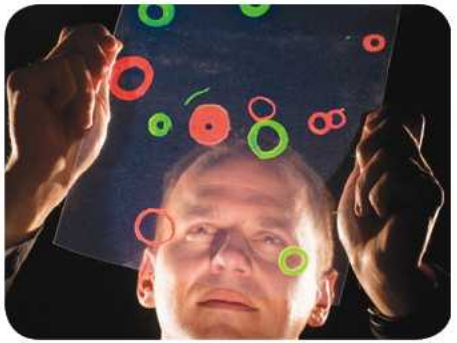
SAND2015-7356PE

Exceptional service in the national interest

Sandia National Laboratories



Seminar- University of New Mexico Sandia Nuclear Facilities and IVA

D. Wheeler 1 September 2015

U.S. DEPARTMENT OF ENERGY

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. SAND2011-0439P

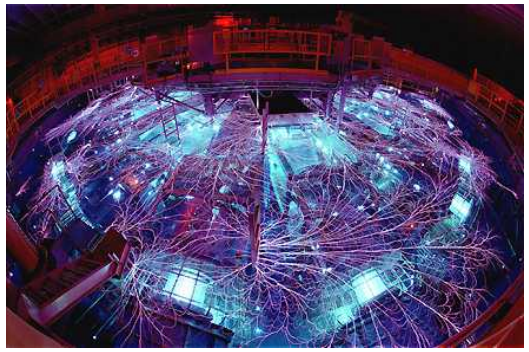
Seminar Agenda

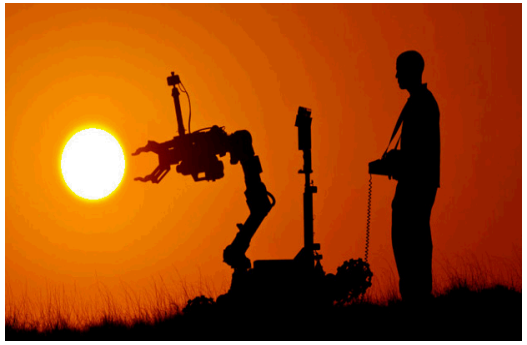
Sandia National Laboratories

- Introduce Sandia National Laboratories
- Overview of Nuclear R&D and Testing Facilities
- Review the UNM/Sandia IVA agreement
- Question and Answer

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 Capability Examples

Cleanroom invented 1963

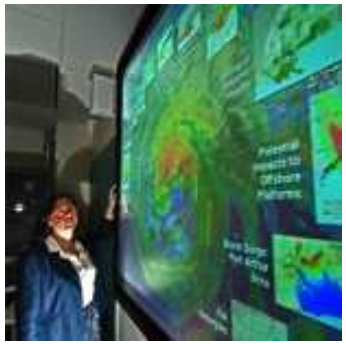
$50 billion worth of cleanrooms built worldwide It's used in hospitals, laboratories and manufacturing plants today.

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.

4

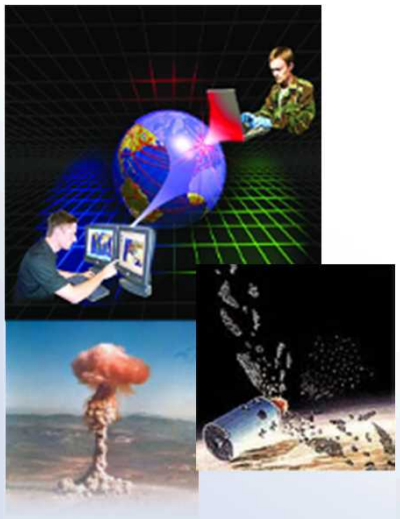
Why? Addressing Our Evolving National Security Environment is of the Greatest Importance

Sandia National Laboratories

Traditional strategic nuclear threats

Threats from other nation states

Threats from non nation states



Threats of tech surprise

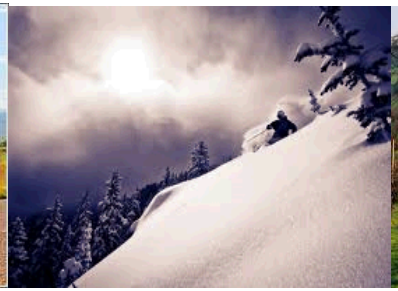
Other threats: natural disasters, climate change, energy supply

Where is Sandia?

Sandia National Laboratories

- Albuquerque, NM
  - Top 10 most affordable cities
  - Outstanding climate with 310 days of sunshine
  - World famous cuisine & arts
  - Paradise for outdoor recreation
    - World-class skiing/snowboarding
    - Challenging cycling/mountain biking & running
    - Camping & fishing
    - 2 of the nation's top 50 golf courses
- Livermore, CA
  - Located in the Bay Area
    - Over 1,100 miles of beaches
    - 6 major professional sports leagues
    - Haven for musicians & artists
  - Over 40 world class wineries
  - Farmers Markets
    - Fresh fruits & veggies grown year round
  - Largest urban national park in the world – Golden Gate Park

