R&D at Sandia

SAND2016-2911PE

Robert Broderick| Photovoltaics and Distributed Systems Integration | 06112

GT Visit | March 2016

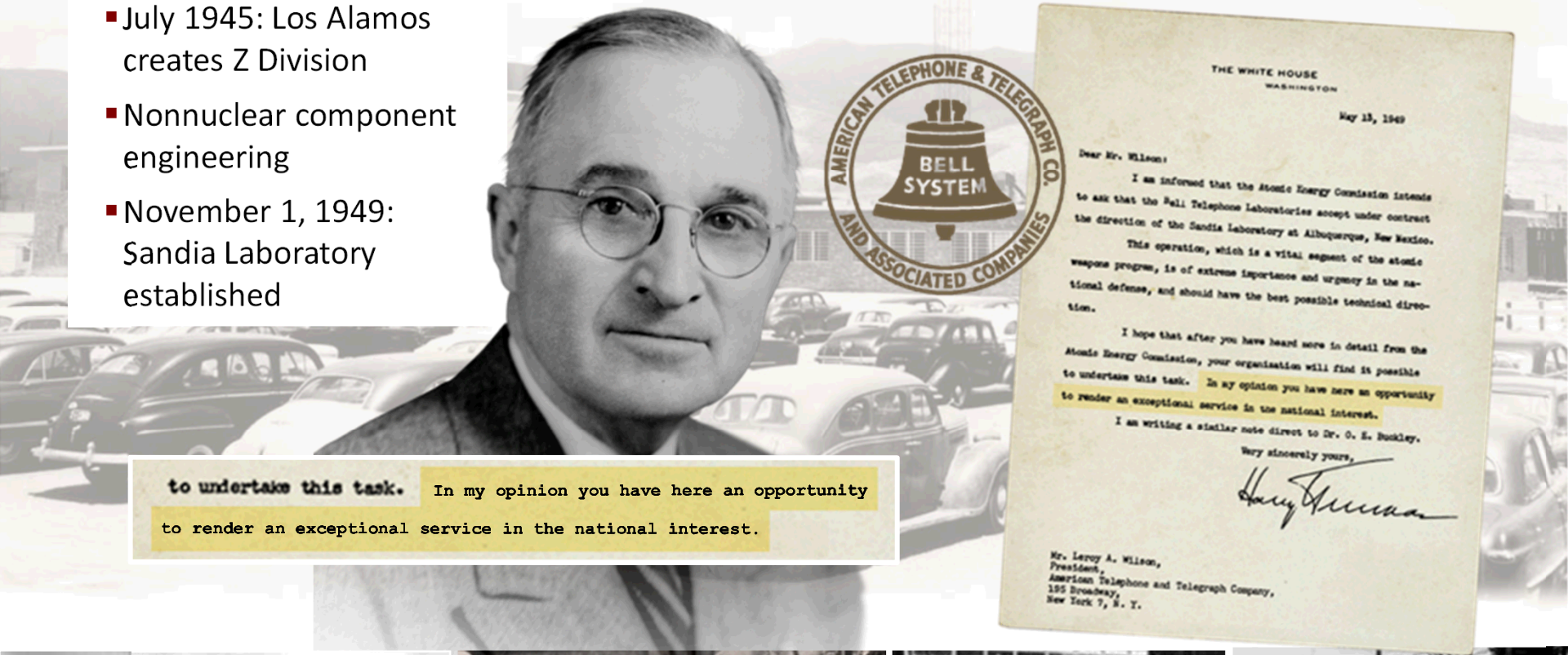
Sandia National Laboratories

SunShot U.S. Department of Energy

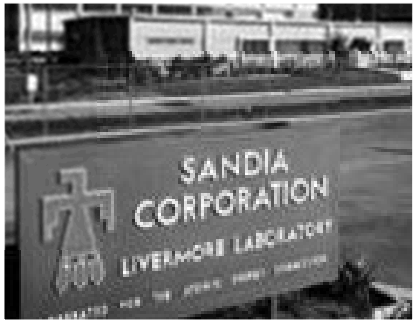
Sandia's History

Exceptional service in the national interest

- July 1945: Los Alamos creates Z Division
- Nonnuclear component engineering
- November 1, 1949: Sandia Laboratory established



to undertake this task. In my opinion you have here an opportunity to render an exceptional service in the national interest.

