Exceptional service in the national interest

Sandia National Laboratories

SAND2014-17395PE

Overview of SNL, Technical Area V and the Annular Core Research Reactor

Presented to the Texas A&M University American Nuclear Society Student Chapter

Dave Wheeler and Ed Parma

September 8, 2014

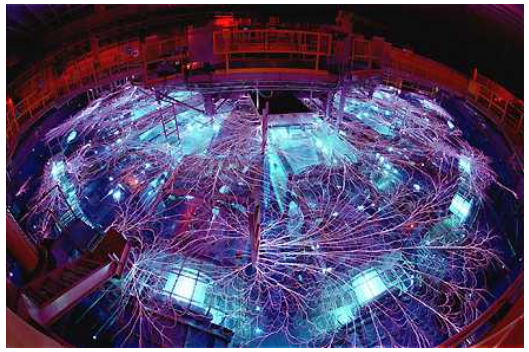
U.S. DEPARTMENT OF ENERGY

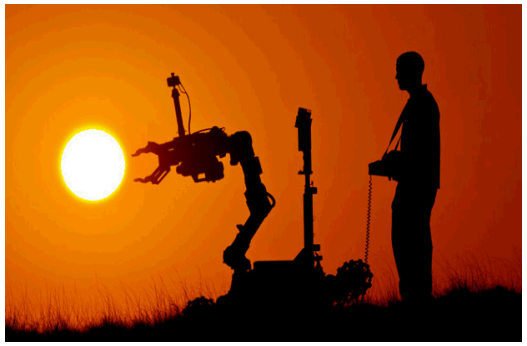
NNSA National Nuclear Security Administration

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. SAND NO. 2011-XXXXP

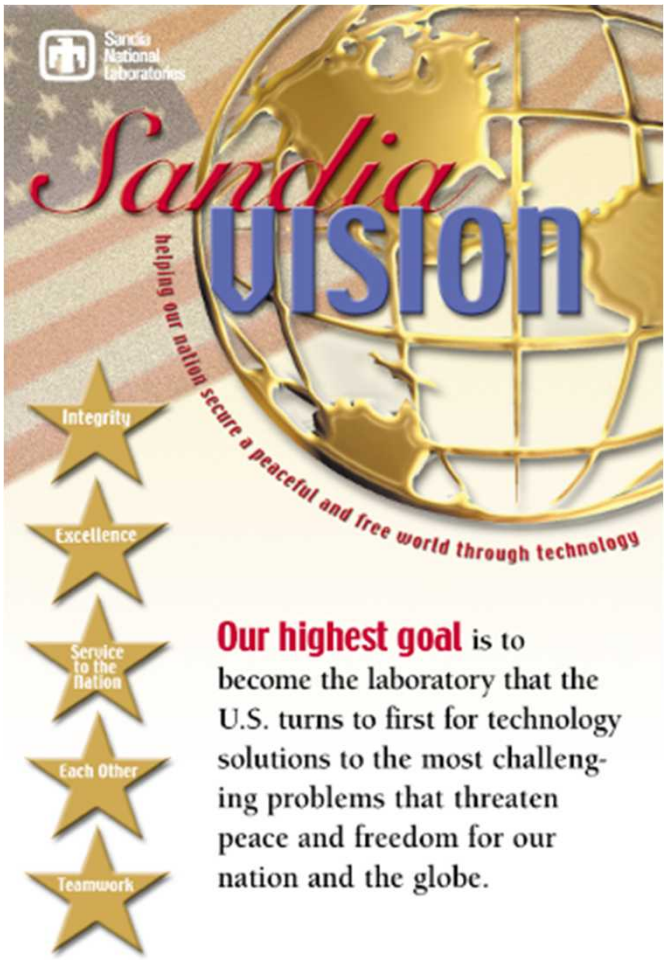
The laboratory the U.S. turns to first

Sandia National Laboratories





- National Security Laboratory
- Broad mission in developing science and technology applications to meet our rapidly changing, complex national security challenges
- Safety, security and reliability of our nation's nuclear weapon stockpile



Sandia's Impact

Cleanroom invented 1963

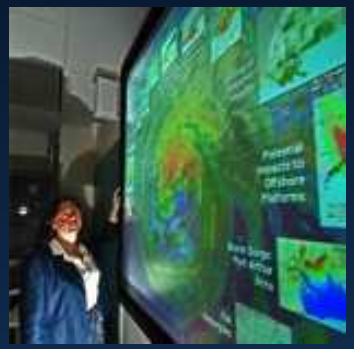
$50 billion worth of cleanrooms built worldwide It's used in hospitals, laboratories and manufacturing plants today.

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.

2008 Satellite Takedown

Red Storm computing helps shoot down rogue satellite.



Hurricane Katrina

Sandia is called to assess flooding and infrastructure failures.

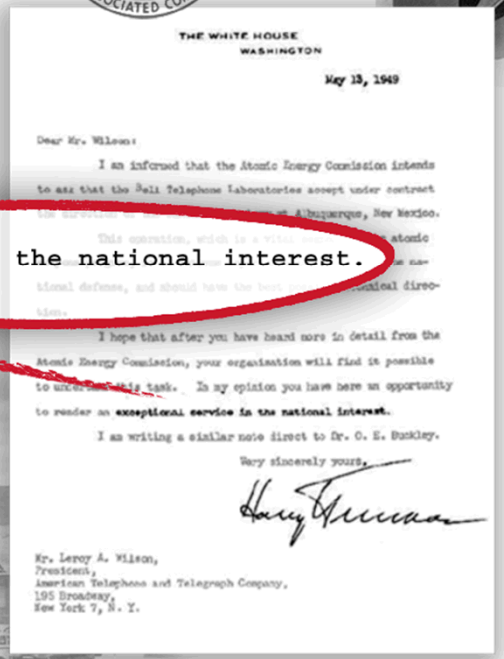
Fukushima Quake

Sandia helps cleanup radioactive wastewater.

Gulf Oil Spill

Sandia works to help to develop an approach for securing the damaged well head, stopping the leak, and minimizing the severity of the oil spill.

Sandia's History



THE WHITE HOUSE
WASHINGTON

May 13, 1949

Dear Mr. Wilson:

I am informed that the Atomic Energy Commission intends to ask that the Bell Telephone Laboratories accept under contract [illegible] at Albuquerque, New Mexico. This operation, which is a vital [illegible] atomic [illegible] national defense, and should have the best [illegible] technical direction.

I hope that after you have heard more in detail from the Atomic Energy Commission, your organization will find it possible to undertake this task. In my opinion you have here an opportunity to render an **exceptional service in the national interest.**

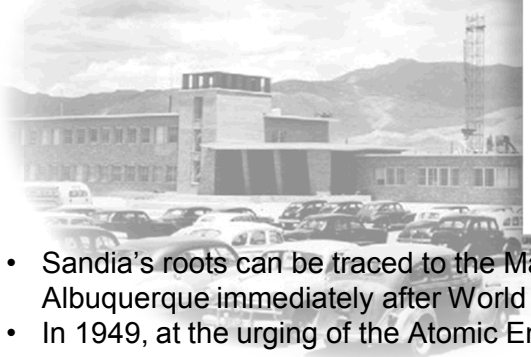
I am writing a similar note direct to Dr. O. E. Buckley.

Very sincerely yours,

Harry Truman

Mr. Leroy A. Wilson,
President,
American Telephone and Telegraph Company,
195 Broadway,
New York 7, N. Y.

exceptional service in the national interest.



- Sandia's roots can be traced to the Manhattan Project. J. Robert Oppenheimer established "Z Division" at Sandia Base near Albuquerque immediately after World War II, to perform stockpile development activities.
- In 1949, at the urging of the Atomic Energy Commission, President Truman encouraged the American Telephone and Telegraph Company to accept management and operating responsibility for the Sandia operation. His letter to AT&T President Leroy Wilson contained a phrase that captures the ethos of Sandia to this day: "In my opinion, you have here an opportunity to render an exceptional service in the national interest." The AT&T Bell Laboratories operated Sandia from November 1949 through 1992.
- In 1993 Martin Marietta Corporation became the management and operating contractor for Sandia National Laboratories. (Martin Marietta later merged with Lockheed to form Lockheed Martin Corporation.)
- Sandia established a laboratory facility in Livermore, California, in 1956 to the support the nuclear weapon development activities of the University of California Radiation Laboratory—now Lawrence Livermore National Laboratory.

Emerging National Security Thrusts

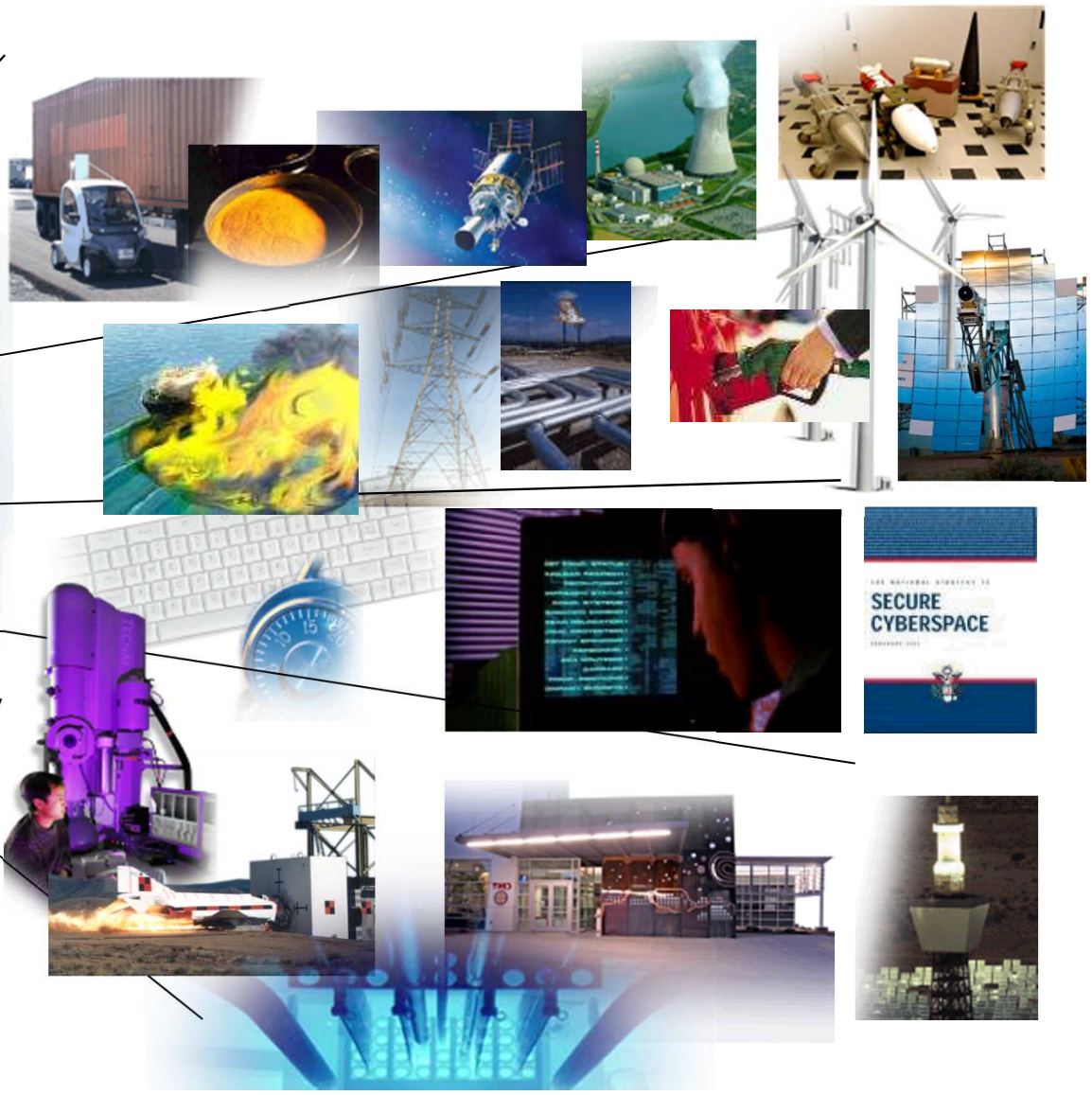
Sandia National Laboratories

Nuclear

Energy

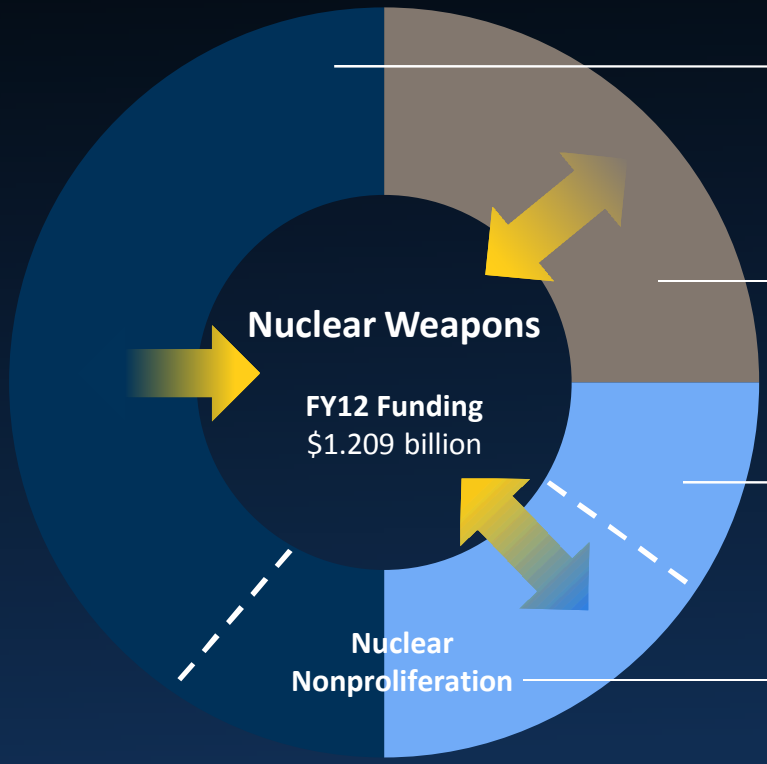
Cyber

Science & Technology



Sandia is a National Laboratory

Sandia's Funding



Department of Defense
$562M + $120M (Nuclear Nonproliferation) = $682M

Department of Energy (DOE) Energy Programs
$197M

Department of Homeland Security & Department of Defense Infrastructure Security
$99M

