*4 R&D 100 Awards in FY12

Quality

- Citations

	Relative Impact for CE, NNSA Labs, DOE Labs, OG Labs					
Standard Field	**SNL**	**SNL LDRD**	**NNSA Labs**	**DOE Labs**	**CE Univ**	**OGA**
Biology & Biochemistry	1.24	0.99	1.31	1.12	1.33	1.10
Computing Science	1.51	1.44	1.33	0.78	1.43	0.84
Chemistry	1.12	1.20	1.54	1.36	1.54	0.92
Physics	1.28	1.27	1.63	1.95	2.18	4.36
Geoscience	1.55	0.56	2.17	1.26	1.49	1.01
Engineering Science	1.77	1.49	1.67	1.10	1.36	0.93
Materials Science	1.63	2.37	1.54	1.01	1.51	1.09
Field Average	**1.44**	**1.33**	**1.60**	**1.23**	**1.55**	**1.46**

CY10 Thomson-Reuters Data

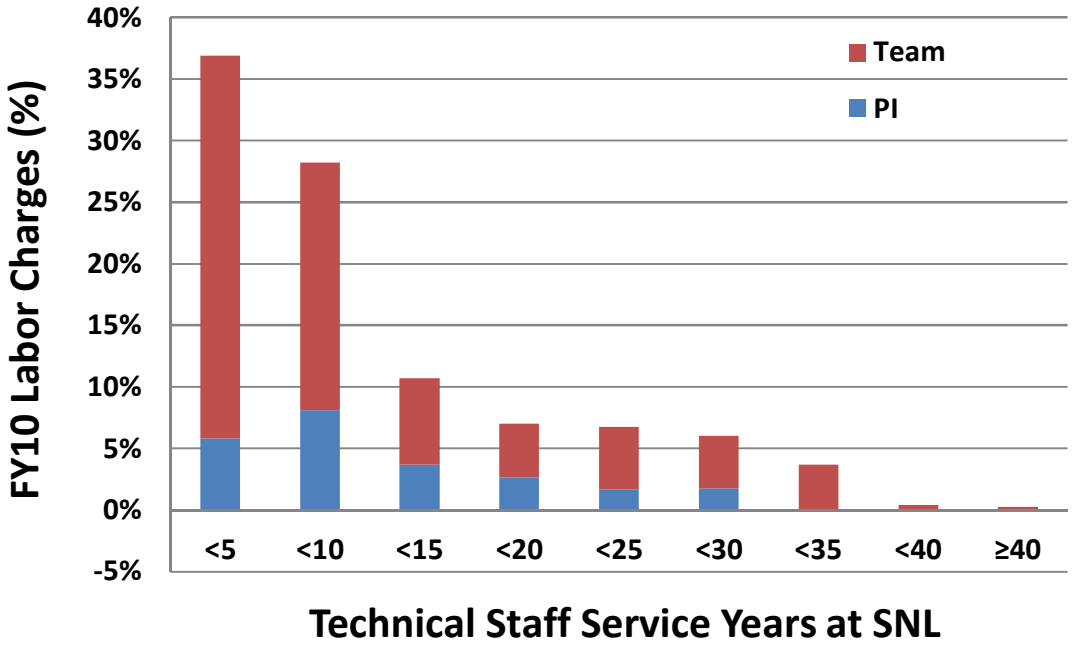


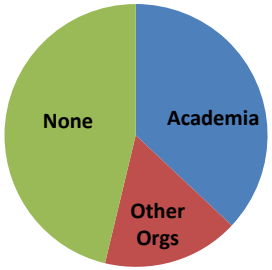
Workforce/Capabilities

Measure	FY08	FY09	FY10	FY11
Post-Doctoral Researchers	74	83	105	107
Post-Doctoral Conversions	8	13	21	25
Awards – Professional and Other	20	22	17	12