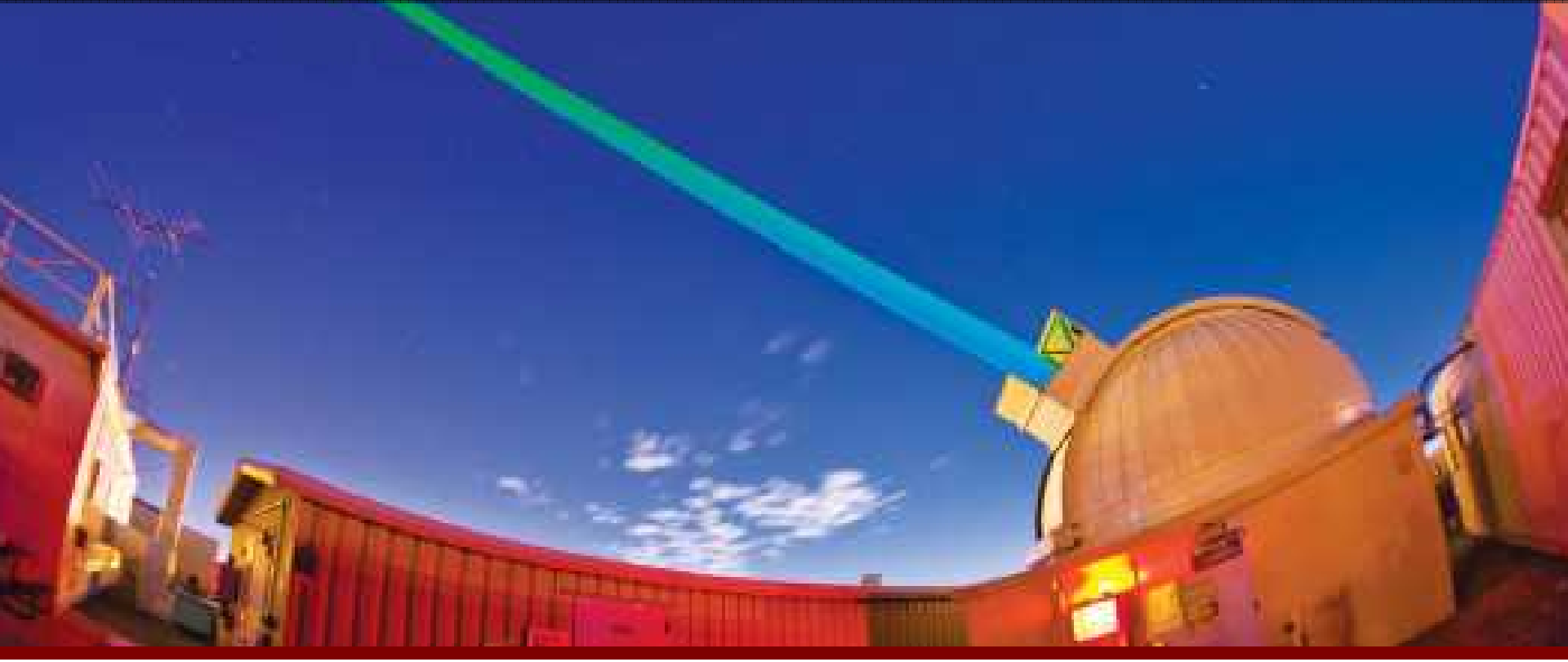


Sandia - *Today*

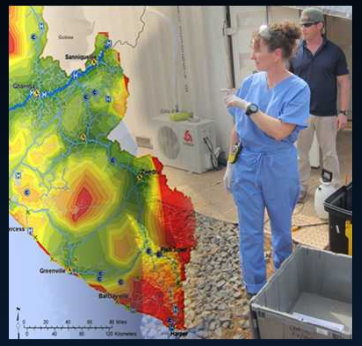
Sandia National Laboratories

As a multi-faceted national security laboratory, Sandia has delivered essential science and technology for more than 60 years and plays a critical role in ensuring U.S. technical superiority.

At Sandia, you can become part of something more—and contribute to our quest to render exceptional service in the national interest.



Sandia's Impact



Ebola Outbreak

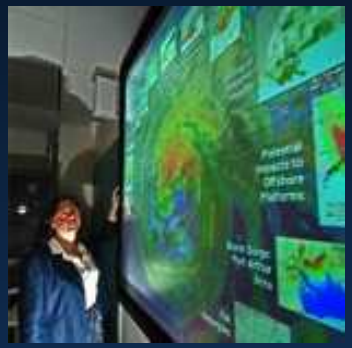
Sandia contributes to global response of Ebola outbreak by developing a sample delivery system cutting the wait time and potentially fatal exposure.

Detecting IEDs

Combat personnel now have a new tool for uncovering improvised explosive devices: Sandia's highly modified miniature synthetic aperature radar system, which is being transferred to the U.S. Army.

Cleanroom invented 1963

$50 billion worth of cleanrooms built worldwide It's used in hospitals, laboratories and manufacturing plants today.



Hurricane Katrina

Sandia is called to assess flooding and infrastructure failures.

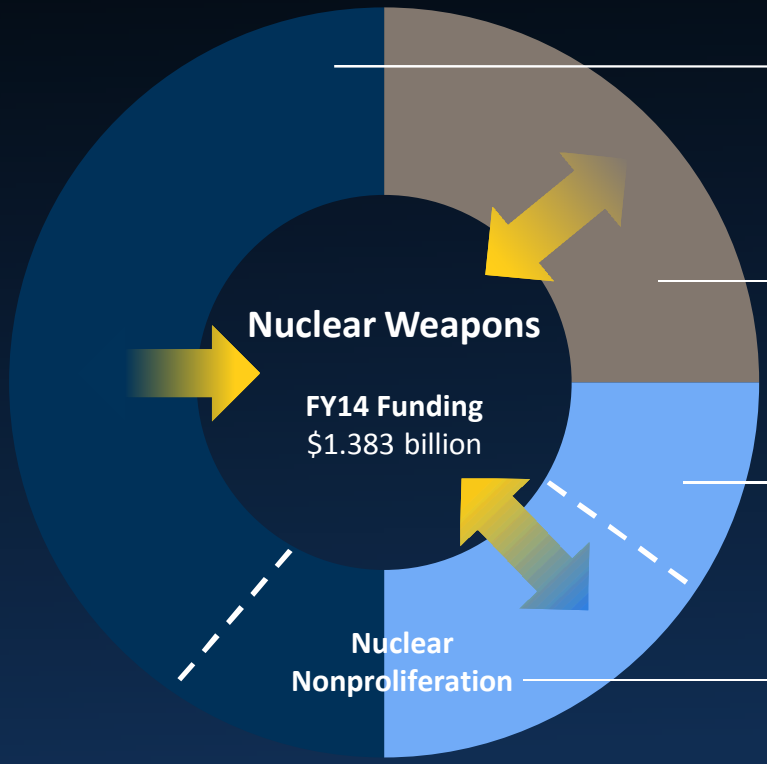
Fukushima Quake

Sandia helps clean up radioactive wastewater.

9/11

Sandia sets contingency plans for release of materials and aircraft attacks on critical facilities immediately after 9/11. Search dogs are equipped with cameras for search and rescue K-9 handlers. The capability allowed search efforts to be carried out in spaces inaccessible to humans.