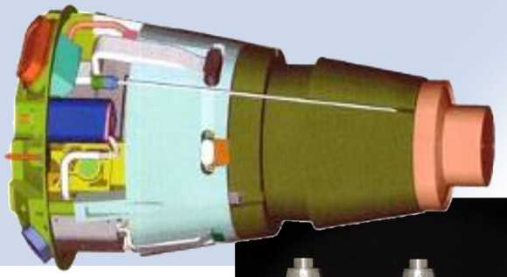


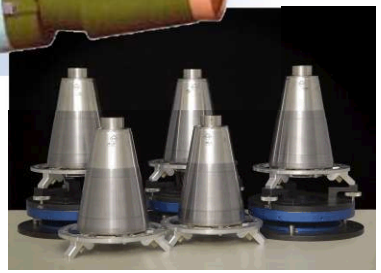


Nuclear Weapons

Sandia National Laboratories

Integrated, engineered warhead systems

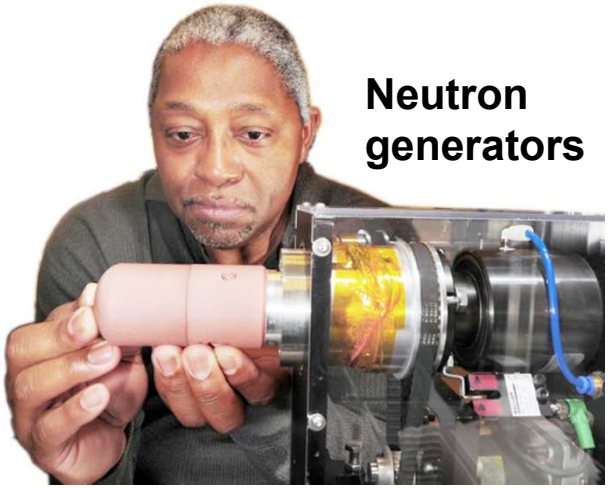




Arming, fuzing, and firing systems

Safety systems

Gas transfer systems



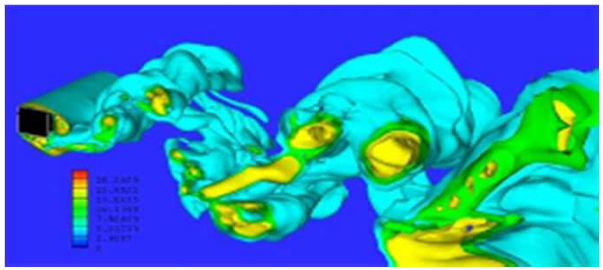
Neutron generators

Sandia National Laboratories

Facilities and Capabilities

Microelectronics and microsystems

Design, fabricate, package, and test trusted semiconductor components



Computational simulation

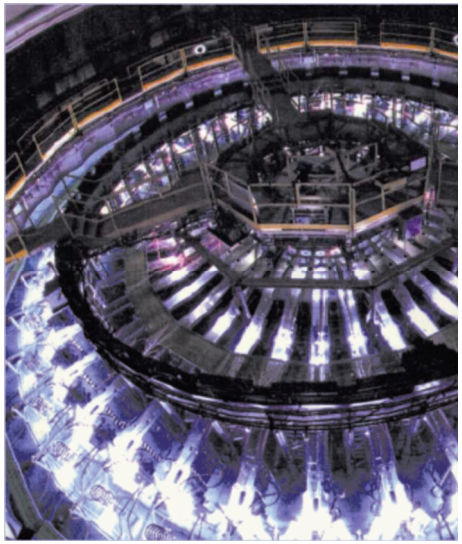
High-performance hardware and software tools to enable solutions requiring massively parallel computers

Environmental testing

Simulate environmental conditions and collect relevant data for systems, subassemblies, and components

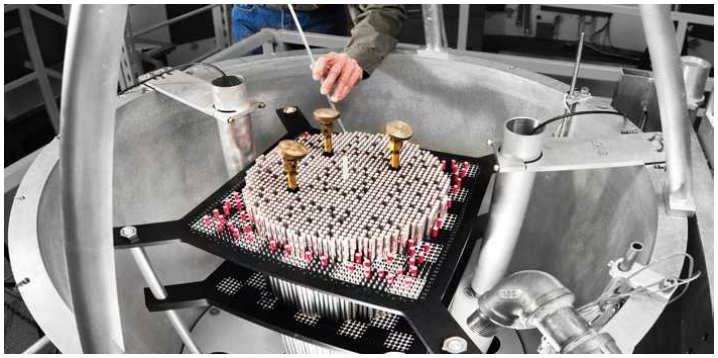
Applied Radiation Sciences

Sandia National Laboratories



Simulating Radiation Environments

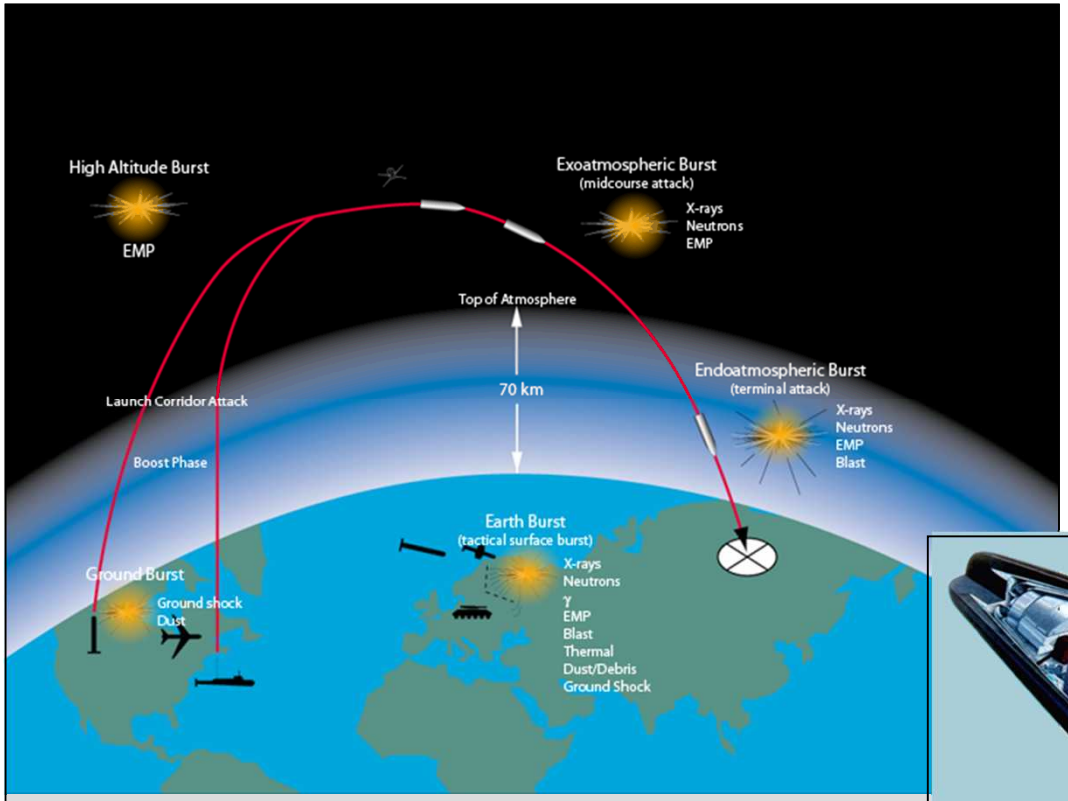
Nuclear Reactor Safety and Accident Testing