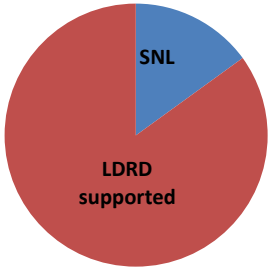
Workforce/Capabilities

- Early career staff, postdocs, and external collaborations are critical

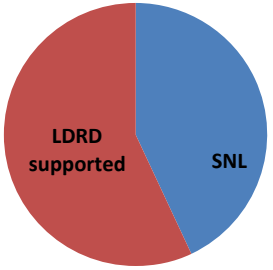




External Collaborations



Postdoc Conversions



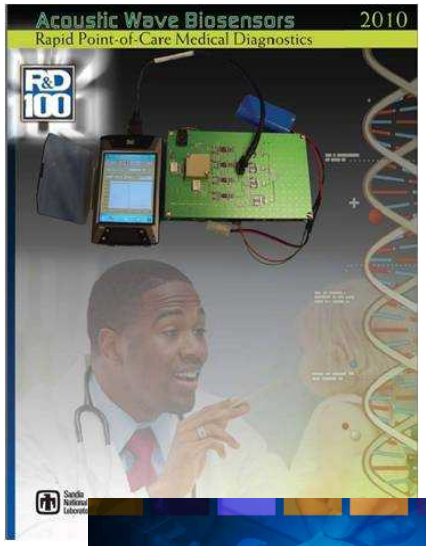
Postdoc Support

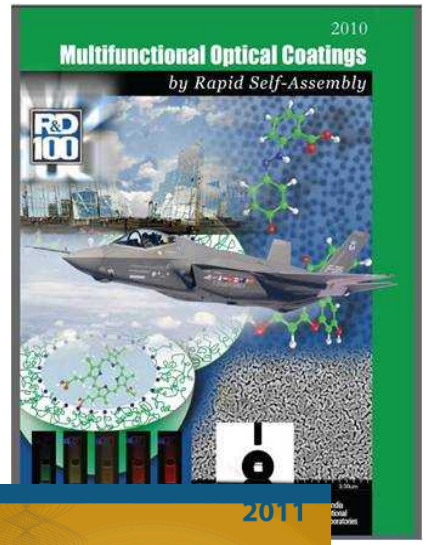
Impact

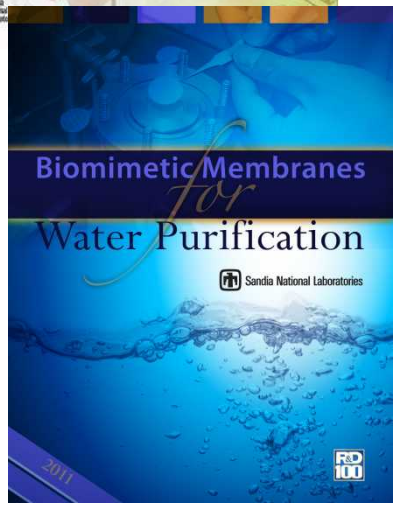
Measure	FY08	FY09	FY10	FY11
New Sponsored Project	41	72	67	57
Another LDRD Project	38	49	48	56
Awards - R&D 100	3	4	3	2

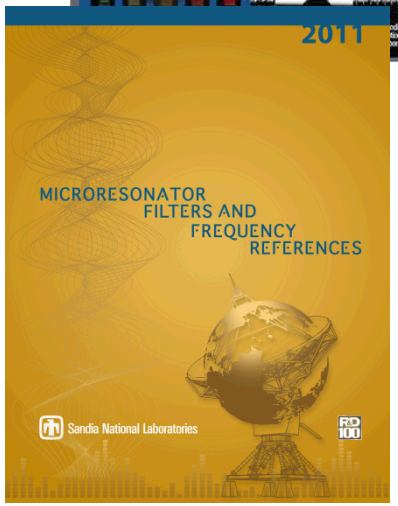
Impact and Quality

- LDRD contributions to Sandia's R&D 100 Awards
  - 2010 – 2 of the 5
  - 2011 – 2 of the 4
  - 2012 – 4 of the 4