Sandia's Funding - ~$2 Billion



Department of Defense
$598M + $98M (Nuclear Nonproliferation)
= $696M

Department of Energy (DOE)
Energy Programs
$166M

Department of Homeland Security &
Department of Defense Infrastructure Security
$108M

NNSA Nuclear Nonproliferation
$163M

Note: **Other DOE and non-DOE Funding**
$195M

High reliability, high consequence of failure, challenging environments, and technology solutions

Fulfilling Our National Security Mission

Sandia National Laboratories

Nuclear Weapons

International, Homeland & Nuclear Security

Energy & Climate

Defense Systems & Assessments

Our Foundations in Research

Sandia National Laboratories

We support essential research-and-discovery activities that translate into invention, innovation, entrepreneurship, economic opportunity, and public benefit.

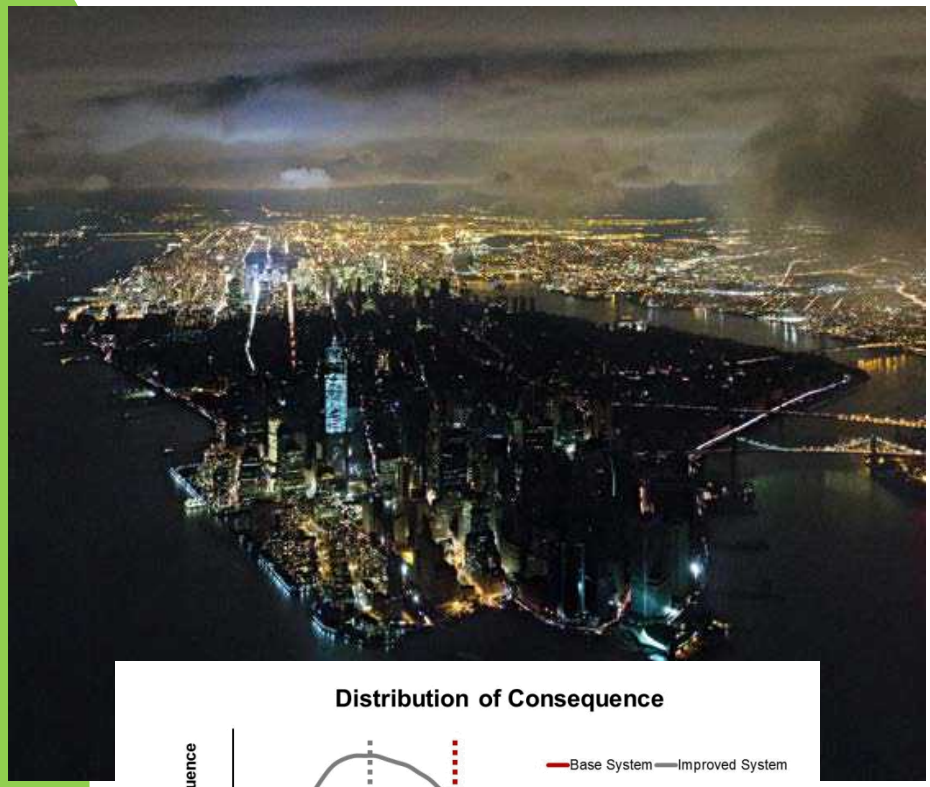
- Bioscience
- Computing and Information Science
- Engineering Science
- Geoscience
- Materials Science
- Nanodevices and Microsystems
- Radiation Effects and High Energy Density Science

