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# **Los Alamos National Laboratory Capabilities to Support the Development of Domestic Mo-99 Production**

Joetta Goda, Greg Dale, Keith Woloshun

Program Manager for Material Management and Minimization at LANL

September 12, 2017

2017 Mo-99 Topical Meeting on  
Molybdenum-99 Production Technology Development



# LOS ALAMOS: A PREMIER NATIONAL-SECURITY SCIENCE LABORATORY FOR THE 21ST CENTURY

Los Alamos National Laboratory has been essential to the nation's security for more than 70 years

- An agile, responsive, and innovative workforce dedicated to addressing complex national security issues and the world's most difficult challenges
- Multidisciplinary science, technology, and engineering capabilities
- Unique experimental, computational, and nuclear facilities



# U.S. Department of Energy National Labs are shaping the world ... Tasked with critical missions for our nation

## ENERGY



Enable discoveries and tools that transform understanding of energy and matter, and advance national, economic, and energy security

## SCIENCE



Create knowledge and understanding that will underpin our future society

## ENVIRONMENT



Deliver S&T solutions to shorten multi-decade environmental management and remediation programs

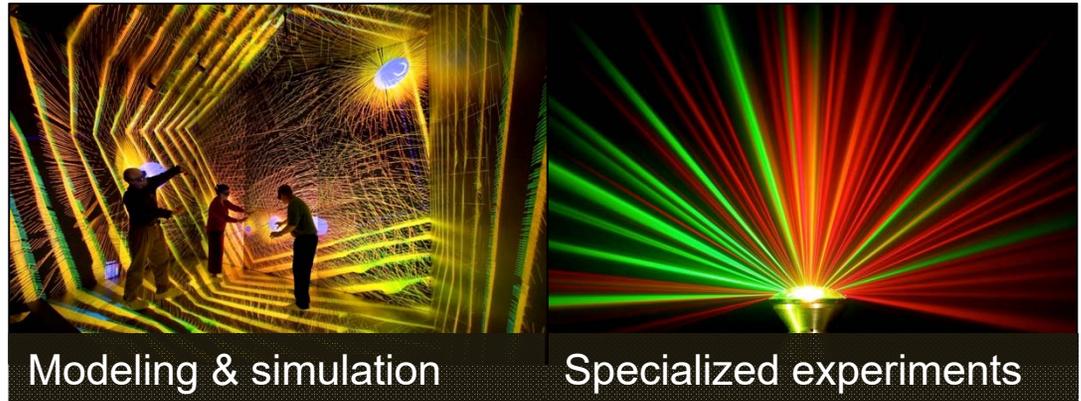
## SECURITY



Provide scientific and technical foundations for our national nuclear and global security

# Los Alamos' core mission is to ensure the U.S. nuclear deterrent

- Ensure safety, reliability, and performance of U.S. nuclear stockpile
- Design agency for four out of seven warhead systems constituting our nation's deterrent
- Modeling, simulation, radiography, and non-nuclear testing provide assurance

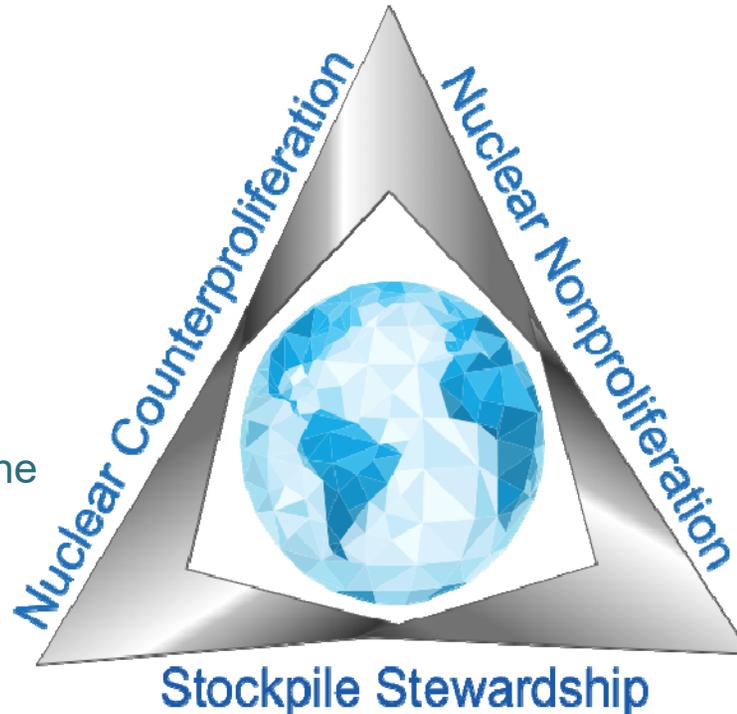


Los Alamos uses scientific assessment, experimentation, & modeling to assess and certify the stockpile, which has aged significantly since it was first developed and since the conclusion of full-scale testing