NNSA Nuclear Nonproliferation
$177M

Note: **Other DOE and non-DOE Funding**
$200M

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

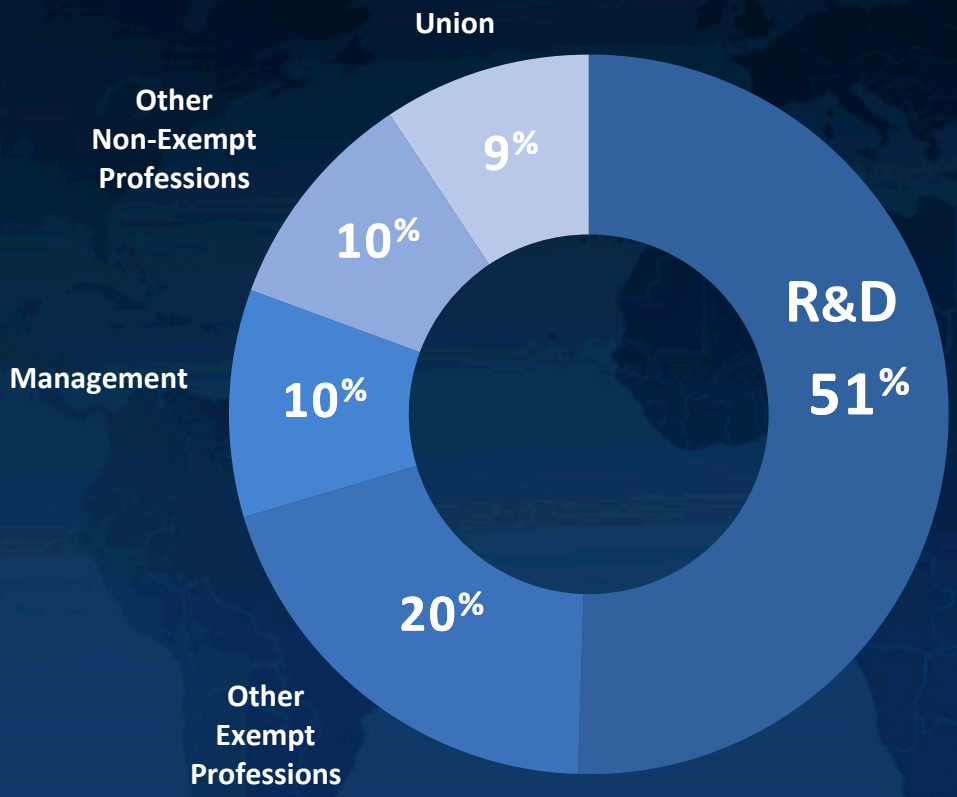
Our Workforce

Regular Employees	Highest Degree
1,728	PhD
3,580	Masters
1,721	Bachelors
8	Doctor of Medicine
31	Doctor of Law

Regular Employees	Years of Service
3,098	Less than 5 years
1,554	5–9 years
2,541	10–19 years
1,652	20–29 years
766	30–39 years
25	40+ years

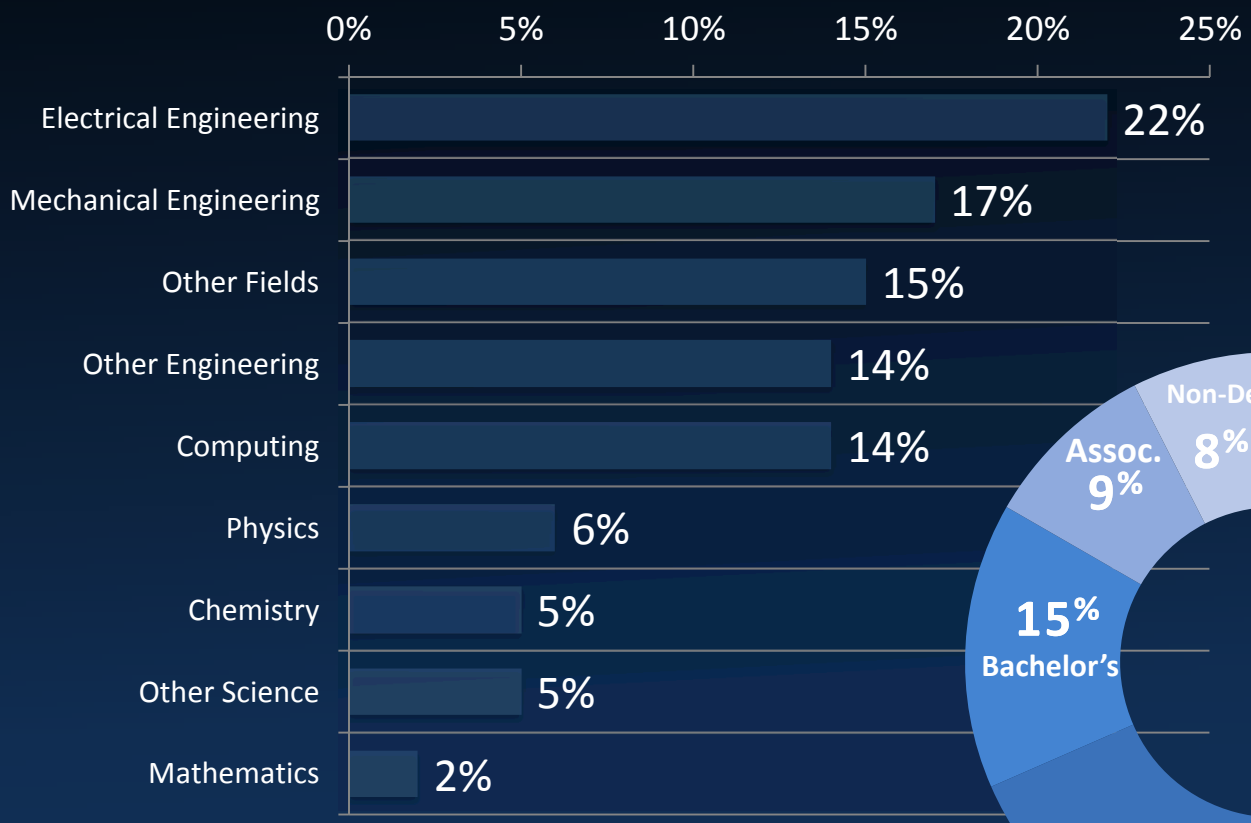
9,633 Regular employees

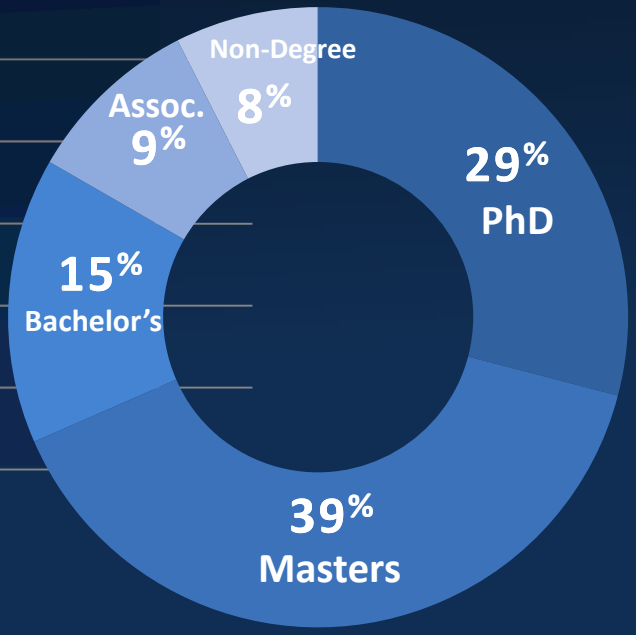
1,743 Temporary employees and contractor associates



Data as of July 15, 2013

R&D by Discipline & Degree

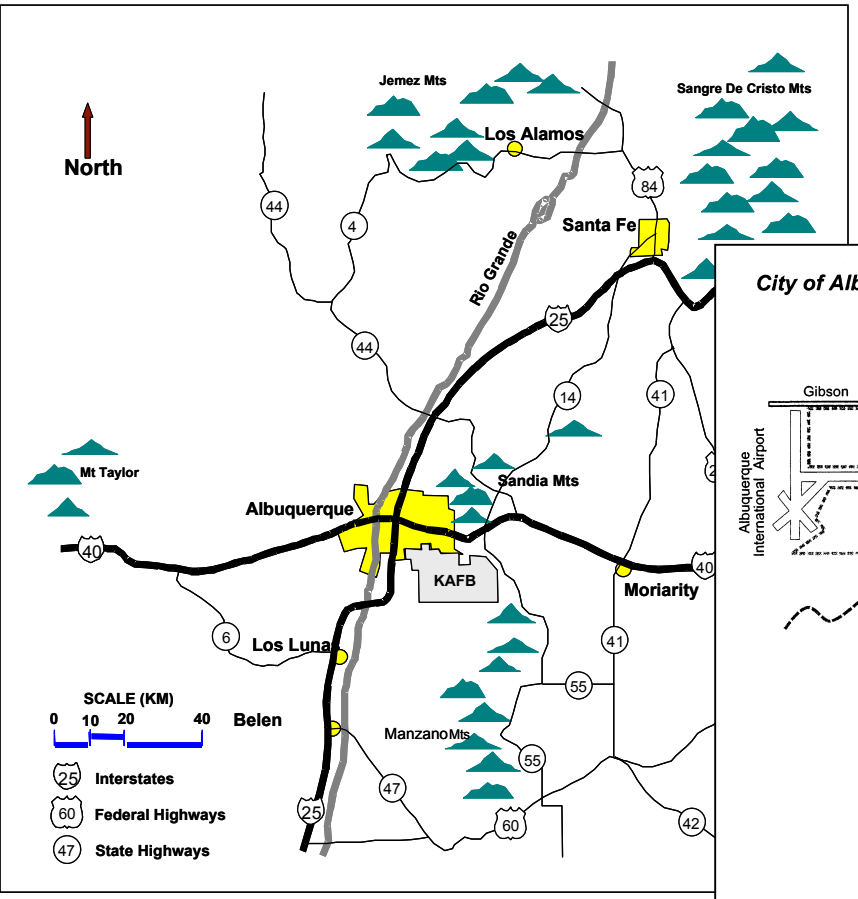


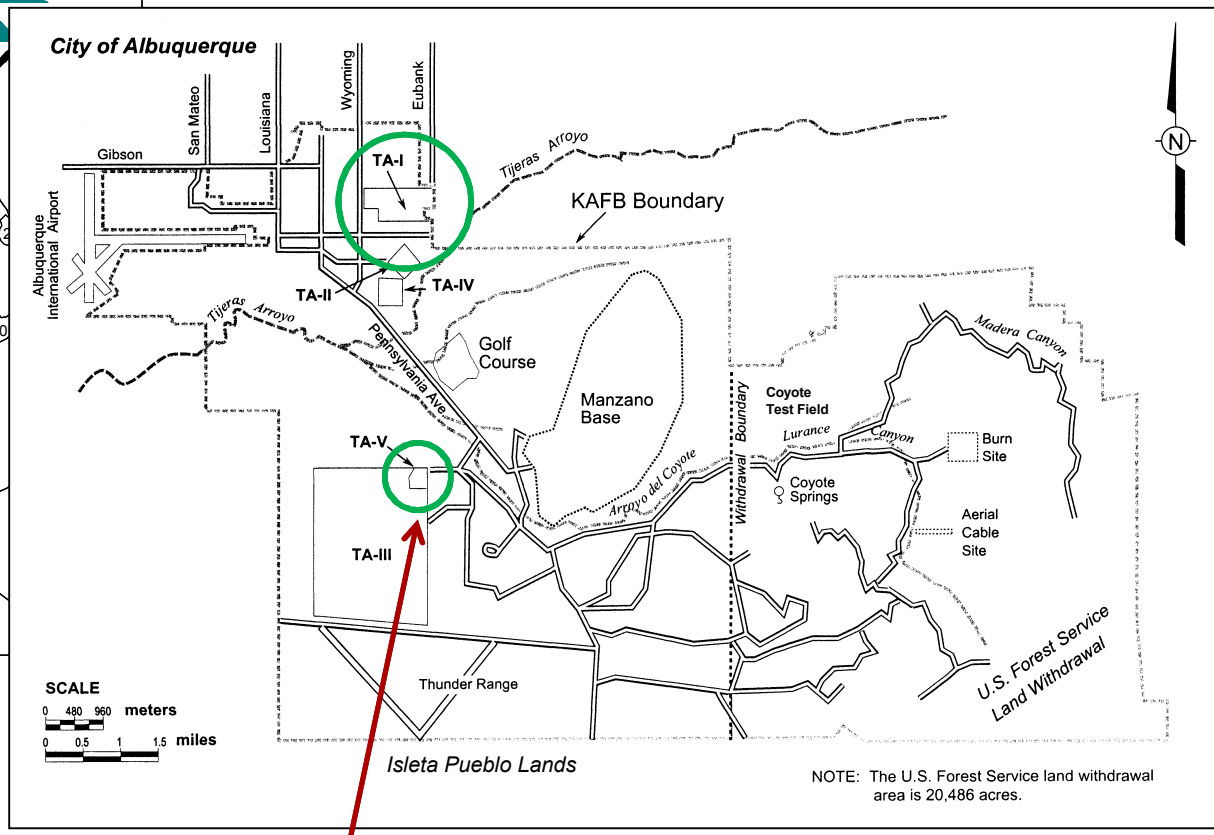


Sandia National Laboratories - ABQ

Sandia National Laboratories

Sandia National Laboratories (SNL) is located on Kirtland AFB in Albuquerque, NM.