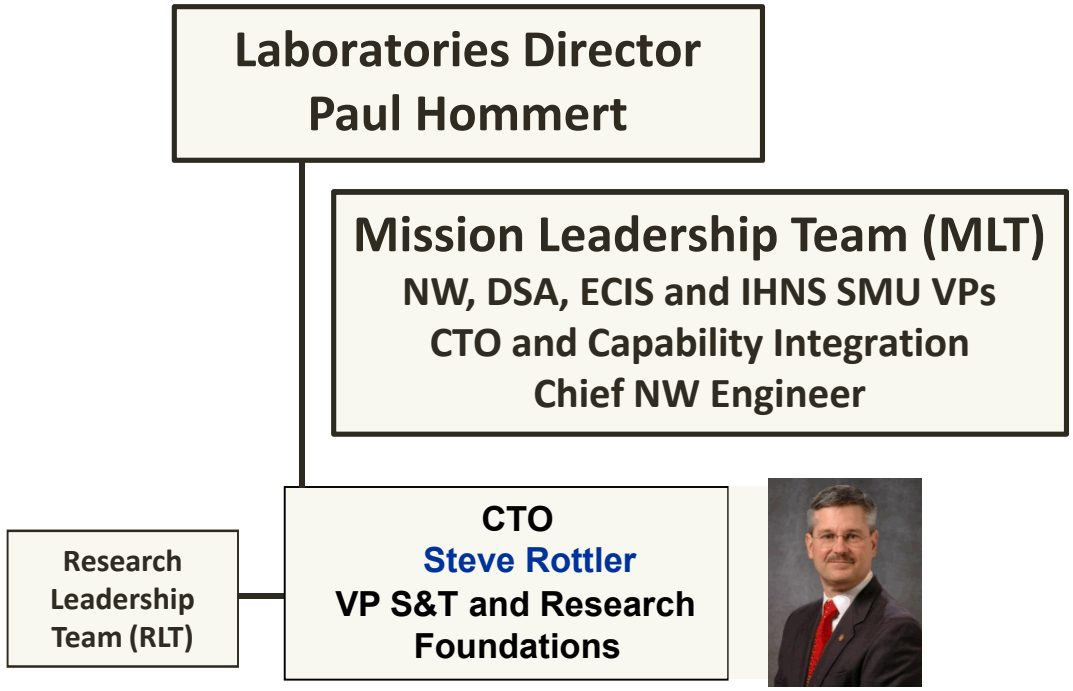




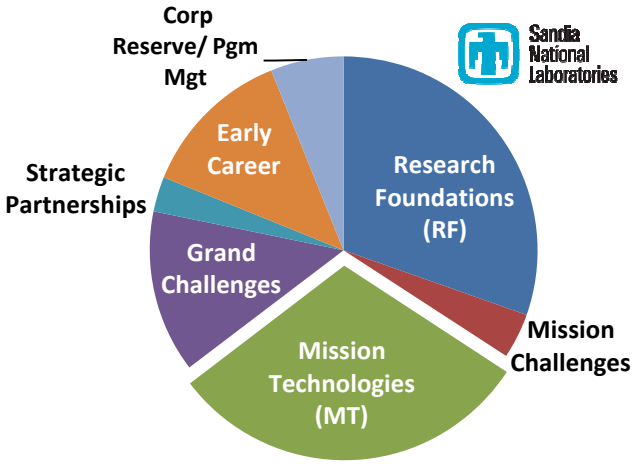
Additional Information

LDRD is managed by the CTO

- Laboratories Director
  - Strategic direction
  - Program budget
  - Policy decisions
- CTO
  - DOE Point of Contact
  - Program management
  - Policy advice
  - LDRD responsibility