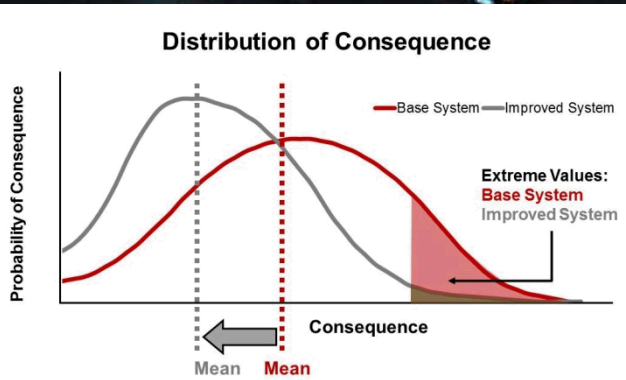
Microgrids and Energy Resilience

Sandia Microgrid Research and Demonstration Projects

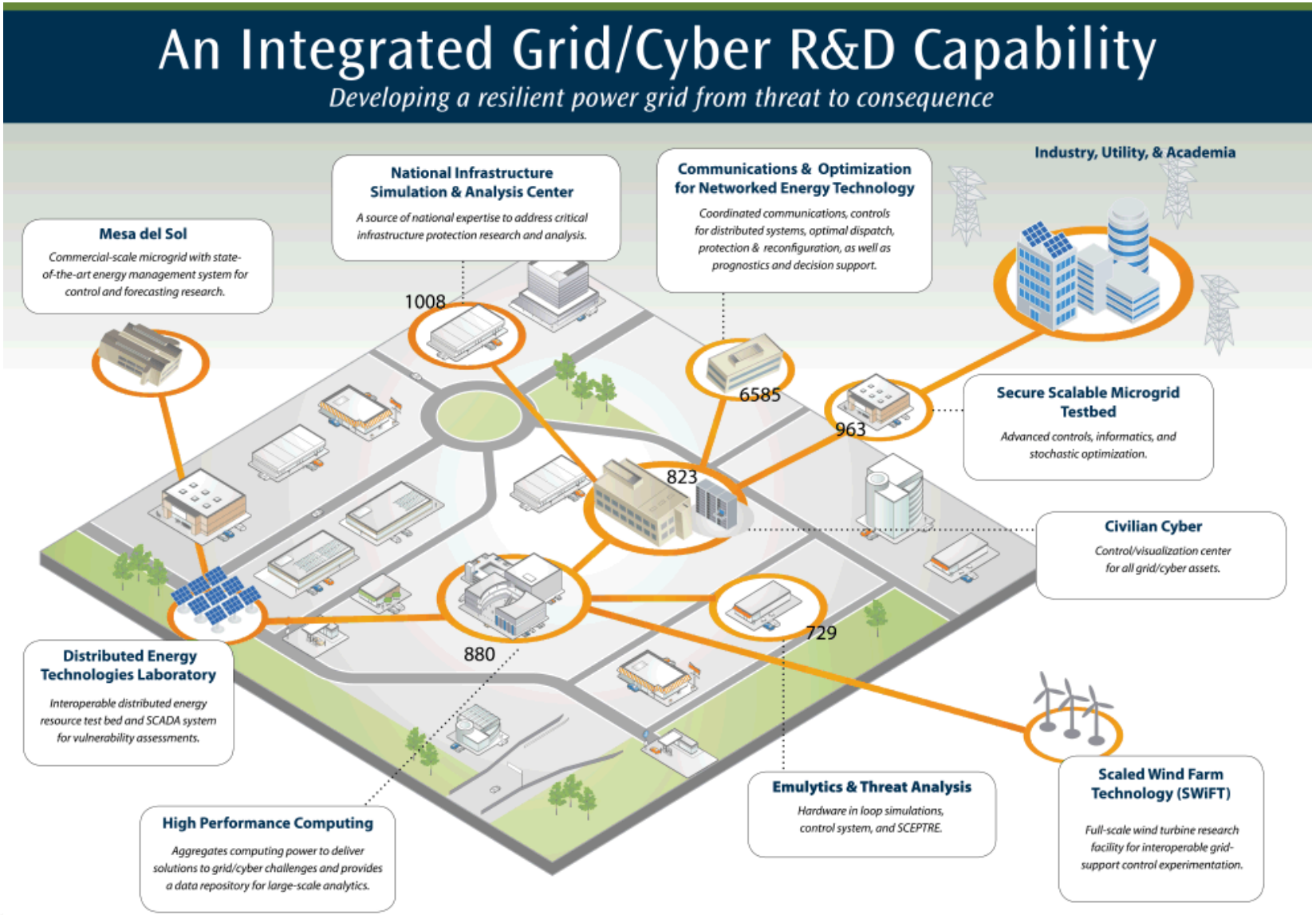
- Improve energy resilience for critical infrastructure
- Conceptual design based on "Energy Surety" Concept

Performance Characteristic	Definition
Safety	Safe supplies of energy to end user
Security	Protection of energy supply infrastructure
Reliability	Can provide energy when and where needed
Sustainability	Can be maintained for long durations with minimal impact on resources
Cost Effective	Provided at affordable cost
Resiliency	Ability to prepare for and adapt to changing conditions and withstand and recover rapidly from disruptions