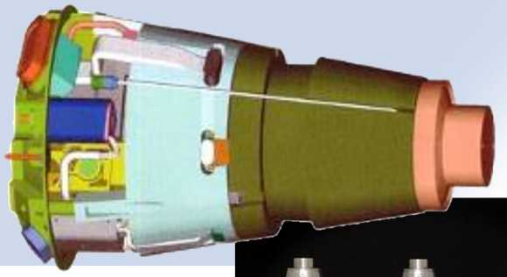


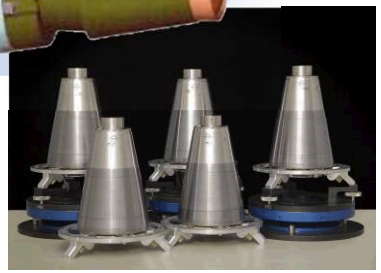
Sandia's nuclear reactor facilities are in Technical Area V - a few miles south of the main research campus.

Nuclear Weapons

Sandia National Laboratories

Integrated, engineered warhead systems

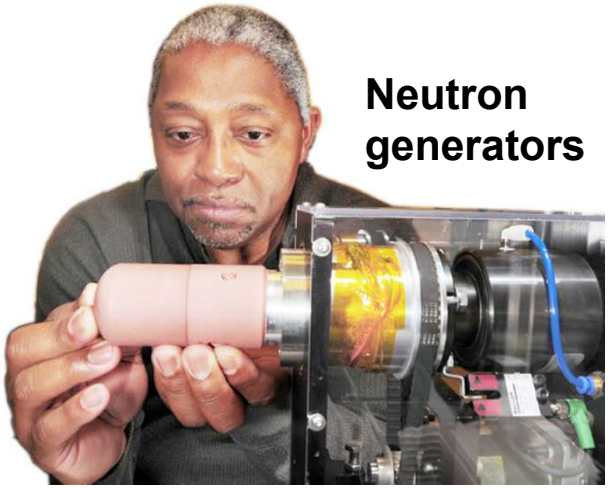




Arming, fuzing, and firing systems

Safety systems

Gas transfer systems

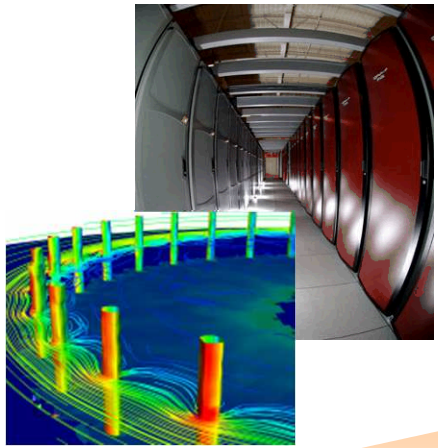


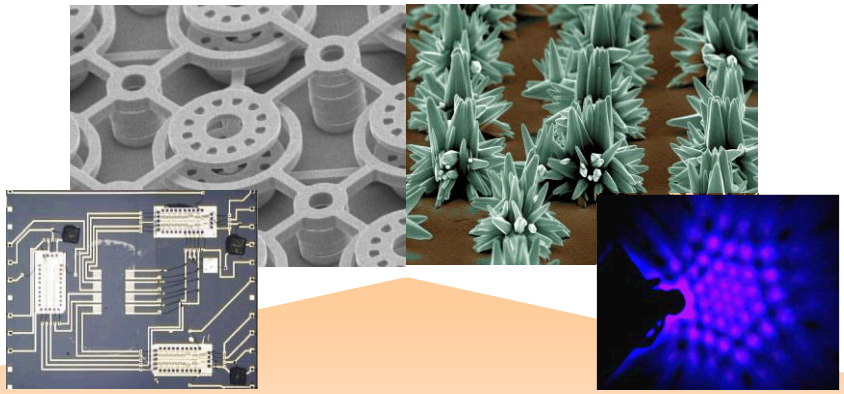
Neutron generators

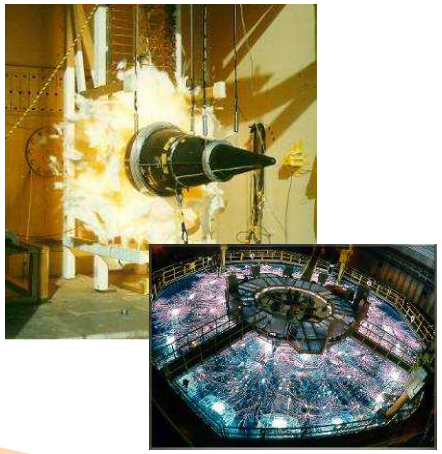
11

Research Disciplines Drive Capabilities

Sandia National Laboratories





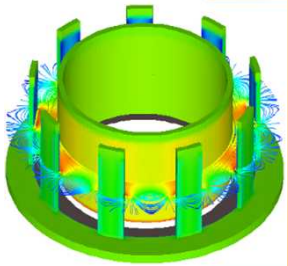


High Performance Computing

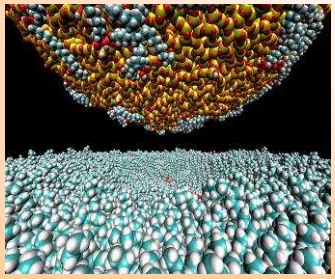
Nanotechnologies & Microsystems

Extreme Environments

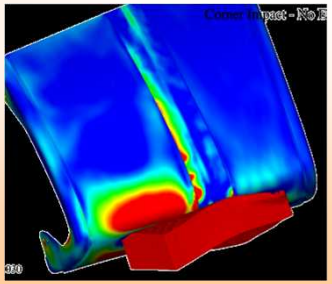
Computer Science



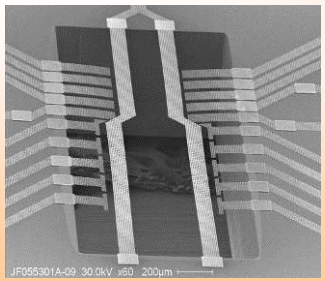
Materials



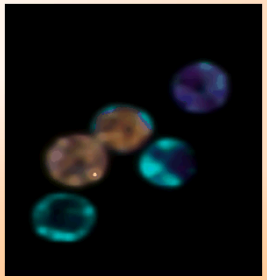
Engineering Sciences



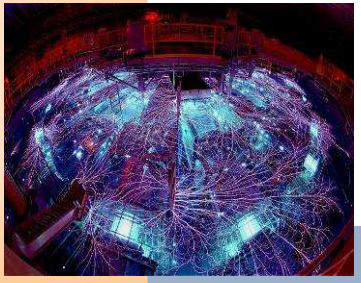
Micro Electronics



Bioscience

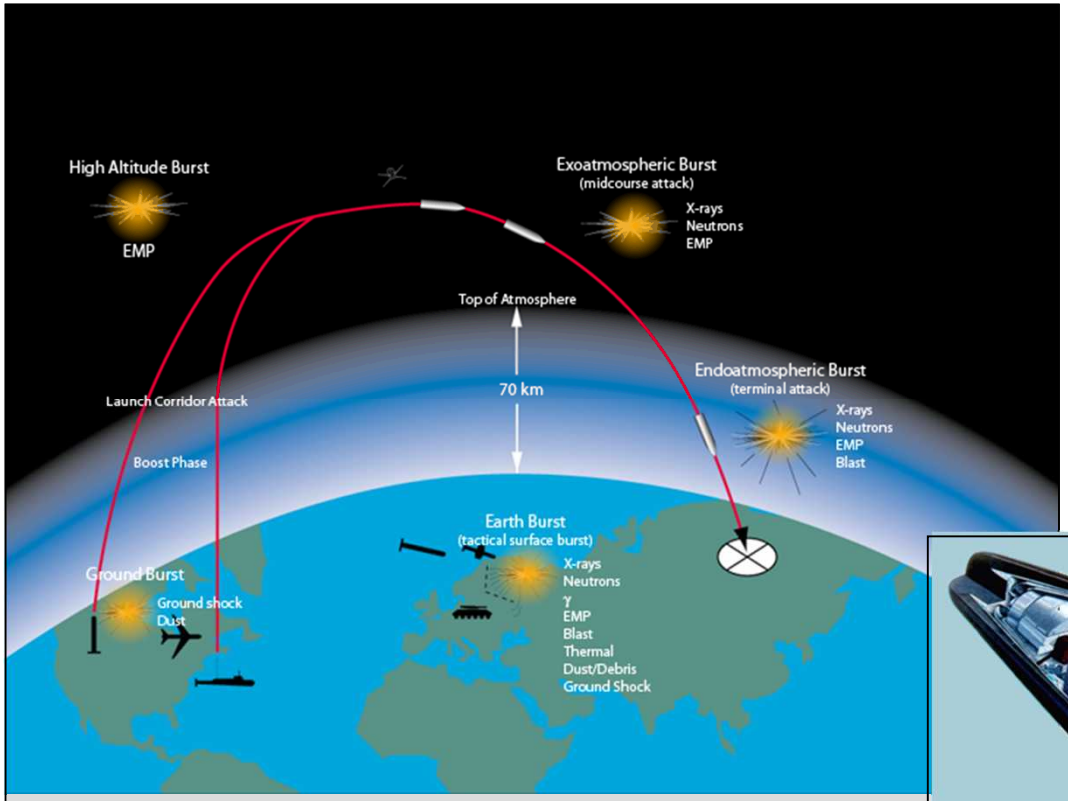


Pulsed Power

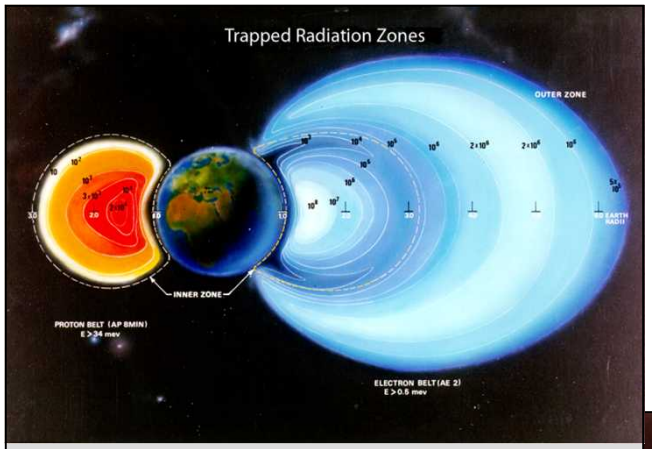


Research Disciplines

Radiation Requirements