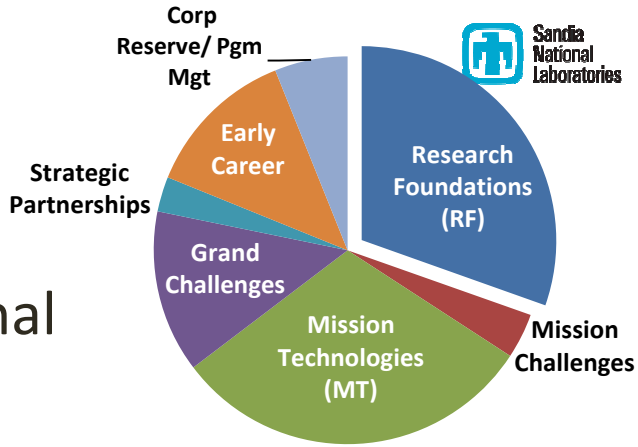


Mission Technologies



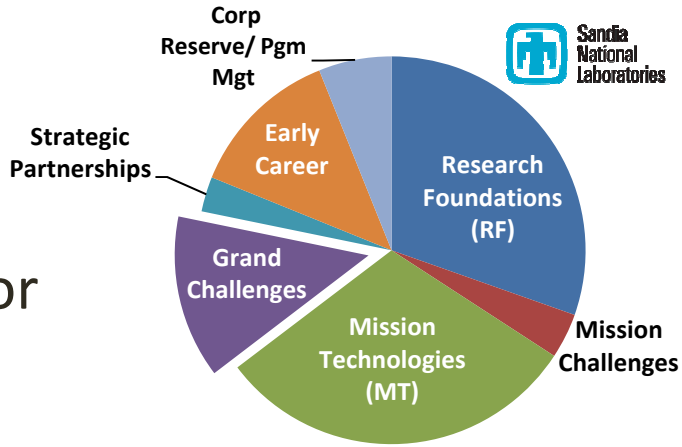
- Seeks to create innovative technologies in direct support of NNSA, DOE, and WFO missions
- Four SMU investment areas
  - **Defense Systems and Assessments**
  - Energy, Climate, and Infrastructure Security
  - International, Homeland and Nuclear Security
  - **Nuclear Weapons**

Research Foundations



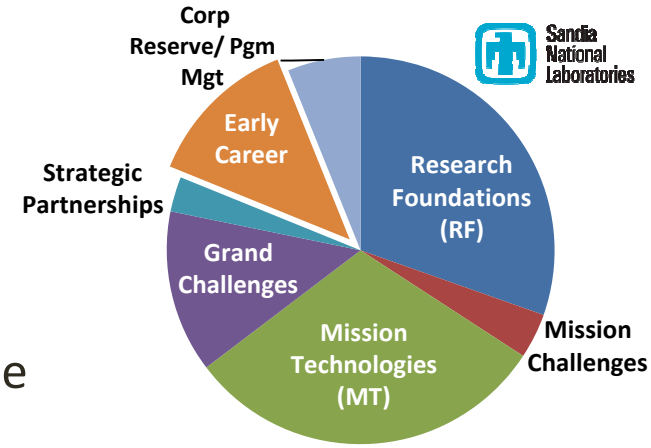
- Provides foundational support for all national security missions
- FY13 portfolio represents nine investment areas
  - Bioscience
  - Computing and Information Sciences
  - Engineering Sciences
  - Geoscience
  - Materials Science
  - Nanodevices and Microsystems
  - Radiation Effects and High Energy Density Sciences
  - New Ideas
  - RLT Bubble

Grand Challenges



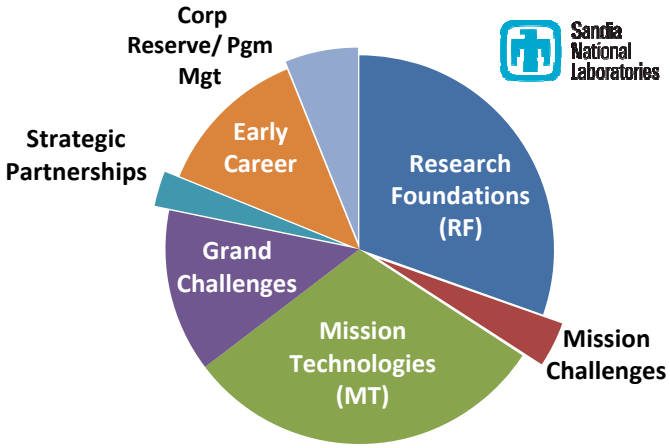
- Bold, high risk ideas with the potential for significant national impact
- Extensive cross-disciplinary content and cross-lab participation
- Expected to create differentiating capabilities that clearly address future mission needs
- Active Grand Challenges
  - Rapid Threat Organism Recognition (RapTOR)
  - Adiabatic Quantum Architectures in Ultracold Systems (AQUARIUS)
  - Secure, Scalable Microgrids
  - Photovoltaics for Disruptive Advances in Solar Power
  - Exascale Computing