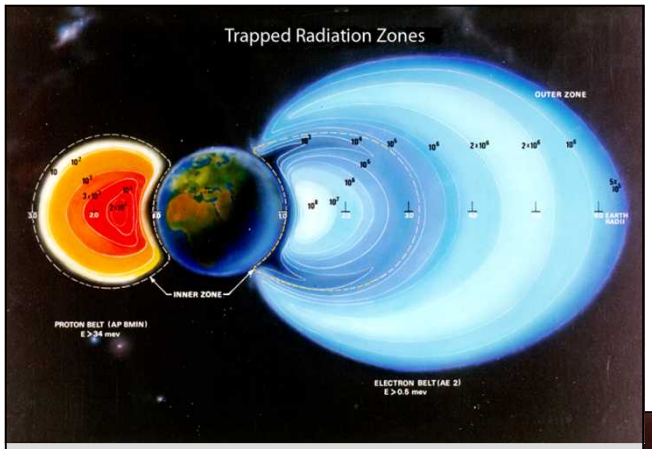
Designing and Testing Nuclear Fuel

Designing and Modifying Nuclear Reactors

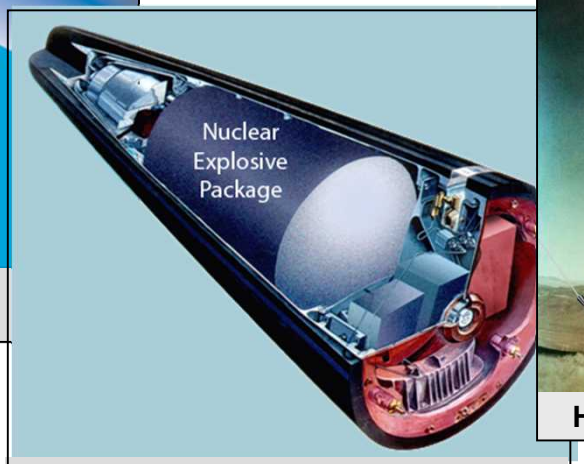
Radiation Requirements



Hardness against nuclear countermeasures



Hardness against space radiation

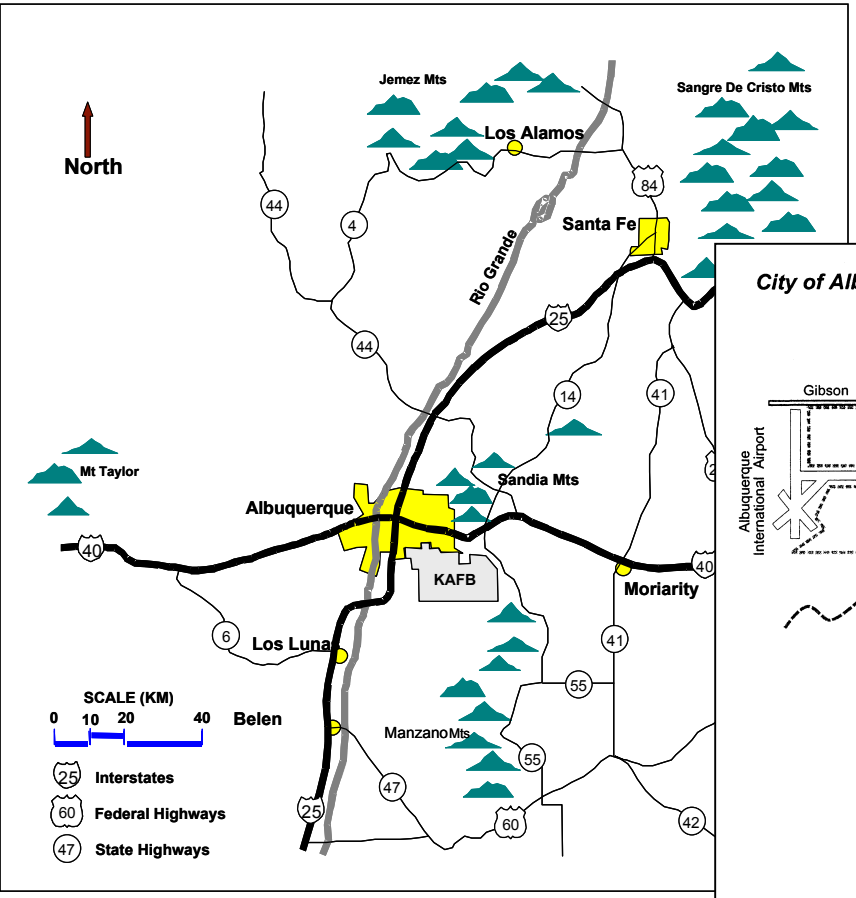


Hardness against in situ radiation

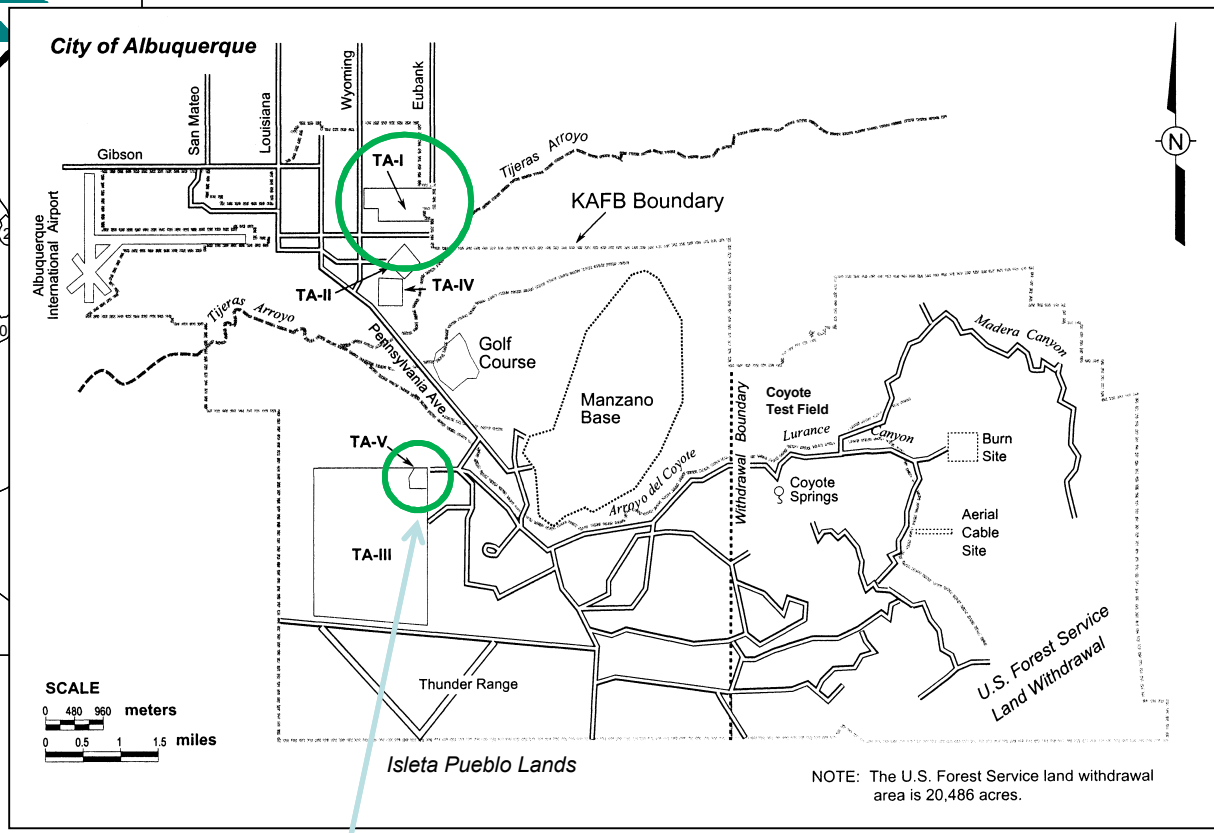