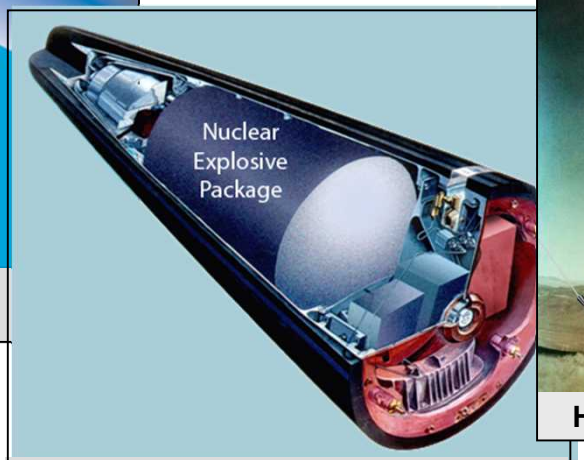


Hardness against nuclear countermeasures



Hardness against space radiation

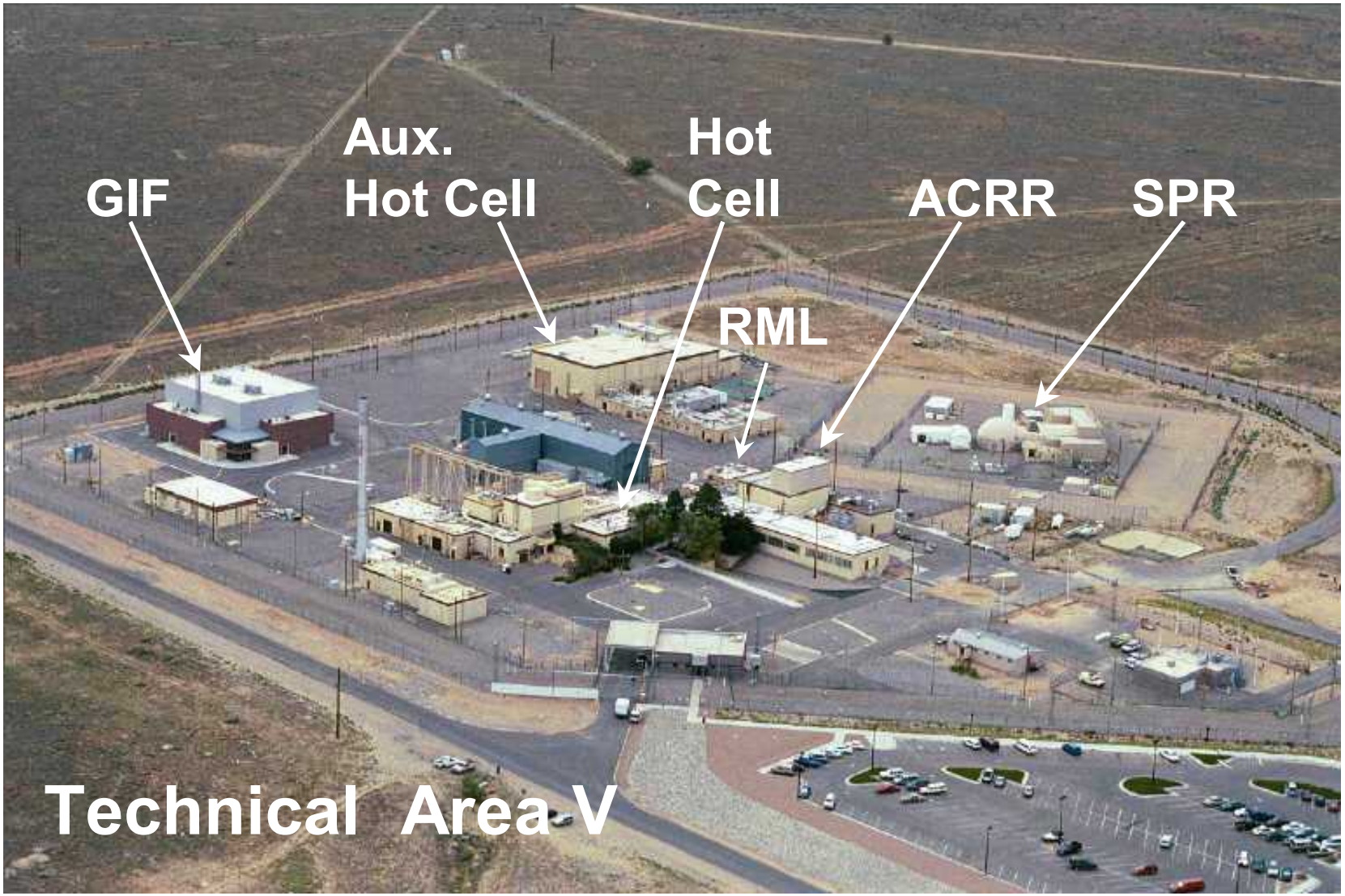
Hardness against fratricide



Hardness against in situ radiation

13

SNL Tech Area V

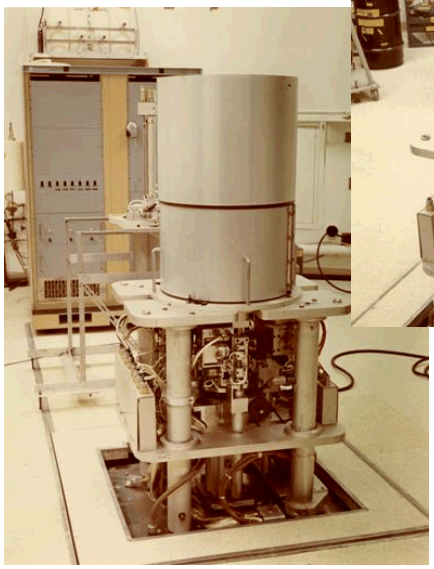


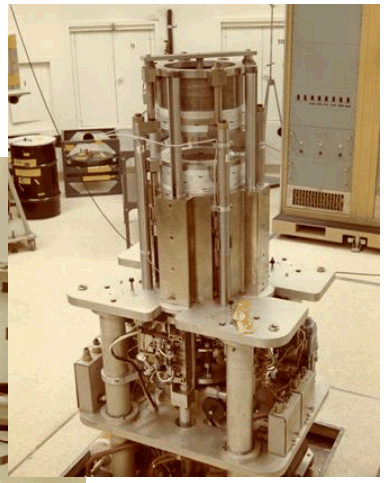
TA-V History

- TAV was constructed in 1959 as part of the Nuclear Airplane Project
  - Sandia Pulse Reactor (SPR-I) – 1961
  - Sandia Pulse Reactor (SPR-II) - 1976
  - Sandia Nuclear Assembly Reactor (SNARE) – 1962
  - Sandia Engineering Reactor (SER) – 1963
  - Annular Core Pulse Reactor (ACPR) 1967

TA-V Recent History

- TAV continued to build on its nuclear reactor success through the ‘70s and ‘80s
  - Sandia Pulse Reactor (SPR-III) - 1976
  - Annular Core Research Reactor (ACRR) – 1978
  - Critical Experiment-Space Nuclear Thermal Power (SNTP-CX) 1989)
  - ACRR-Fueled Ringed External Cavity (FREC-II) – 1988

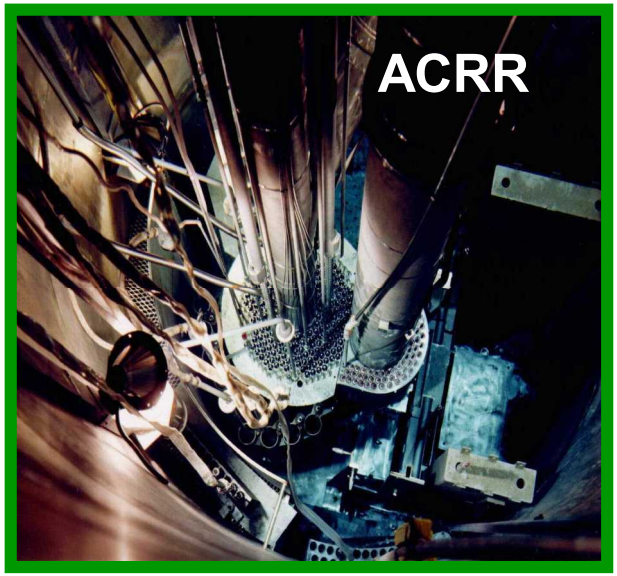




TA-V Facilities Currently Operating

Sandia National Laboratories

Annular Core Research Reactor



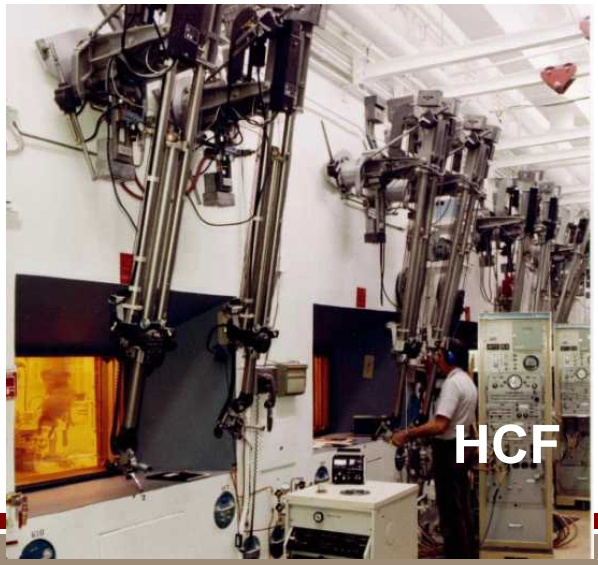
Sandia Pulse Reactor and Critical Facility