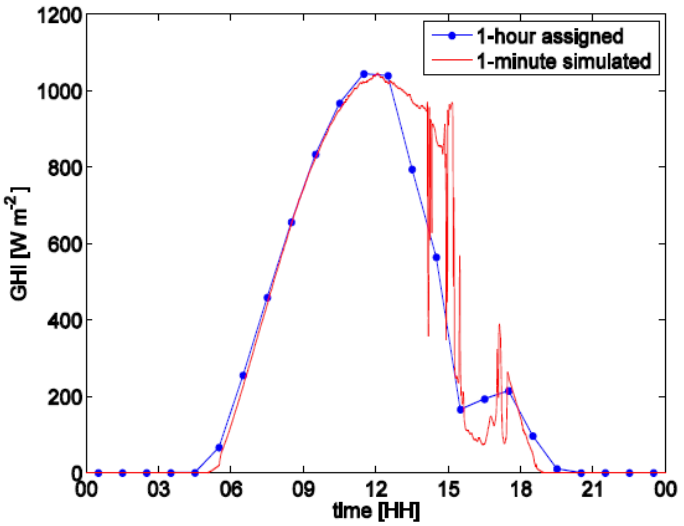


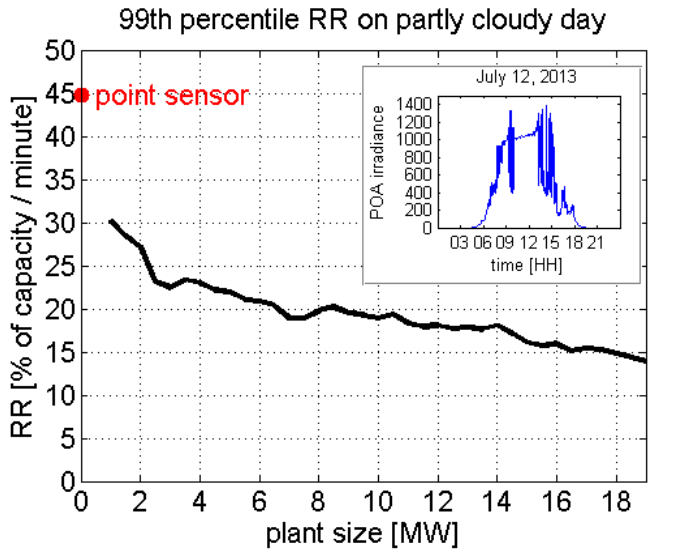
Cyber R&D

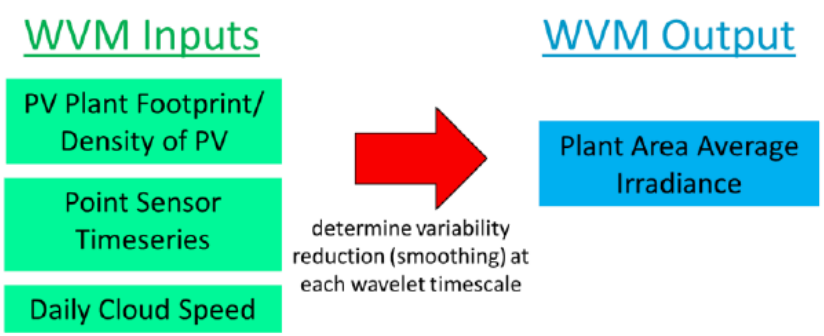

An Integrated Grid/Cyber R&D Capability
Developing a resilient power grid from threat to consequence
Industry, Utility, & Academia
National Infrastructure Simulation & Analysis Center
A source of national expertise to address critical infrastructure protection research and analysis.
Communications & Optimization for Networked Energy Technology
Coordinated communications, controls for distributed systems, optimal dispatch, protection & reconfiguration, as well as prognostics and decision support.
Mesa del Sol
Commercial-scale microgrid with state-of-the-art energy management system for control and forecasting research.
1008
6585
963
823
880
729
Secure Scalable Microgrid Testbed
Advanced controls, informatics, and stochastic optimization.
Civilian Cyber
Control/visualization center for all grid/cyber assets.
Distributed Energy Technologies Laboratory
Interoperable distributed energy resource test bed and SCADA system for vulnerability assessments.
Emulytics & Threat Analysis
Hardware in loop simulations, control system, and SCEPTRE.
Scaled Wind Farm Technology (SWiFT)
Full-scale wind turbine research facility for interoperable grid-support control experimentation.
High Performance Computing
Aggregates computing power to deliver solutions to grid/cyber challenges and provides a data repository for large-scale analytics.

PV Plant Variability Modeling

- Goal
  - Characterize solar output variability at plant and fleet level
  - Develop methods to generate high resolution data at specific locations for transmission and distribution integration analyses





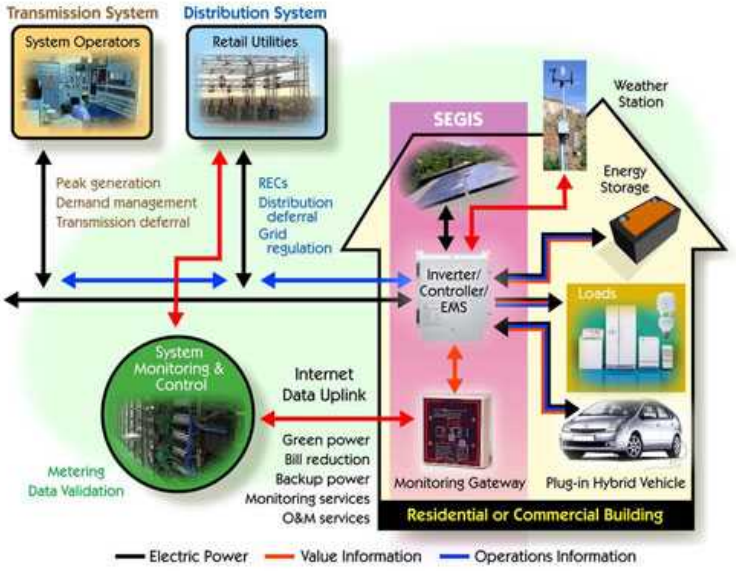


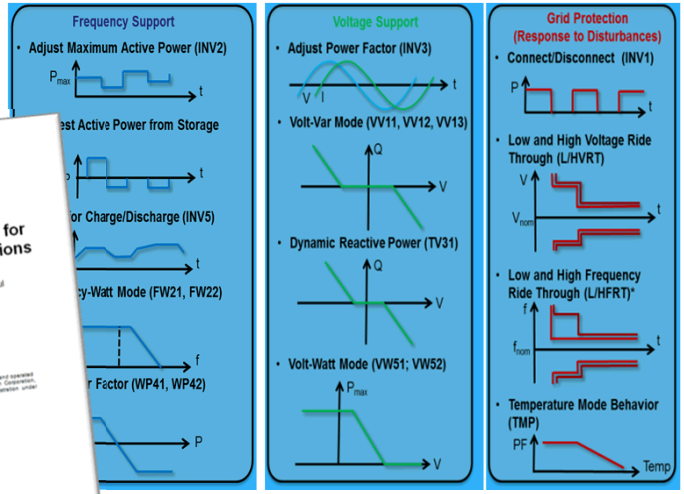
Interoperability and Testing Protocols

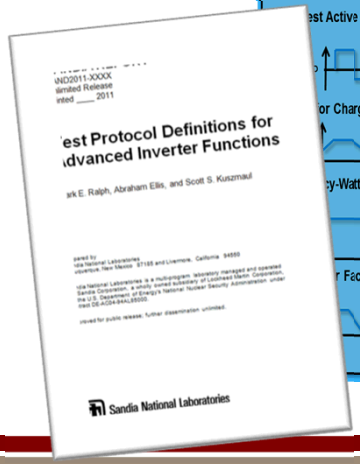
- Goals
  - Improve grid-inverter control interoperability
  - Develop and validate laboratory testing protocols for advanced functions
  - Update interconnection standards
- Partners
  - Inverter manufacturers

    SunSpec, US/International

    testing laboratories







Distributed Energy Technologies Laboratory (DETL)

UNIQUE CAPABILITIES

DETL conducts research with industry and academic partners to integrate emerging energy technologies into new and existing electricity infrastructures.