Hardness against fratricide

Sandia's Technical Area V (TA-V)

Sandia National Laboratories



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

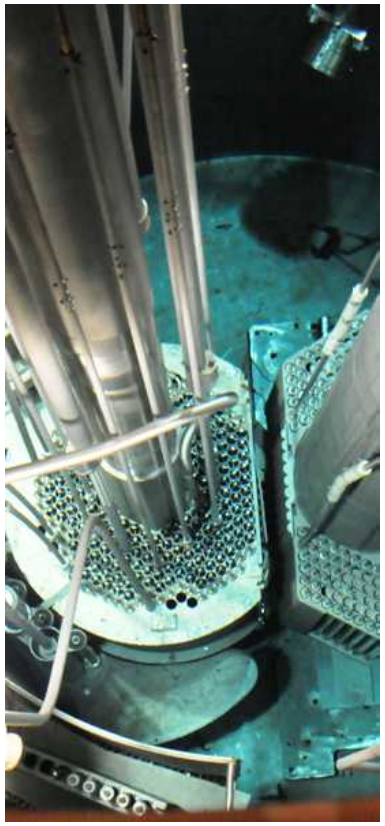


https://youtu.be/valvf2yoVvU

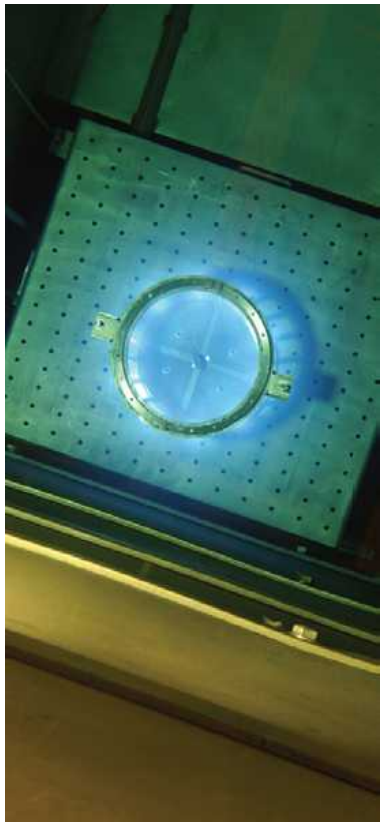
Sandia's nuclear reactor facilities are in Technical Area V - a few miles south of the main research campus.