Radiation Metrology Laboratory

Gamma Irradiation Facility

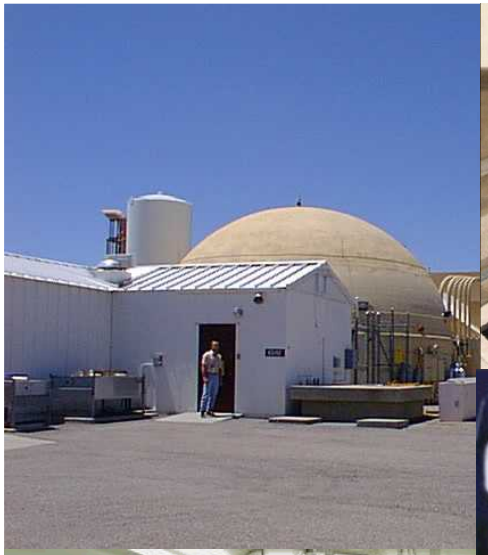
Auxiliary Hot Cell Facility

Hot Cell Facility

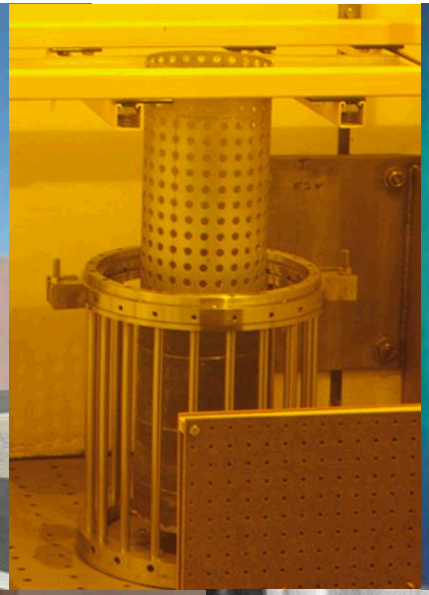


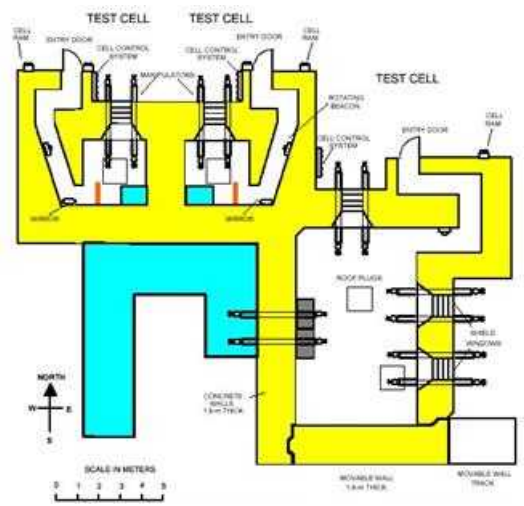
SPR/CX Description

Sandia National Laboratories

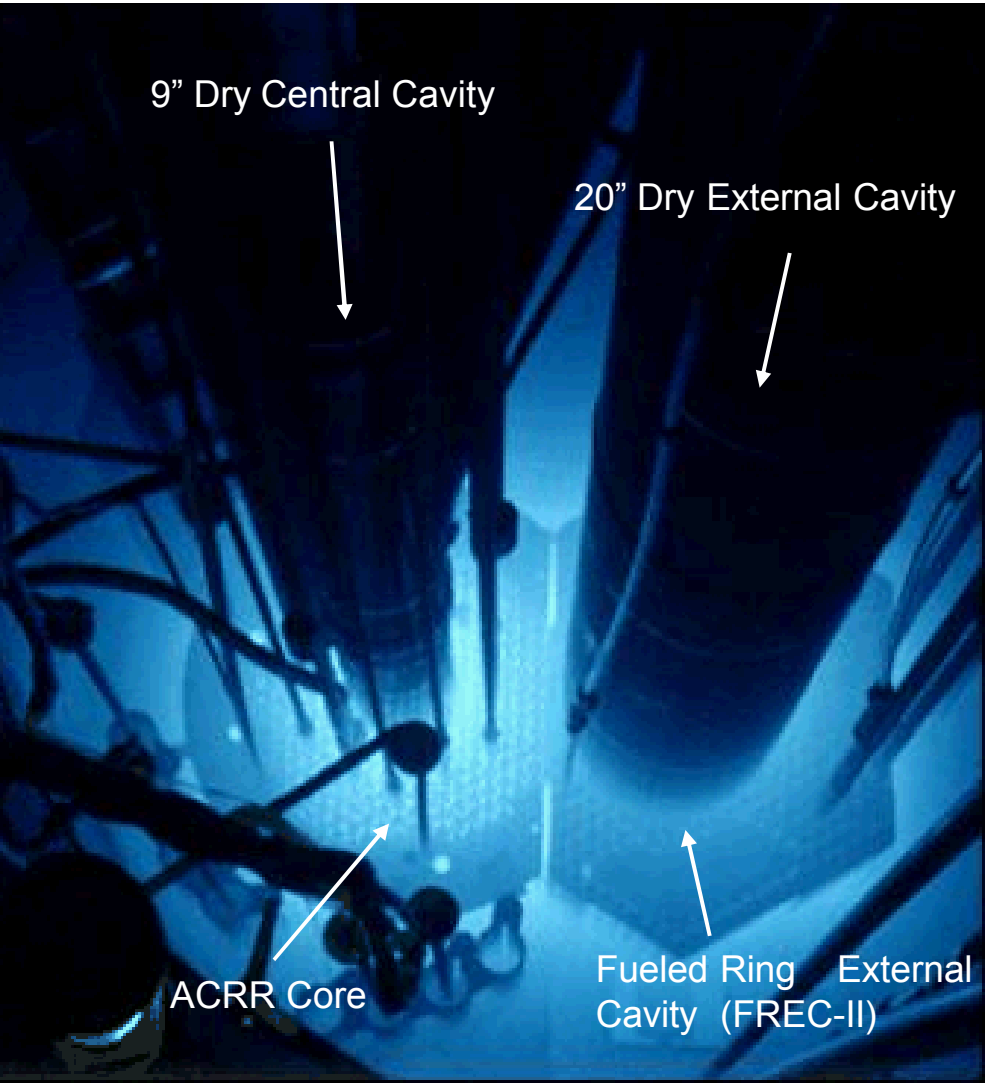


GIF Description





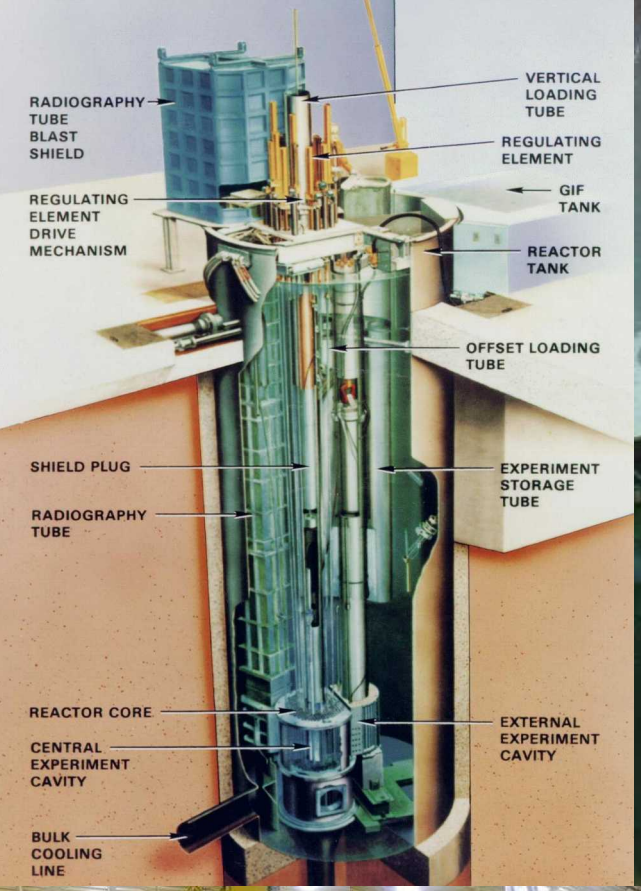
ACRR Description

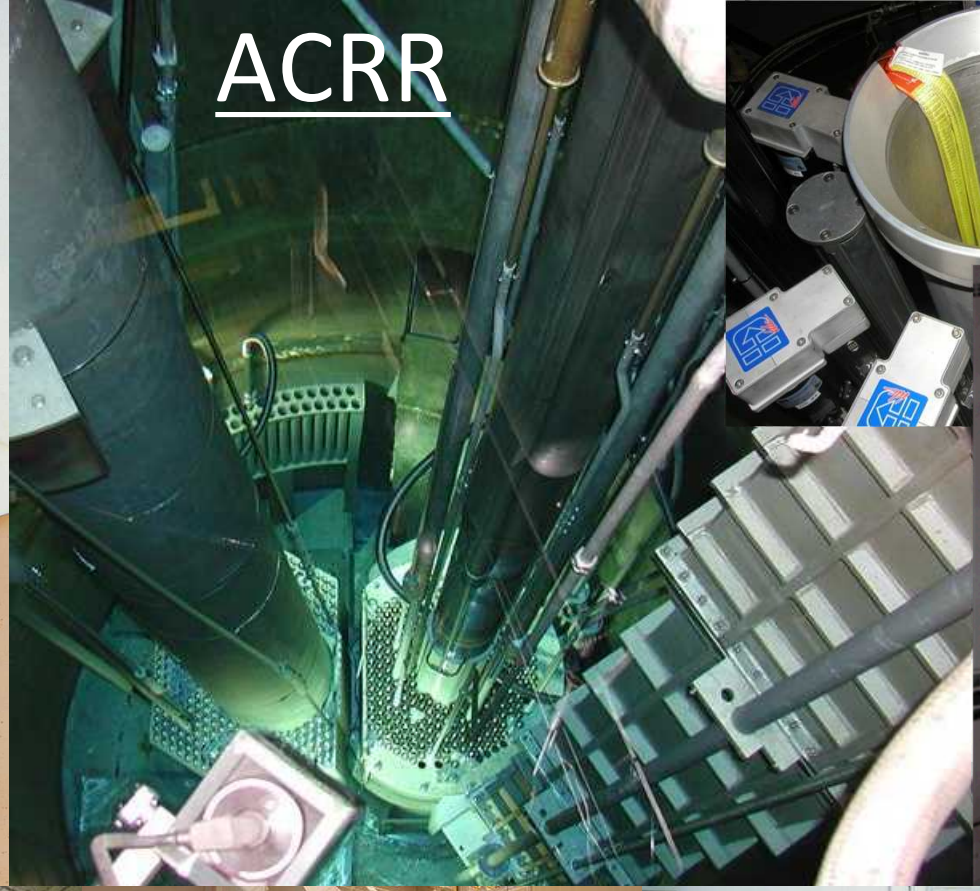


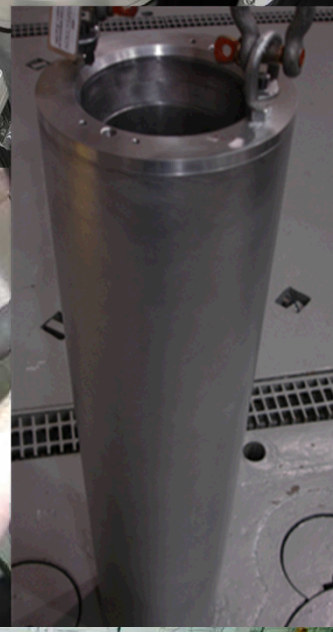
ACRR and FREC-II

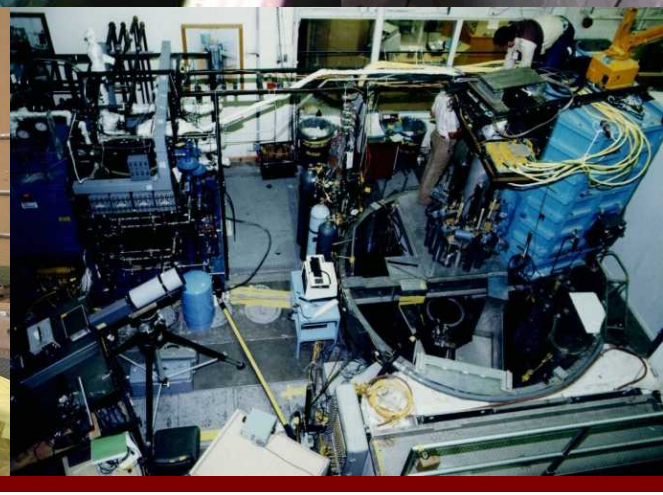
- 236 UO_2-BeO fueled elements
  - 1.5 in (3.8 cm) dia. x 20 in (51 cm)
  - 100 g U-235 per element – 35% enr.
- Operating Power level
  - MW_{th} Steady State Mode
  - 250 MJ Pulse Mode (6 ms FWHM)
  - 300 MJ Transient Mode (Programmable)
- Dry cavity 9 in (23 cm) diameter
  - Extends full length of pool through core
  - Neutron Flux 4E13 n/cm^2-s at 2 MW
  - 65% > 1 eV, 56% > 10 keV, 45% > 100 keV
- Epithermal Spectrum
  - Flux in cavity can be tailored for desired energy spectrum (Poly, B4C)
- Open-pool type reactor
  - Fuel elements cooled by natural convection
  - Pool cooled by HX and cooling tower
- FREC-II uses previous ACPR fuel
  - TRIGA type (UZrH) – 20 in (51 cm) dia. dry cavity
- Fuel burnup is minimal
- Reactor used for short duration power runs, pulses, and transients

ACRR


RADIOGRAPHY TUBE BLAST SHIELD
VERTICAL LOADING TUBE
REGULATING ELEMENT
GIF TANK
REGULATING ELEMENT DRIVE MECHANISM
REACTOR TANK
OFFSET LOADING TUBE
SHIELD PLUG
EXPERIMENT STORAGE TUBE
RADIOGRAPHY TUBE
REACTOR CORE
EXTERNAL EXPERIMENT CAVITY
CENTRAL EXPERIMENT CAVITY
BULK COOLING LINE

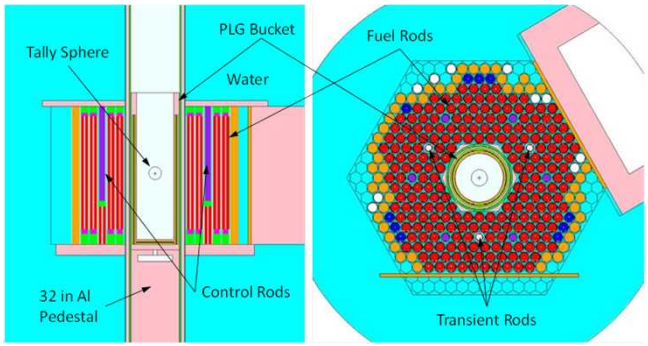


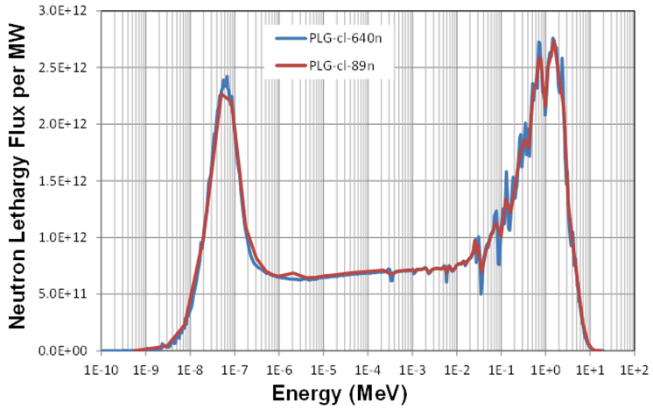


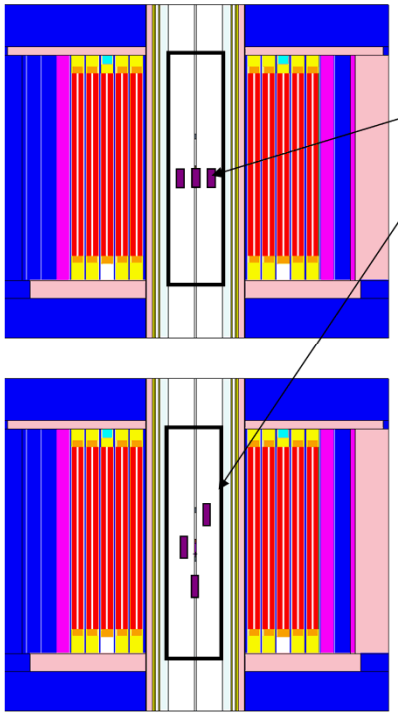


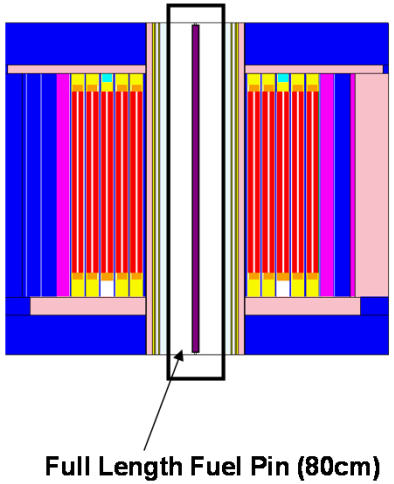
ACRR Modeling

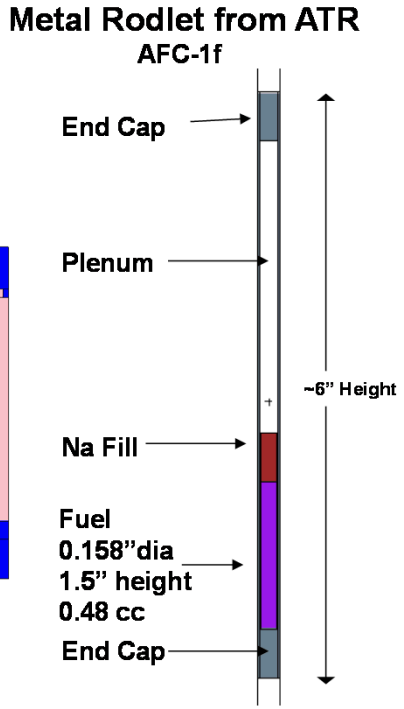
- Modeling the ACRR Core is a lot of what we do
  - Experiment Response
  - Safety
  - Characterization