NATIONAL VALUE

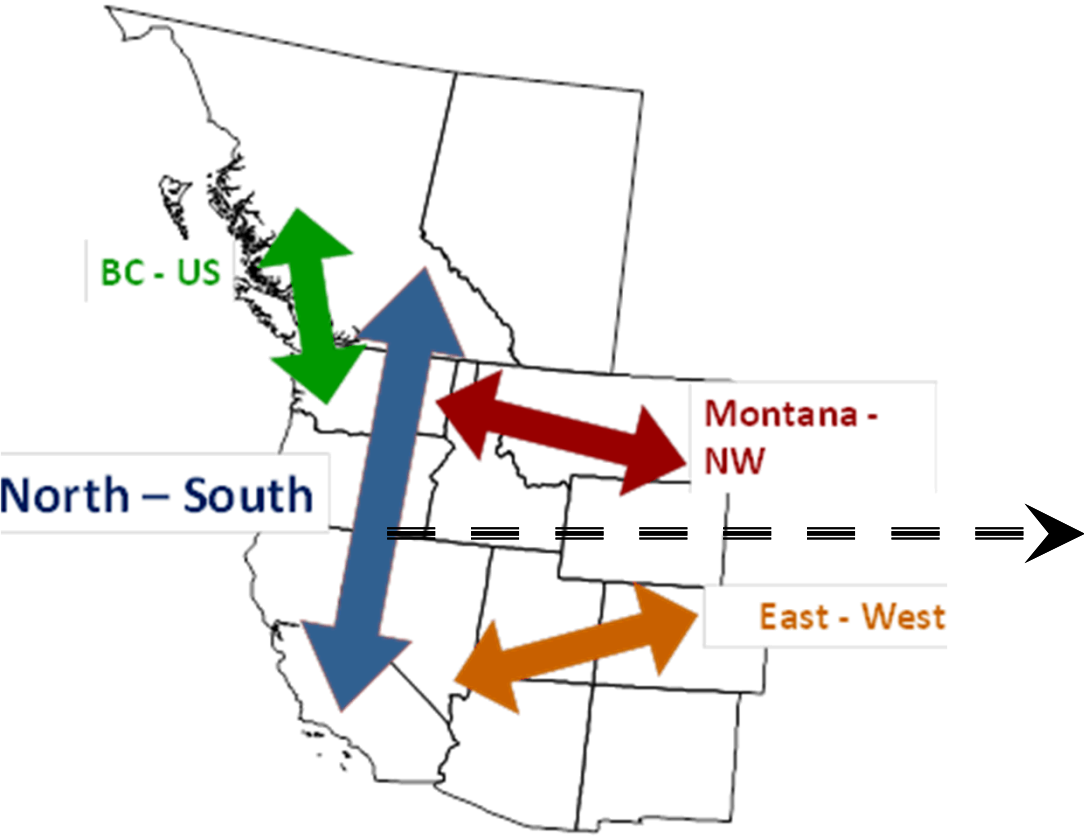
- DOE User Facility for new smart grid technologies in an integrated, fully functioning environment
  - New photovoltaic inverters and energy management systems
  - Integrated storage and new controls
  - Demand-side management and utility interactions
- Provides lab evaluations prior to field installations

RESEARCH IMPACT

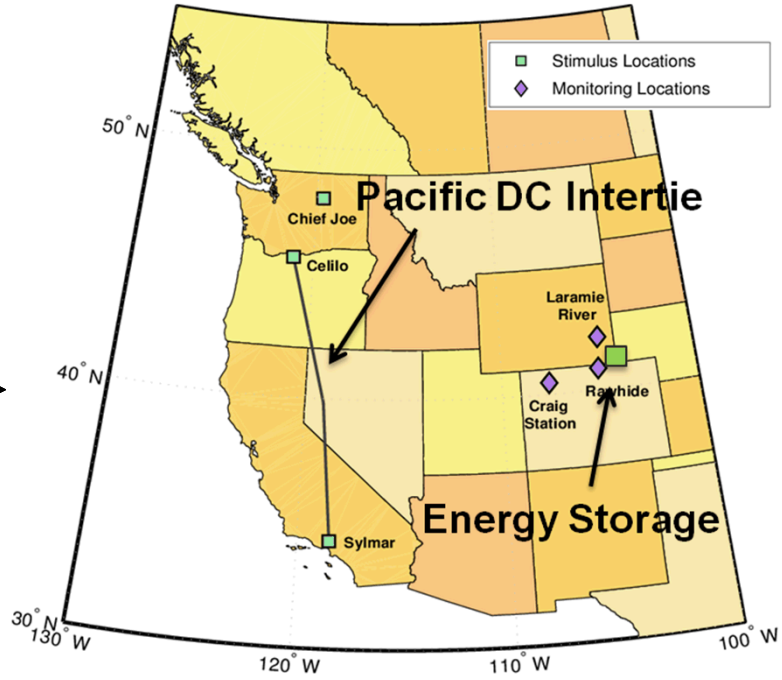
- Electric Power Research Institute (EPRI)
- Department of Defense
- PNM (NM utility)
- GreenSmith
- GreenRay
- Enphase
- Petra AMPT
- Princeton
- AE (PVPowered)
- StatCon
- SMA
- Fronius
- Xantrex (Schneider)
- Aurora

Wide Area Damping Control

Western Interconnect Oscillation Modes



North-South Mode



Exceptional service in the national interest

Sandia National Laboratories

IOWA STATE UNIVERSITY

UCDAVIS
UNIVERSITY OF CALIFORNIA

arpa·e

ALSTOM

ISO new england

Improved Power System Operations using Advanced Stochastic Optimization

U.S. DEPARTMENT OF ENERGY

NNSA National Nuclear Security Administration

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.

Sandia's Energy Storage Research Crosscuts Several Technology Areas

Hydrogen Storage

Hydrogen and Fuel Cells program is developing technologies to accelerate large-scale deployment of hydrogen storage.

Thermal Storage

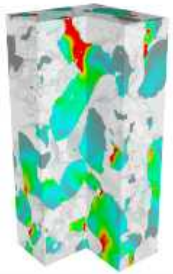
Sandia's Concentrating Solar Power (CSP) program is developing molten salt thermal storage systems for grid-scale energy storage.

Battery Materials

Sandia has a large portfolio of R&D projects related to advanced materials to support the development of lower cost energy storage technologies including new battery chemistries, electrolyte materials, and membranes.

Systems Modeling

Sandia is performing research in a number of areas on the reliability and safety of energy storage systems including simulation, modeling, and analysis, from cell components to fully integrated systems.