Unique Nuclear Environments

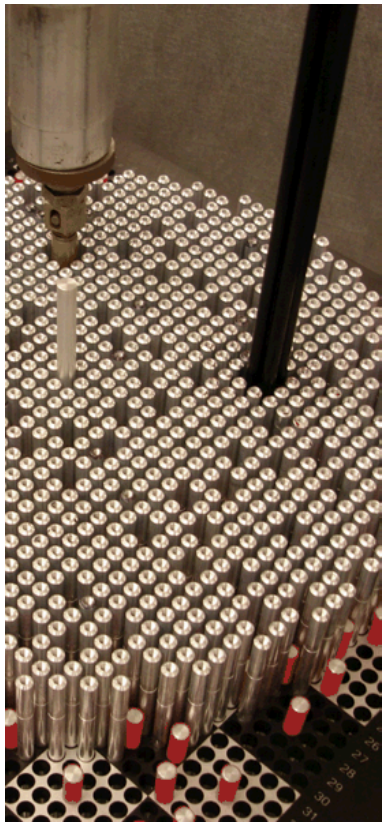
Sandia National Laboratories



Annular Core Research Reactor (ACRR)



Gamma Irradiation Facility (GIF)



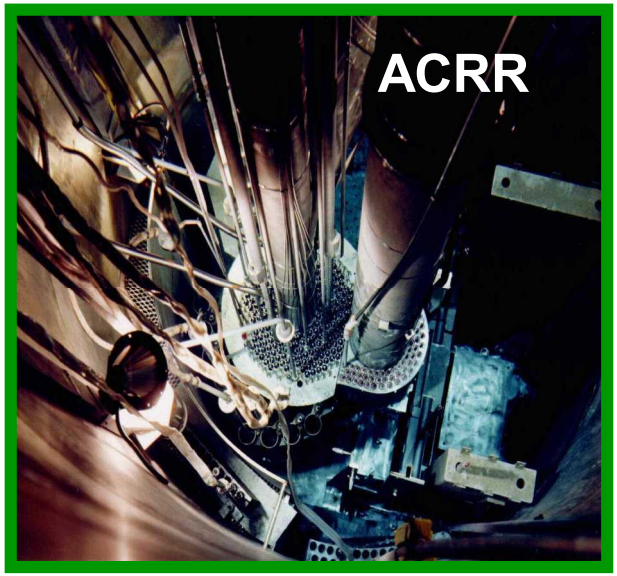
Sandia Pulsed Reactor Critical Experiments (SPR/CX)

Radiation Metrology Lab (RML)

TA-V Facilities Operating Status

Sandia National Laboratories

Annular Core Research Reactor



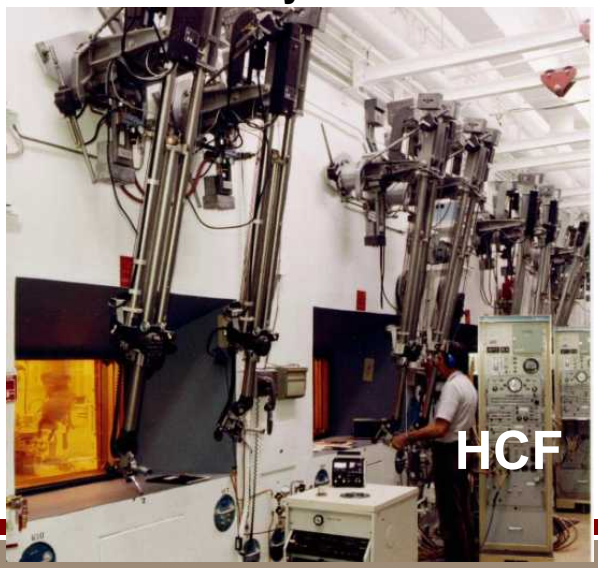
Sandia Pulse Reactor and Critical Experiments