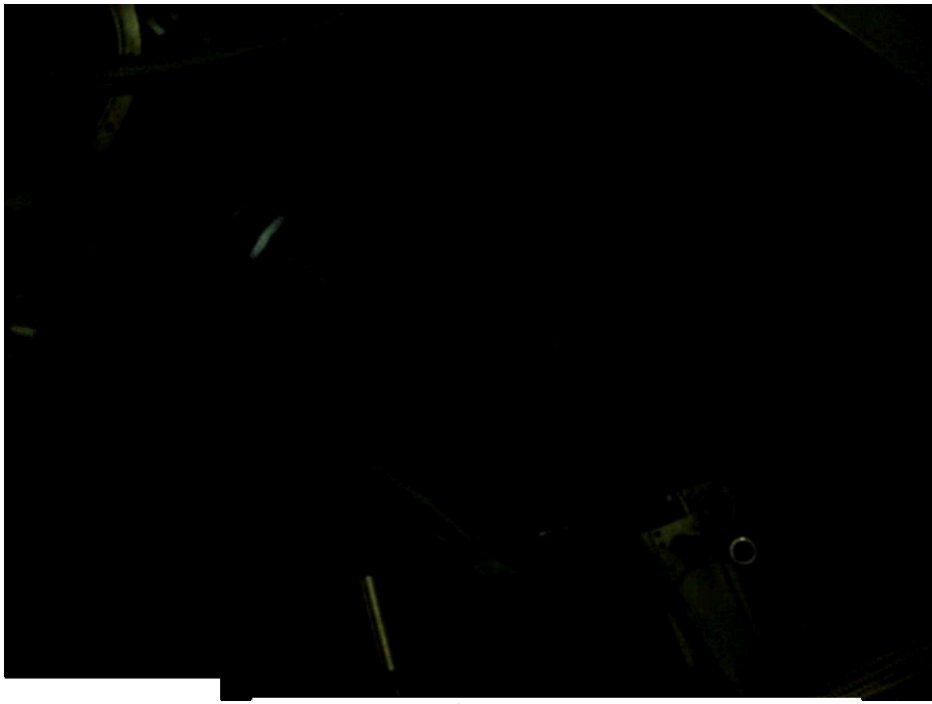


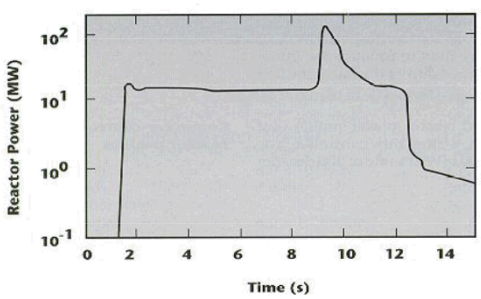
ACRR Pulse and Transient Operating Modes

Sandia National Laboratories

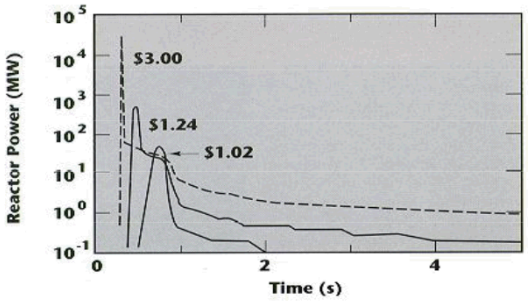
Single Pulse Mode

Programmed Transient Mode

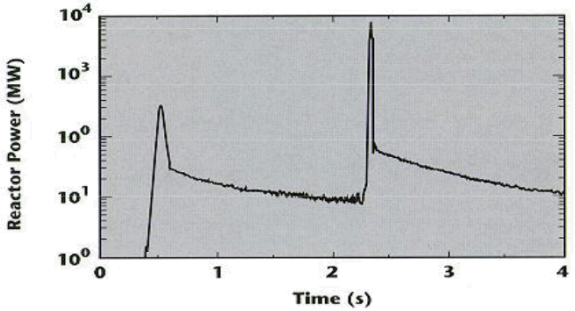




Programmed Transient Mode



Single Pulse Mode



Double Pulse Mode

Past Experiment Programs at TAV

Sandia National Laboratories

- TAV has been involved in many nuclear experiment programs over the years
  - Weapon Component Testing – Our original and continuing mission
  - Radiation Effects Sciences – New methods base on science discovery
  - Fast Reactor Safety – CRBR, Advanced fuel/cladding testing, equation of state
  - Light Water Reactor Safety – TMI, Severe fuel damage and fission product release from debris beds
  - Nuclear Pumped Laser (FALCON) – Part of Reagan's Star Wars Defense
  - Space Thermal Nuclear Power (SNTP) – Critical experiments, particle fuel testing, element testing using hydrogen
  - Medical Isotope Production (Mo-99, I-125) – Domestic production initiative
  - Space Power (JIMO) – Advance reactors for space power
  - Nuclear Hydrogen Production – Hydrogen as transportation fuel

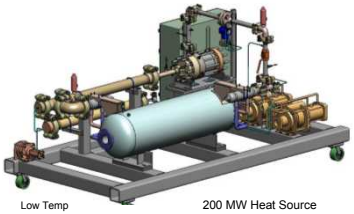
Current Experiment Programs at TAV

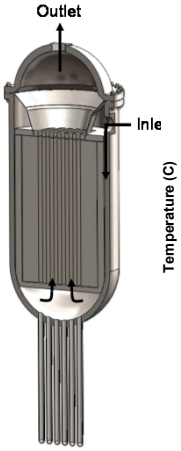
Sandia National Laboratories

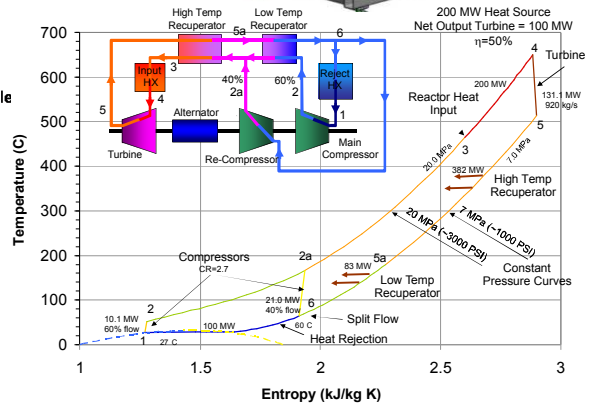
- TAV is still relevant – last research reactor standing
  - Weapon Component Testing – Our original and continuing mission
  - Radiation Effects Sciences – New methods base on science discovery
  - Burnup Credit – Critical experiments fission product reactivity effects
  - Criticality Safety – Critical experiments training for the complex
  - Advanced Reactor Concepts – Right Size Reactor Concept (RSR)
  - Advanced Power Generation Cycles – Supercritical CO2 cycle

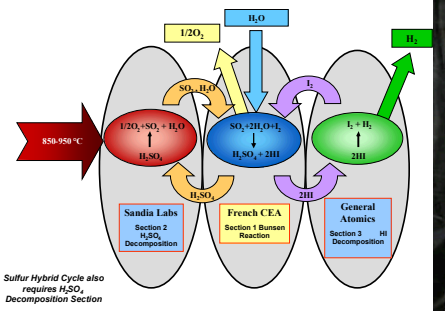
Future Experiment Opportunities

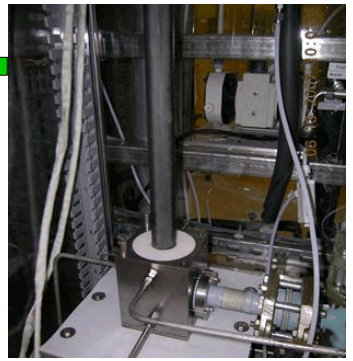
- Future Generation Reactors
  - Advanced Fuel Performance Transient Testing
    - Phenomenology and Model Validation
    - Safety Margins
  - Advanced Power Cycles
  - Advanced Reactor Design Concepts
  - Hydrogen Production
- Critical Experiments
- Small Reactor Technology
  - NASA Missions
    - Nuclear Propulsion
    - Space Power
  - Commercial Space Propulsion
    - Space Tug
  - Medical Isotope Production
    - Target Reactor Concept

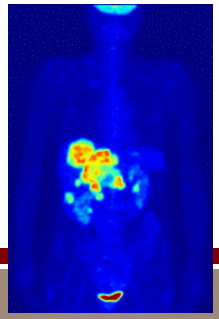








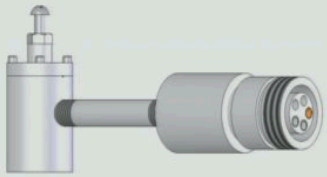


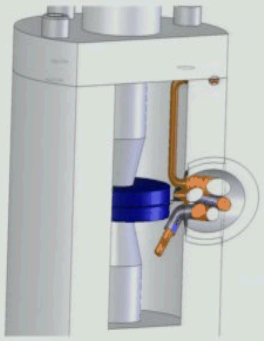


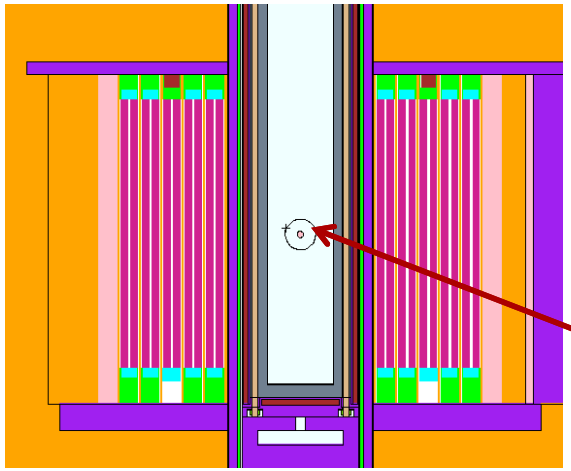
RES Calorimeter Diagnostics

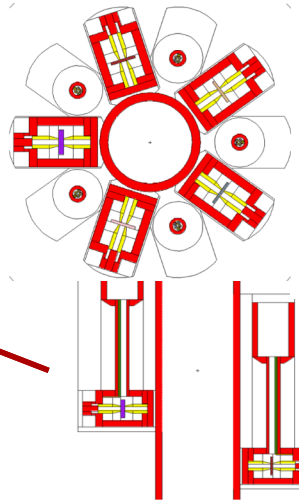
Sandia National Laboratories

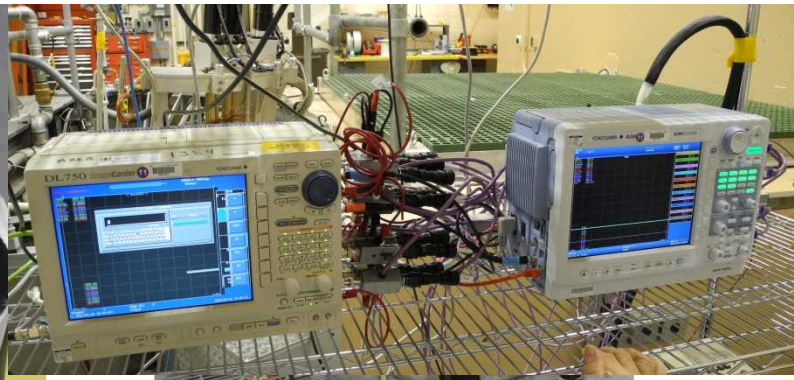
- Real-time total dose measurement in ACRR central cavity for pulse mode operations.
- Can be used for multiple shots.
- As a primary standard, no calibration required.
- Two 0.375" diameter x 0.040" thick undoped silicon wafers
- Type-E thermocouple, 0.001" diameter.
- Fully shielded and twisted-shielded pair up to data acquisition system.