Early Career



- Nurture the workforce
  - Engage new PhD technical staff in leading-edge R&D projects
  - Facilitate professional development and transition to mission support
  - Support development of new Sandia capabilities
  - Maps to RF or MT investment areas for project management and integration
  - High demand and reduced hiring has led to a program cap

Other portfolio elements



- Strategic Partnerships develop external partnerships and promote strategic collaborations
  - University collaborations, Truman Fellows, Labs Fellows, and special awards (R&D 100)
- Mission Challenges address difficult national security areas critical to mission success
  - Currently addressing cyber security
- Corporate Reserve / Program Management addresses revenue uncertainty and supports program operations

Selected examples

- Elements (a reminder)
  - Strategy
  - Relevance
  - Quality
  - Workforce / Capabilities
  - Impact
- These five elements frame all research assessments

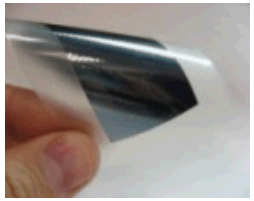
Strategy

- LDRD is a critical component of Sandia's research strategy implementation
- The RLT, SMU, and RF strategies provide the context for the LDRD strategy
- Research strategies to be derived from mission strategies
  - Mission challenges and research challenges
  - Investigating ways to strengthen integration (entanglement) between SMUs and research
- The LDRD call for each RF focuses on a subset of its strategy and:
  - Defines scope
  - Identifies Sandia differentiation
  - Focuses research efforts

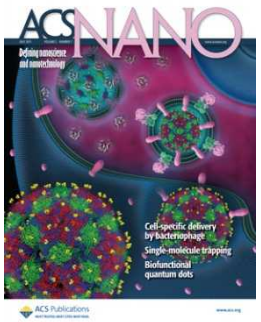
Workforce / Capabilities

- Principal Investigator external achievements (2011) - examples
  - APS Polymer Physics Prize
  - DOE Early Career Research Award
  - Society for Laboratory Automation and Screening Innovation Award
  - Asian American Engineer of the Year
  - Two Fellows American Chemical Society
  - Fellow of the Geological Society of America

- Truman Fellows professional achievement and development - examples
  - Greg Nielson (2004 Truman) - Solar Glitter
    - 2010 SNL Up-and-Coming Innovator
    - 2011 FLC Excellence in Technology Award
    - PI on Photovoltaics Grand Challenge



  - Carlee Ashley (2010 Truman) - Targeted cancer treatment
    - Nature Materials and ACS Nano covers



  - Applicant pool is steadily improving

Impact – Synthetic Aperture Radar

Challenge: Engineer small, lightweight RADAR systems essential for tactical warfare or civilian applications requiring ultra-miniaturized electronics & sophisticated algorithms for data processing and interpretation

LDRD Origin: 6 projects over 10 years

- Enabled MiniSAR deployment (< 30 pounds)
- Very rapid data acquisition enabled VideoSAR: video-radar
- New user interfaces for radar operators
- Inverse SAR for moving target imaging

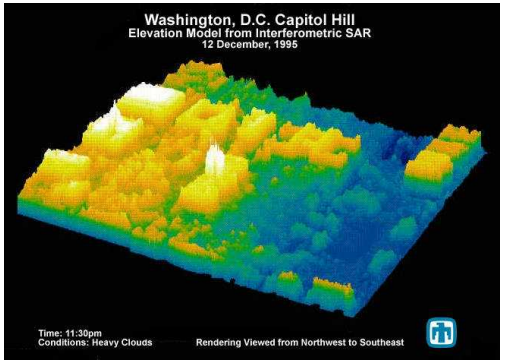
MiniSAR Mounted on Navy Tigershark UAS

Additional R&D Investments:

- Nonproliferation (DOE)
- Generation of terrain maps (US Army)
- Lunar orbiter (NASA)

Program Impact:

- Military: intelligence, surveillance, force protection, targeting, damage assessment, mine detection.
- Civilian: Hurricane/fire damage assessment, search and rescue, monitoring environmental issues (vegetation, sea ice, oil spills), nonproliferation/treaty verification.