Radiation Metrology Laboratory

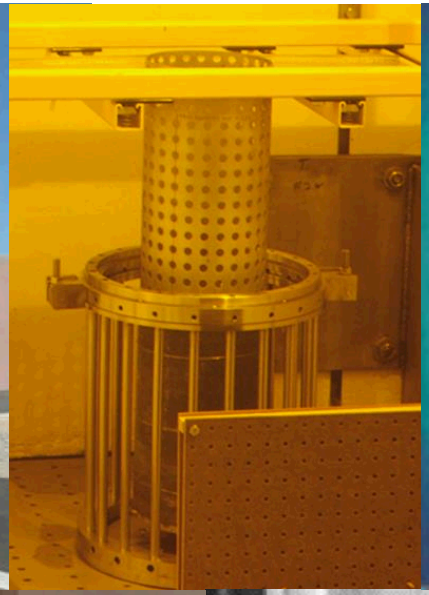
Gamma Irradiation Facility

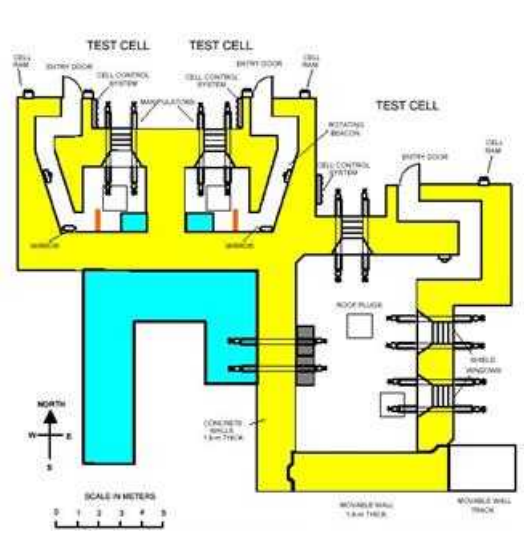
Auxiliary Hot Cell Facility

Hot Cell Facility



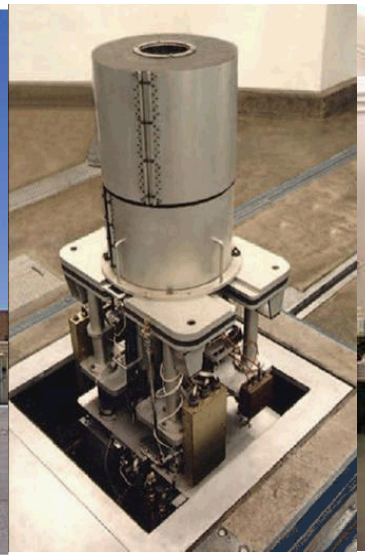
GIF Description

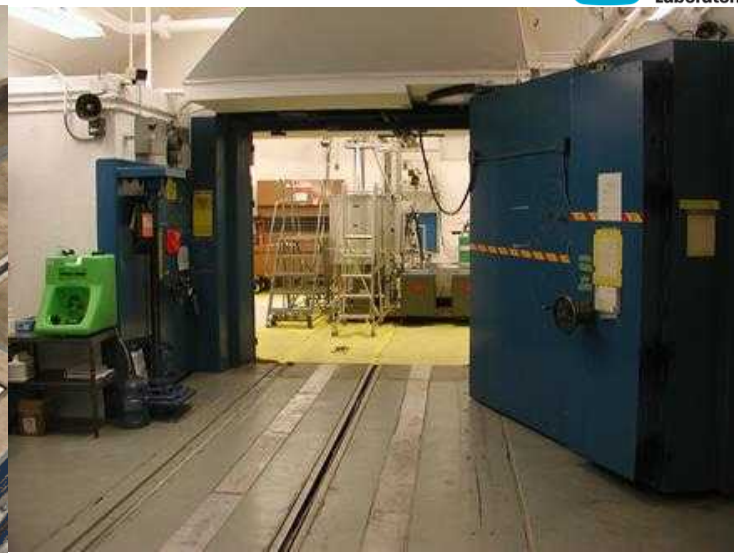




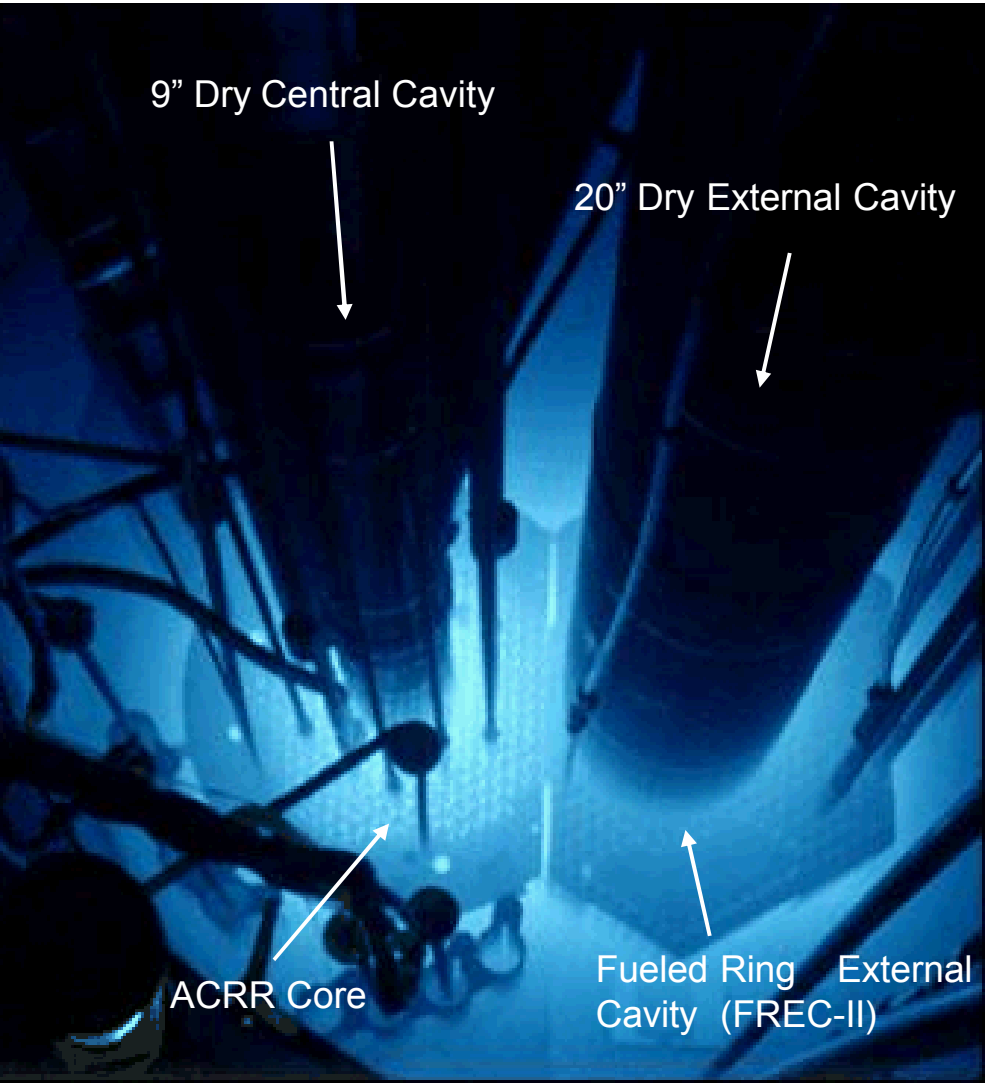
Sandia Critical Experiments

Sandia National Laboratories





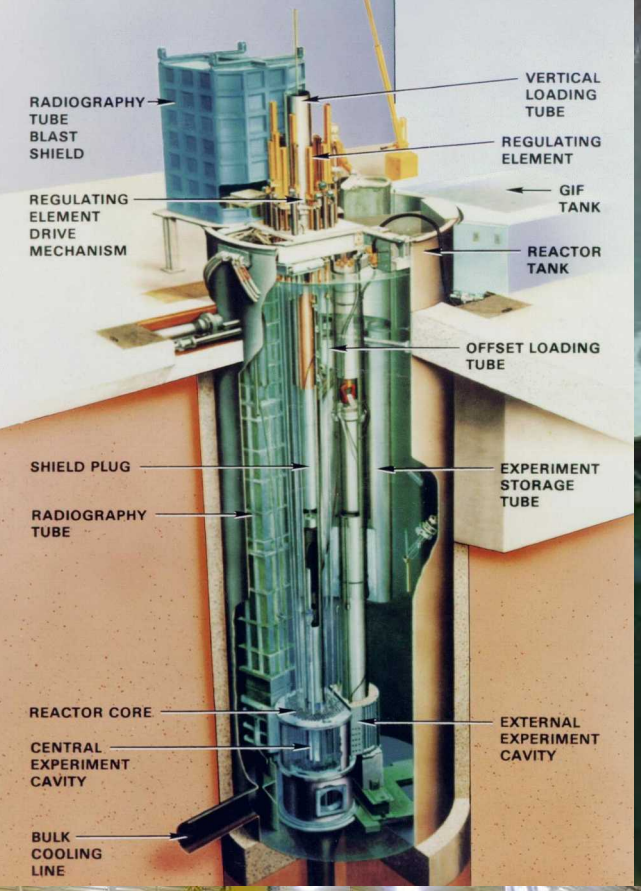
ACRR Description