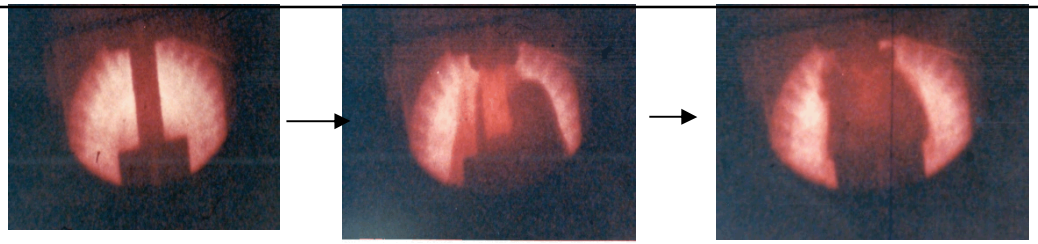




Reactor Safety Testing

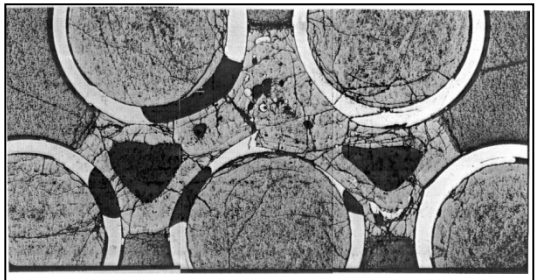
Sandia National Laboratories

NRC tests of Oxide and Irradiated Mixed Oxide Fuels



Pin heatup, clad melt and FP release, and fuel disruption sequence in LMFBR high burnup fuel pin (FD Program - JNC, UKAEA, KFK, NRC)

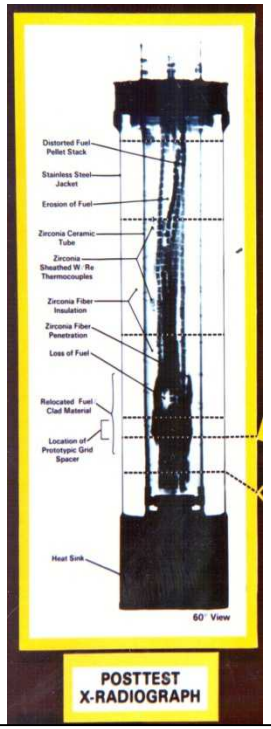
Axial clad and fuel relocation in LMFBR pin array (STAR Program - JNC, NRC)



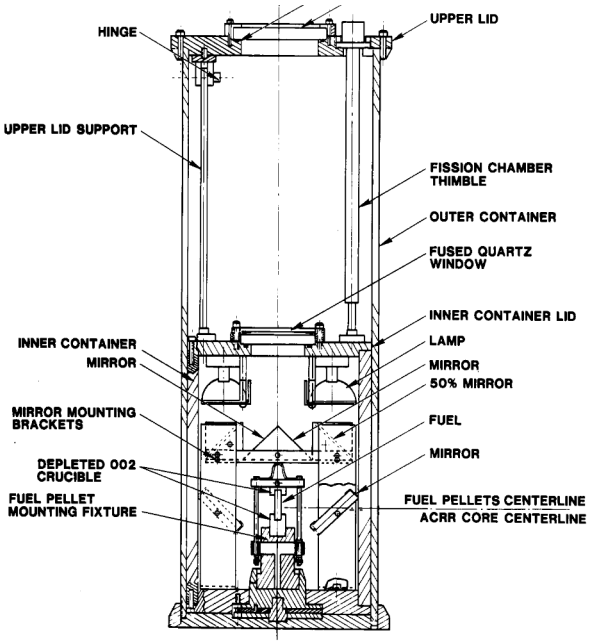
Transition phase studies in LMFBR pin arrays (TRAN Program - JNC, NRC)

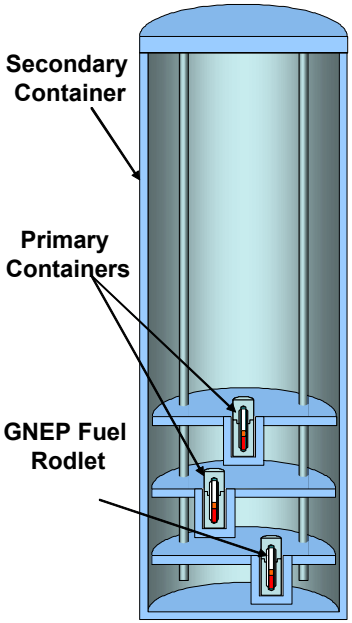
ACRR has been used to simulate a wide range of transient fuel test conditions

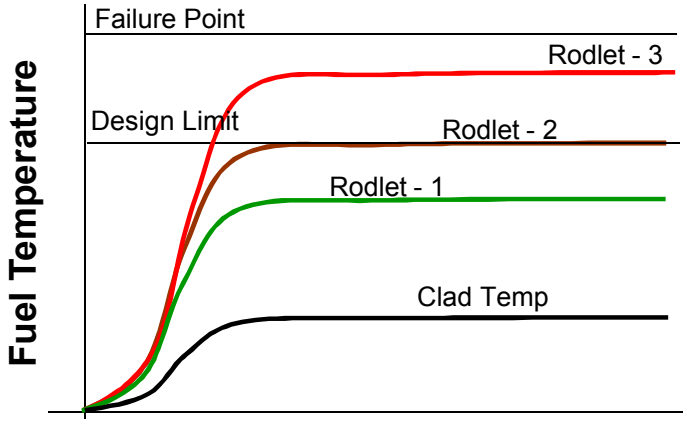
Severe fuel damage and FP release tests on LWR fuel bundle (SFD Program)



Sample Fuel Rodlet Tests



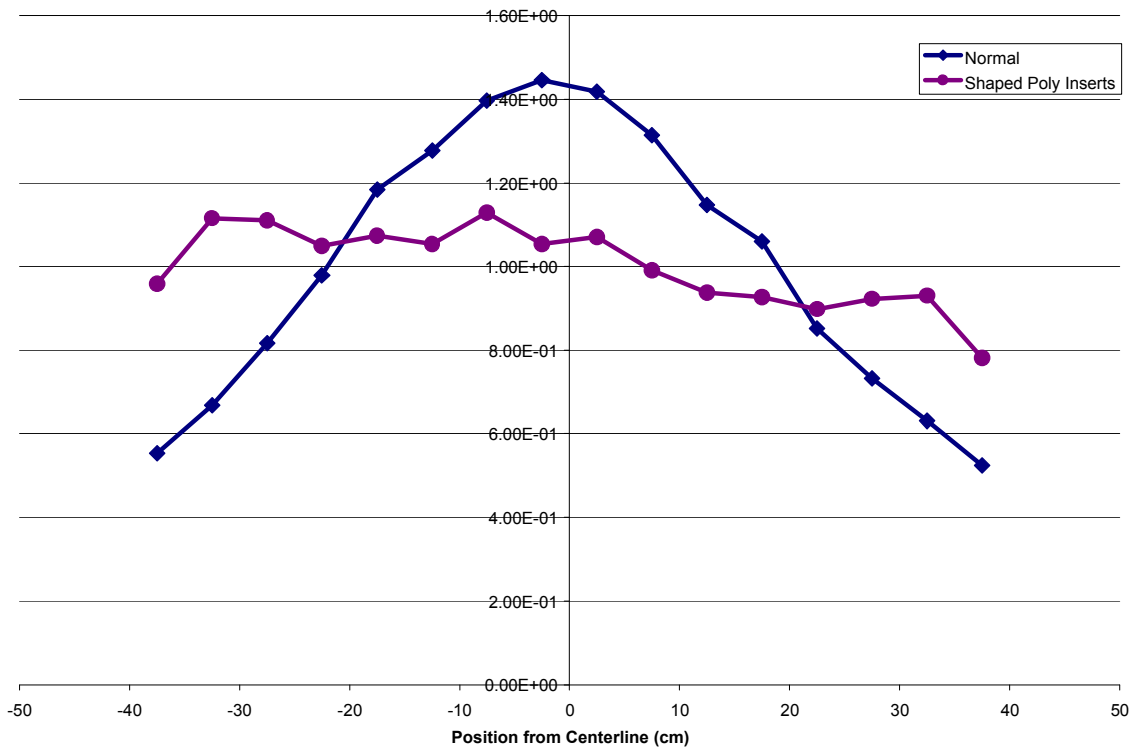




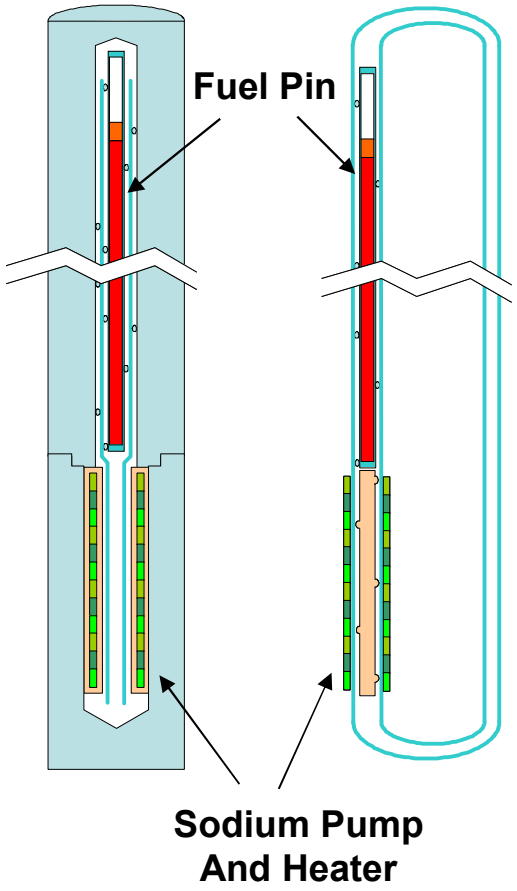
Full Length Fuel Pin Test With Sodium Cooling