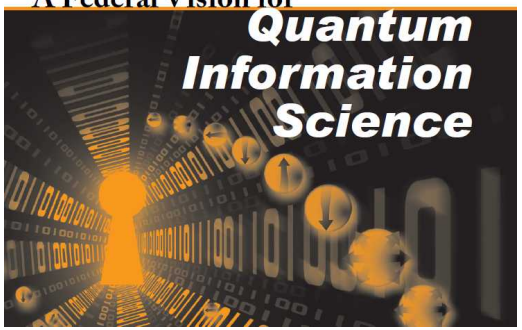
Interferometric SAR, Capitol Hill

Impact – Quantum Information Processing

Challenge: Manipulating, exploiting, and controlling quantum matter by micro-engineering and integrating the physical implementations and architectures of QIP systems.

LDRD Origin: 4 projects over 8 years

- Quantum computing (QC) accelerator I/O
- Engineer component building blocks for trapped-ion quantum computation
  - Solid state surface micro ion-traps
- Engineer/model silicon-based solid state quantum bits (qubits)
- Adiabatic Quantum Architectures in Ultracold Systems (AQUARIUS) Grand Challenge



Additional R&D Investments:

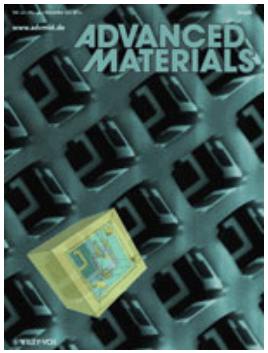
- Trap foundry—Intelligence Advanced Research Projects Activity (IARPA)
- Quantum Radar—Defense Advanced Projects Research Agency (DARPA)
- Quantum-enhanced sensing—DOE
- Other government agencies

Mission Impact:

- S&T leadership in quantum systems engineering
- Creates a new conceptual platform with staggering impact on information processing.
- Ability to solve some of the “impossible” problems would enhance discovery and economic strength.
- Applications that rely on the “impossibility” of certain data protection problems are rendered obsolete.

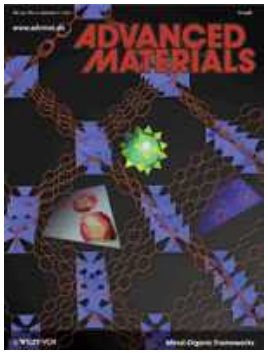
Quality

- Journal covers and media coverage

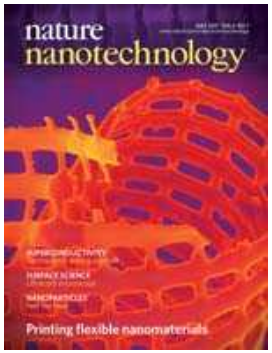


November 2010

December 2010



January 2011



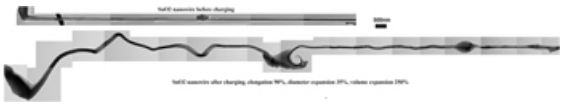
July 2011

August 2011

Sandia Labs engineers create 'self-guided' bullet (>400 news articles, Feb 2012)

Sandia seeks better neural control of prosthetics for amputees (physorg.com, February 2012)

Smallest Li-Ion Battery Ever Created Swells and Contorts While Charging (popsci.com, December 2010)



Quality

- LDRD program execution
  - Investment Area Project Reviews
    - Summary of accomplishments
    - Potential for mission application and next steps and future work
    - End-of-project review and documentation
  - Recognition of S&E leadership and accomplishments
    - Poster session events
    - Journal cover recognition
    - Invited talks and service on review panels
  - Continuous process improvement
    - Call focus, with town halls
    - Proposal review feedback
    - Reduced complexity for continuation proposals
    - CTO MAR for selections (transparency)