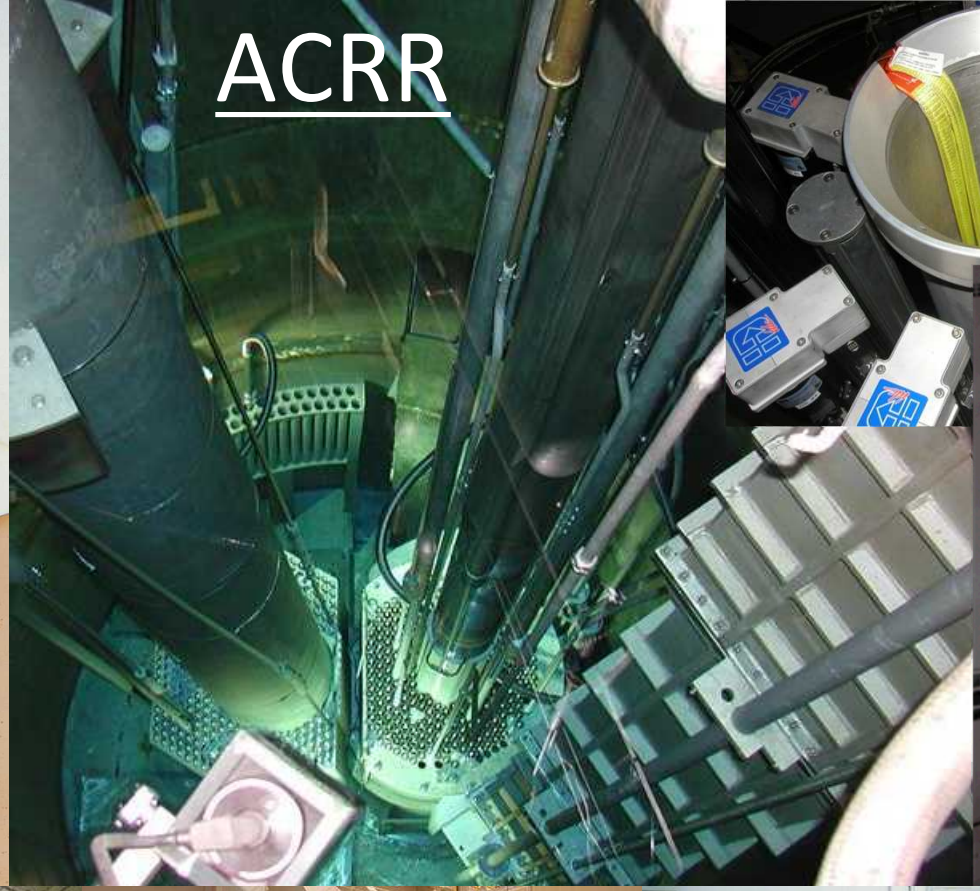


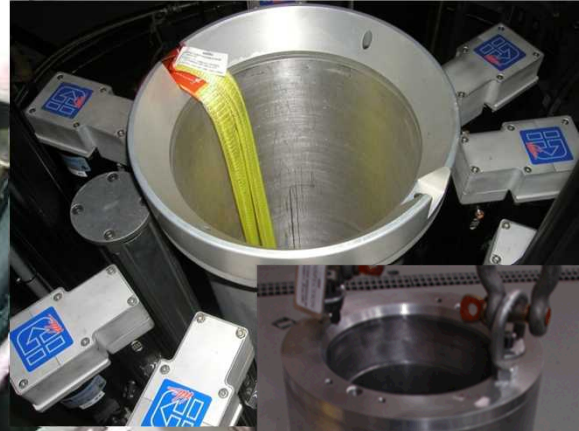
ACRR and FREC-II

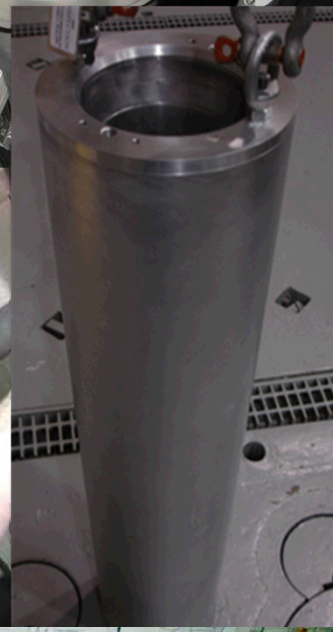
- 236 UO_2-BeO fueled elements
  - 1.5 in (3.8 cm) dia. x 20 in (51 cm)
  - 100 g U-235 per element – 35% enr.
- Operating Power level
  - MW_{th} Steady State Mode
  - 250 MJ Pulse Mode (6 ms FWHM)
  - 300 MJ Transient Mode (Programmable)
- Dry cavity 9 in (23 cm) diameter
  - Extends full length of 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