Sandia National Laboratories

Axial Power Shaping Options

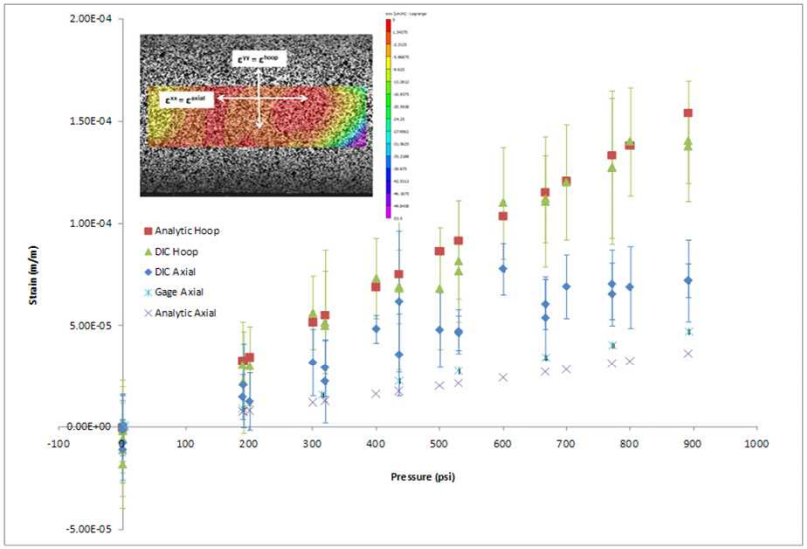


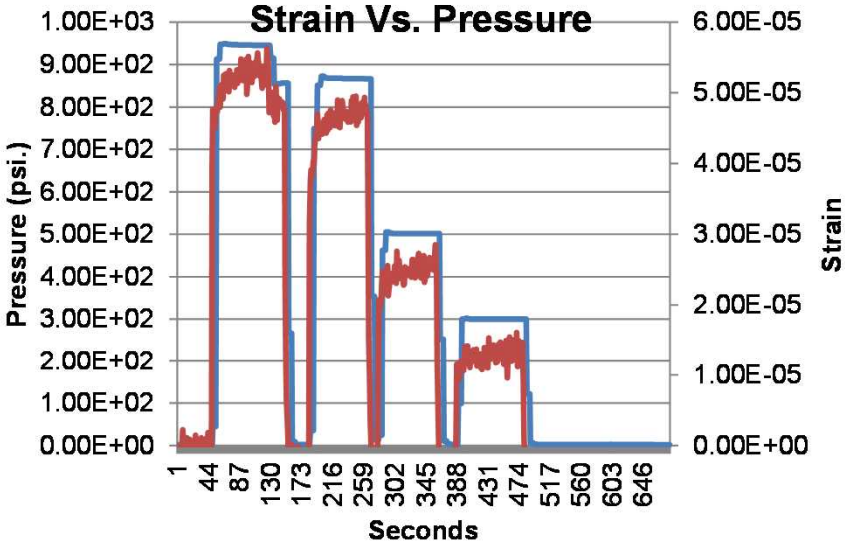
Annular or Loop Configuration

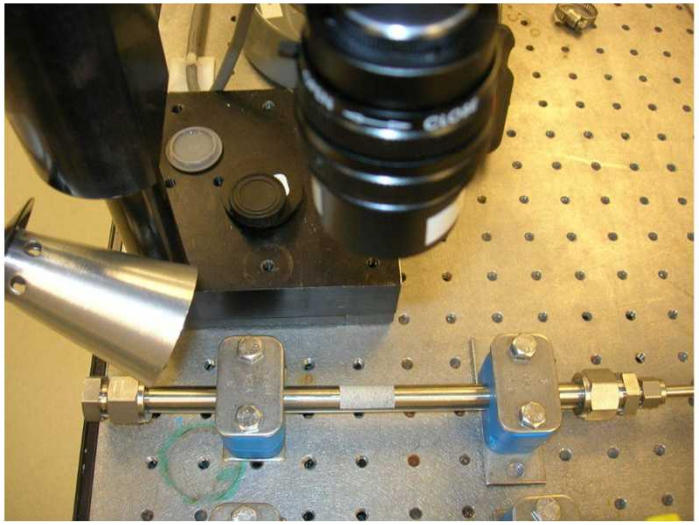


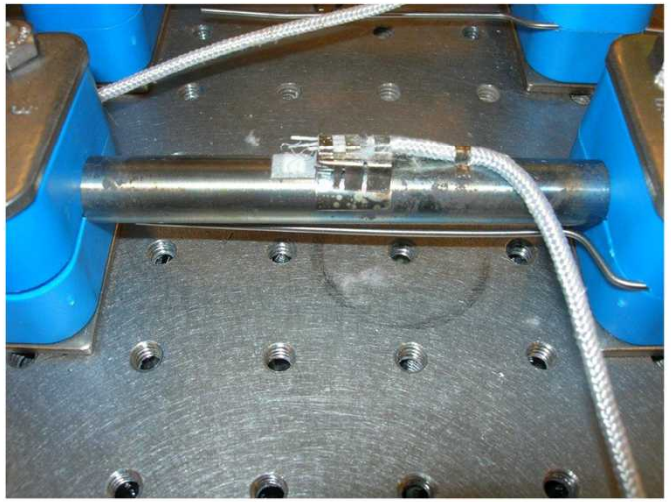
LDRD Strain Measurements and Advanced Diagnostics

Sandia National Laboratories









What's a career like at Sandia?

The Work Experience

- Take on challenging assignments in state-of-the-art research facilities
- Work with internationally recognized scientists and engineers
- Receive recognition through service awards, employee recognition awards, R&D 100 Awards *and more*
- Take a leave to pursue qualifying research and professional opportunities
- Receive patent royalties, if eligible
- Pursue multiple careers through retraining and rotational opportunities
- Participate in diversity training and awareness programs that promote an all-inclusive workforce

Quality of Work/Life

Flexible Work Schedules

- 9/80 – work week
- Telecommuting arrangements
- Part-time options
- Vacation Buy Plan

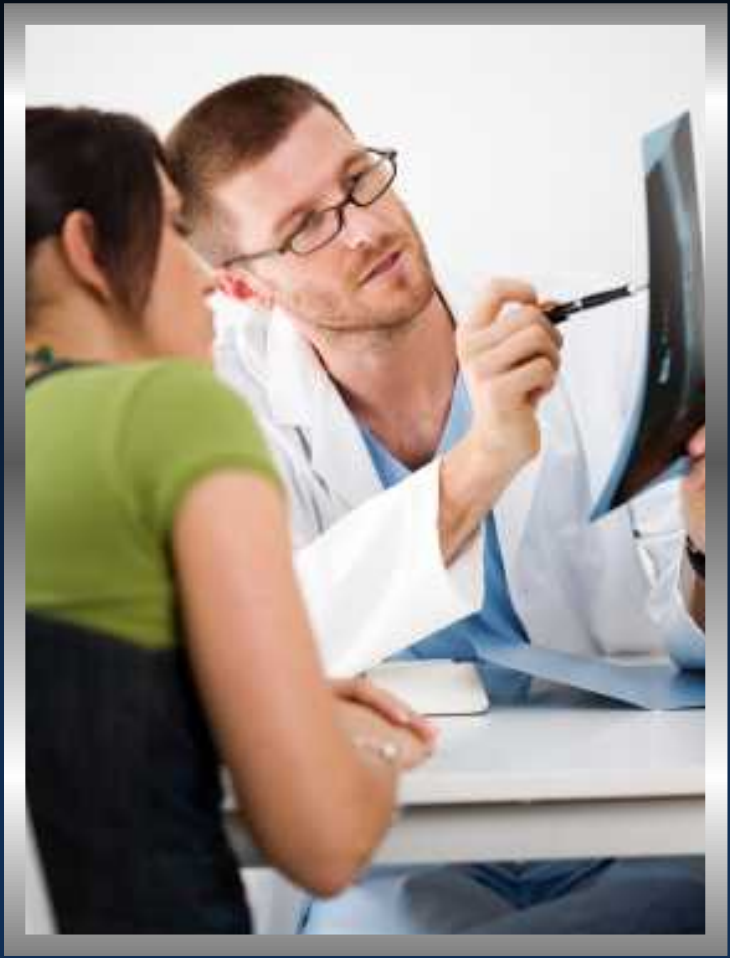
Family Life

- Referral services/Workplace options
- Adoption assistance
- Family recreational activities

Health

- Health risk assessment screenings
- Onsite fitness facility and fitness programs
- Onsite health clinic
- Health education
- Behavioral health
- VirginHealth Miles Program

Convenience



On-site Amenities

- Medical Clinic
- Sandia Laboratory Federal Credit Union
- Café
- Fitness Center
- Access to group exercise classes, clubs and sporting activities
- Employee self-formed sports teams

**These amenities are available at CA and NM sites only*

Living in Albuquerque

Life in Albuquerque

- Albuquerque is the largest city in New Mexico with a population of over 500,000
- Affordable housing, reasonable cost of living
- Minimal traffic congestion

Albuquerque Environment

- High desert climate with 278 annual days of sunshine
- Average temperatures between 78˚ and 40˚
- Wide-open spaces

Things to Do

- Outdoor recreation - Ski, snowboard, hike, etc.
- Santa Fe – rich culture
- International Balloon Festival
- Explore Indian pueblos and our Hispanic
- Green chile – N.M. Cuisine
- Museums, Parks, Sports

Living in Livermore

Life in Livermore

- Livermore's relaxed lifestyle populates nearly 81,000
- Close proximity to first-tier universities, Silicon Valley companies, and other top research laboratories and facilities
- Access to California's finest public and private schools

Livermore Environment

- 260 annual days of sunshine
- Average temperatures between 73˚ and 46˚
- Annual average rainfall: 14.8 inches

Things to Do

- Vineyards
- Beaches
- State Parks
- Sports – Nearby are six major league franchises
- Art haven
- Proximity to SF Bay Area

For more information, visit: http://www.trivalleycvb.com

Employment Opportunities

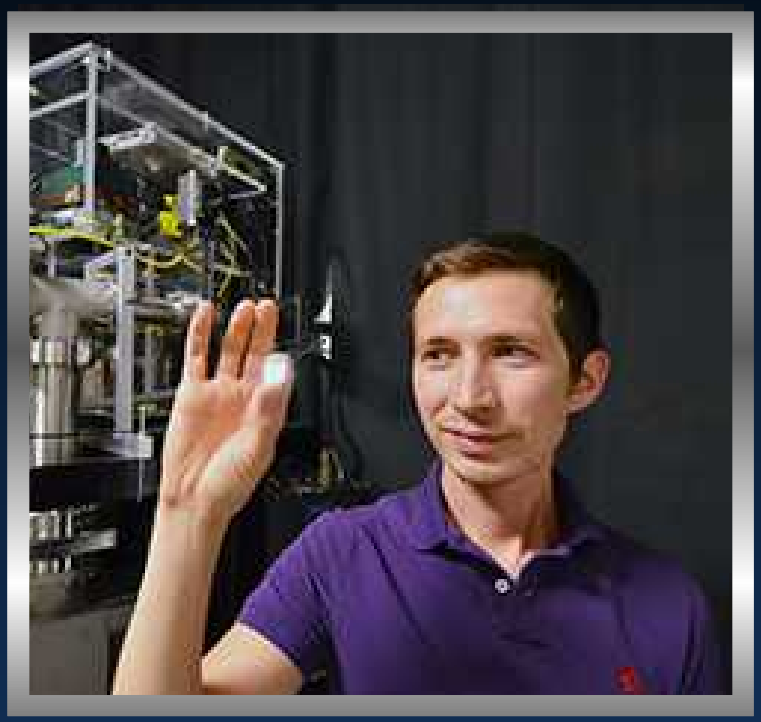
Internships

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.

Requirements

- Min. cumulative GPA (3.2 Undergrad/3.5 Grad)
- U.S. citizenship
- 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 postdocs at Sandia:

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

Requirements

- Min. cumulative GPA (3.5 Undergrad/3.7 Grad)
- U.S. citizenship
- A recent PhD (awarded within the past three years) or the ability to complete all PhD requirements before beginning
- No previous postdoc appointments at a national laboratory

Special Degree Programs & Fellowship Opportunities

Sandia National Laboratories

Special Degree Programs

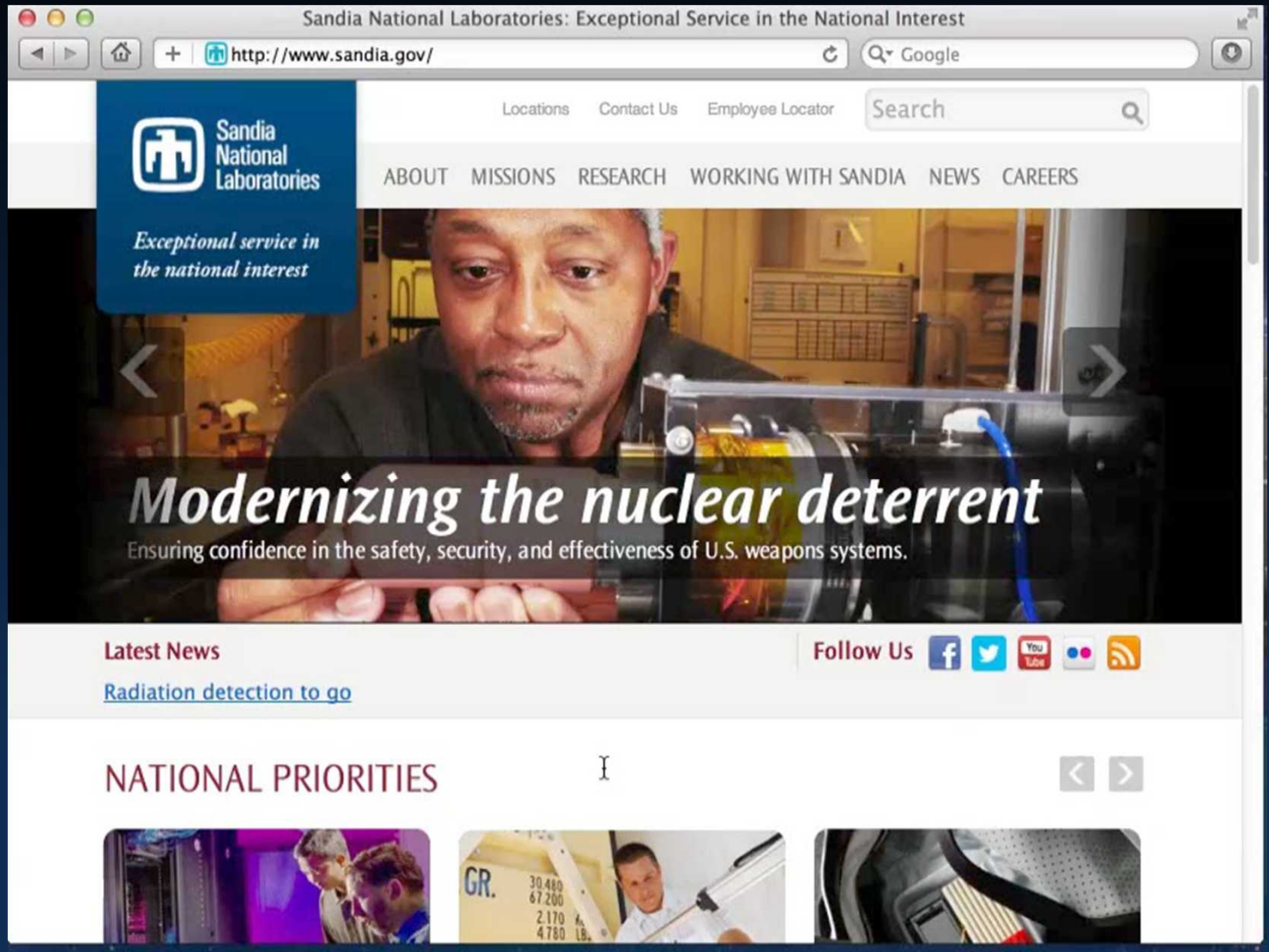
- Critical Skills Master's Fellowship Program
- Master's Fellowship Program

Ph.D. Level Fellowships

- Harry S. Truman Fellowship
- John Von Neumann

How to Apply - sandia.gov/careers

Basic



How to Apply - sandia.gov/careers

Advanced Search & Job Agent/email notification