Systems Analysis

Sandia has extensive infrastructure to evaluate megawatt-hour class energy storage systems in a grid-tied environment to enable industry acceptance of new energy storage technologies.

Cell & Module Level Safety

Sandia has exceptional capabilities to evaluate fundamental safety mechanisms from cell to module level for applications ranging from electric vehicles to military systems.

Power Conversion Systems

Leveraging exceptional strengths in power electronics, Sandia has unique capabilities to characterize the reliability of power electronics and power conversion systems.

Grid Analytics

Analytical and multi-physics models to understand risk and safety of complex systems, optimization, and efficient utilization of energy storage systems in the field.

Wide ranging R&D covering energy storage technologies with applications in the grid, transportation, and stationary storage

Our Workforce & Culture

Our Workforce ~11,700 employees

Sandia National Laboratories

~10,300 Regular employees

~1,400 Temporary employees, stud
& postdoctoral appointees

New Mexico Site:

Workforce: ~10,500

R&D employees: ~4,700

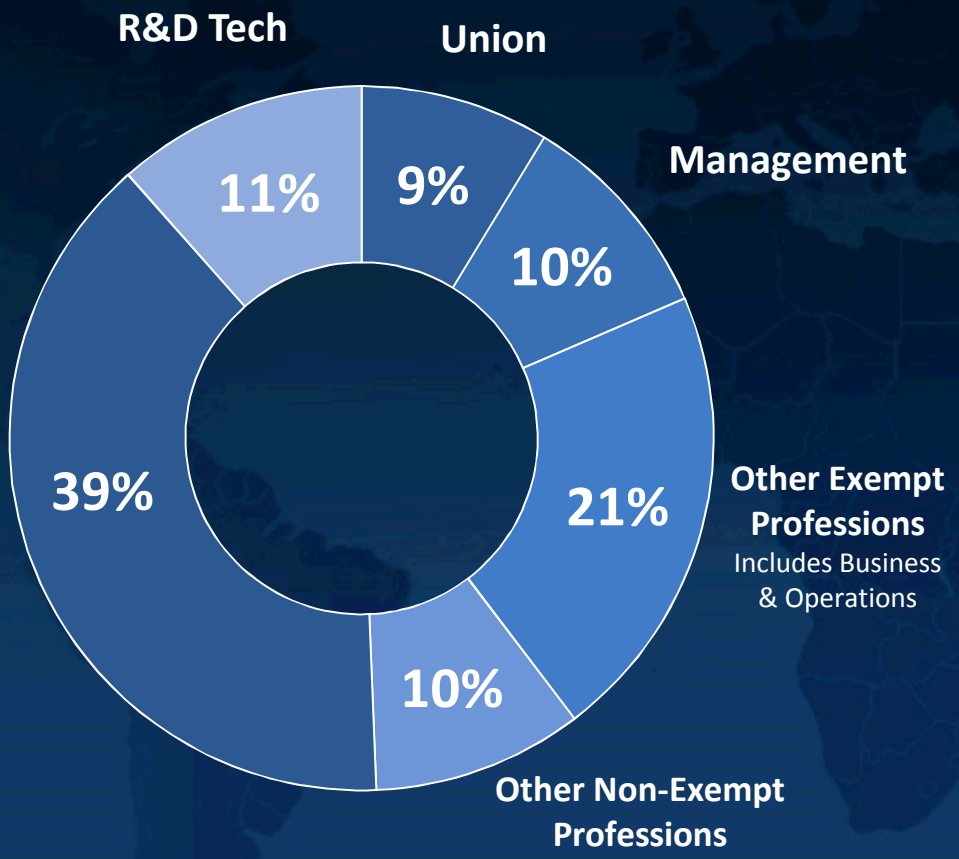
(R&D Staff & Technologists)

California Site:

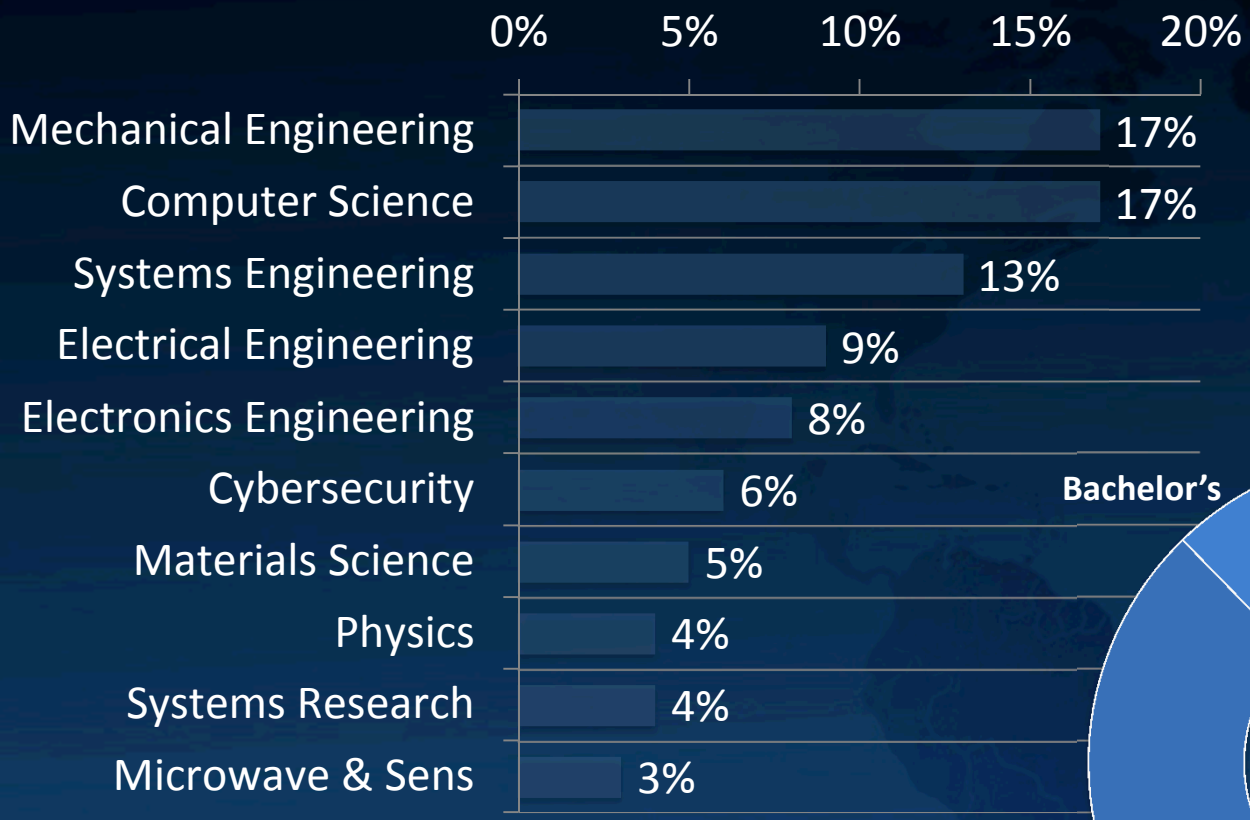
Workforce : ~1,200

R&D employees: ~600

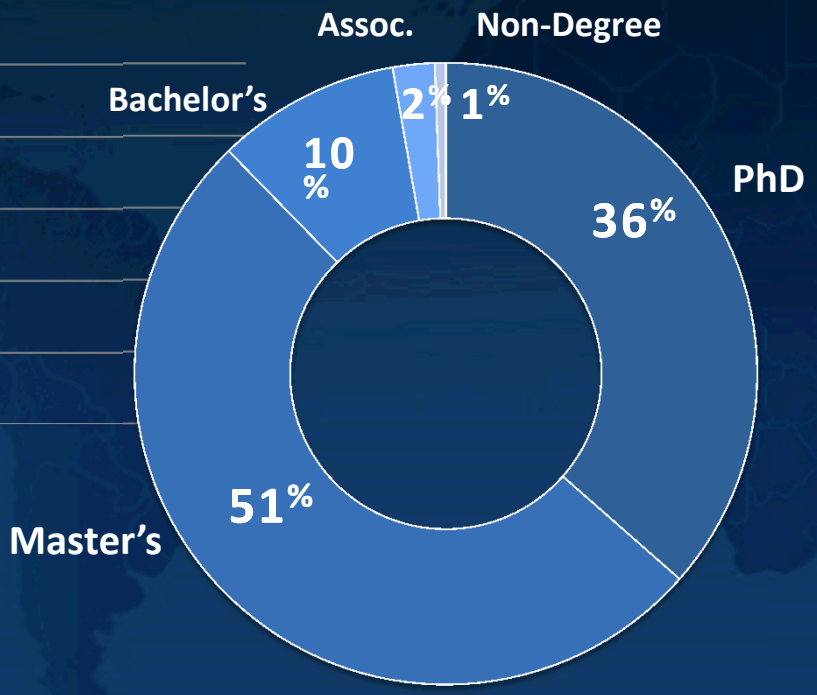
(R&D Staff & Technologists)



R&D by Discipline & Degree



Top 10 job descriptions shown, Regular exempt non-management employees only



The Work Experience

- Challenging assignments
- State-of-the-art research facilities
- Work with top minds
- Join outreach and networking groups
- Receive recognition, R&D 100 Awards *and more*
- Take a leave to pursue qualifying research and professional opportunities
- Receive patent royalties, if eligible
- Career mobility

Employment Opportunities

Internships

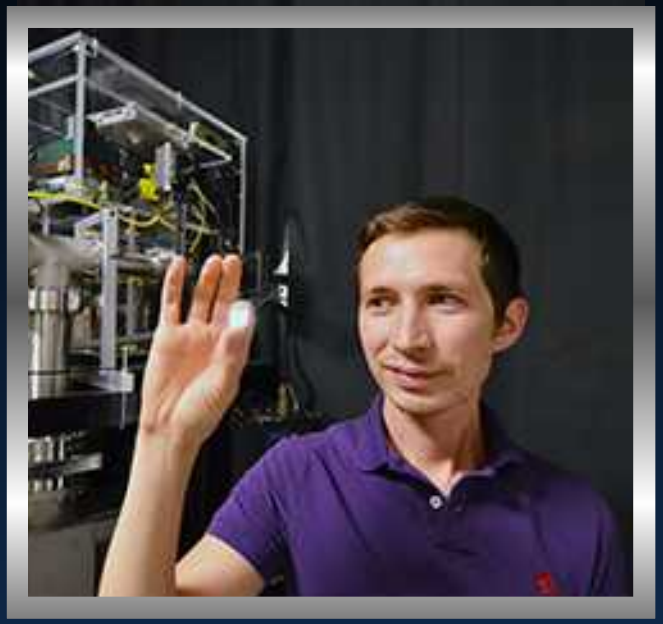
Sandia National Laboratories

Encourages qualified students to develop interests in critical skills areas related to our mission, with the ultimate objective of developing our pipeline for our future. Available for Summer, Year Round and Co-op.

Eligibility Criteria

- Min. cumulative GPA (3.2 Undergrad/3.5 Grad)
- Have U.S. citizenship for positions that require clearance or as stated in the job posting
- Full-time enrollment status at an accredited college, university, or local high school
- At least 16 years of age

Post-doc Opportunities



Key areas for post-docs at Sandia:

- Biosciences and biotechnology
- Chemistry and materials science
- Combustion
- Computational mechanics
- Computer science
- Hydrogen
- Microelectronics and microfluidics
- Nanotechnology
- Physics

Eligibility Criteria

- A recent PhD (awarded within the past five years) or the ability to complete all PhD requirements before beginning
- No previous post-doc appointments at a national laboratory