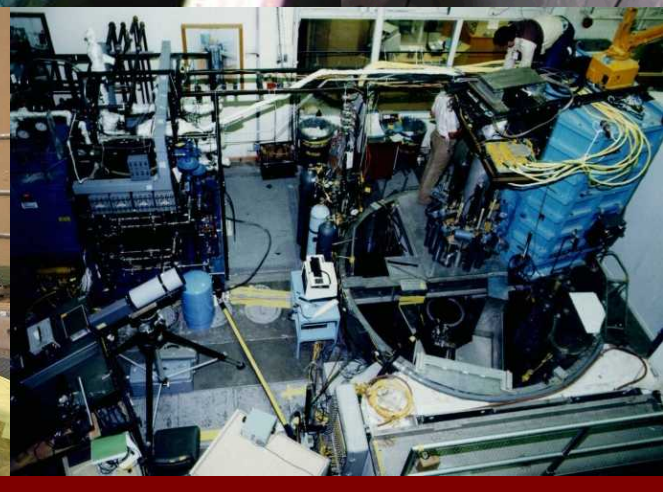
ACRR


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









Past Experiment Programs at TAV

Sandia National Laboratories

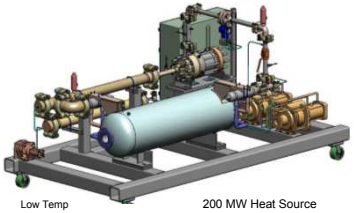
- TAV has been involved in many nuclear experiment programs over the years
  - Weapon Component Testing – Our original and continuing mission
  - Radiation Effects Sciences – New methods base on science discovery
  - Fast Reactor Safety – CRBR, Advanced fuel/cladding testing, equation of state
  - Light 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

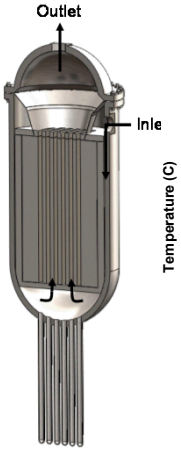
Current Experiment Programs at TAV

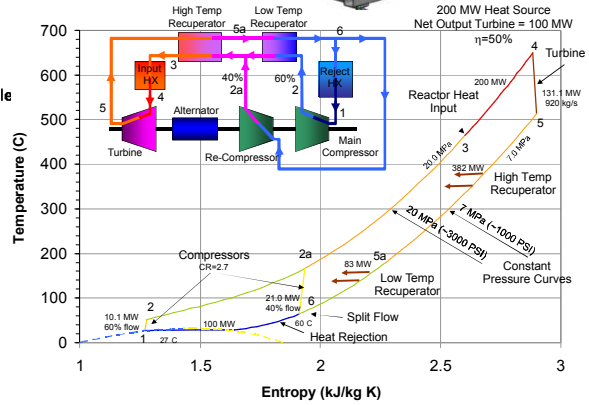
- TAV is still relevant – last research reactor standing
  - Weapon Component Testing – Our original and continuing mission
  - Radiation Effects Sciences – New methods base on science discovery
  - Burnup Credit – Critical experiments fission product reactivity effects
  - Criticality Safety – Critical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

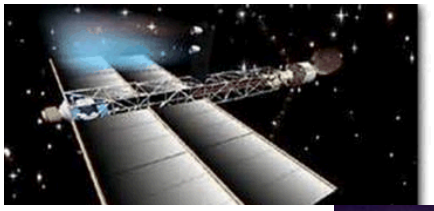
Future Experiment Opportunities

- 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









IVA Overview

- Permits utilization of Sandia capabilities for the benefit of advancing science
- No funds exchange between the institutions
- Sandia has limited capacity to support UNM experiments

IVA Scope

- Irradiations to study radiation-induced effects on materials
- Irradiations of systems and components to characterize their performance in radiation environments
- Benchmarking of radiation transport and reactor kinetics models
- Operational testing in facilities for radiation field and power characterization studies
- Radiation metrology activities in support of fielding dosimetric measurements and analysis
- Engineering analysis and studies associated with nuclear systems, safety systems, support systems, and system performance measurements

- Experimental activities conducted within the TA-V facilities

General IVA Process

- UNM submits SOW to TA-V staff for review
- TA-V reviews for relevancy and capacity
- If approved by TA-V then other internal approvals required before work is authorized
- Upon authorization UNM faculty and students will need to understand TA-V:
  - Access requirements
  - Escorting requirements
  - Safety requirements
  - Experiment Plan requirements
- Upon completion of experiment plan and work authorizations, work may be scheduled at applicable facility

IVA Potential Training Activities

- Radiography principles and operations
- Experiment development and process planning
- Pulse performance calculation
- Detector theory and application
- Radiation induced thermal loading
- Reactivity affects and measurements
  - Shutdown Margin
  - Excess Reactivity
  - Regulating Rod Worth
  - Neutron Lifetime
  - Minimum period

IVA Benefits

- Access to unique neutron and radiation capabilities
- Masters thesis work opportunities
- Distinguishes the uniqueness of UNM with regard to collaboration with a national laboratory
- TA-V has very competent staff covering all aspects of the radiation sciences and nuclear technology

Sandia National Laboratories

Q&A?

email address:
TAV_nuclear@sandia.gov

Partnerships & Collaboration Accelerate Innovation

Sandia National Laboratories