# Los Alamos' broader national-security missions comprise strategic deterrence



Detecting and preventing the development or use of nuclear weapons and improvised devices



Reducing nuclear arms and limiting the spread of nuclear technology, material, and expertise through cooperation and diplomacy

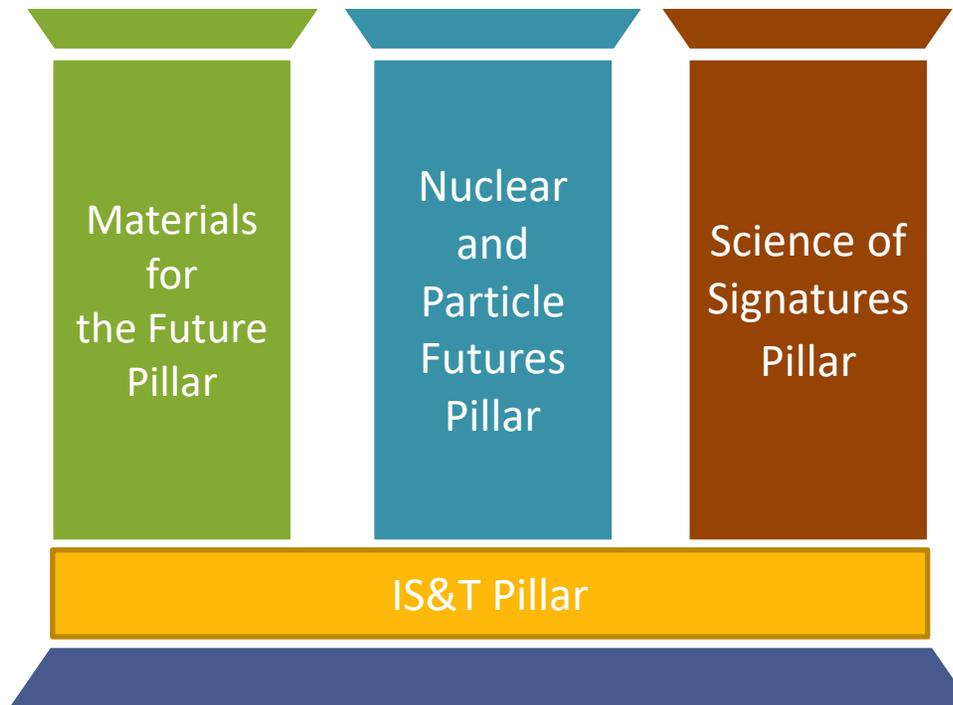


Providing the foundation for global security programs through theory, modeling and simulation, and experimentation

# Science Pillars define key areas of science, technology & engineering at Los Alamos

**Broad and deep multidisciplinary capabilities in each Science Pillar support national security missions and national needs**

## NATIONAL SECURITY MISSIONS/NATIONAL NEEDS



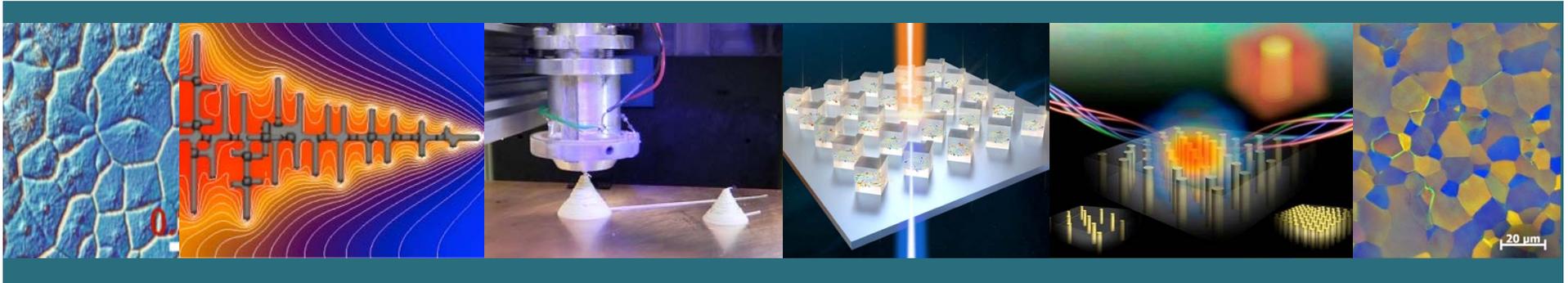
**LANL Science Pillars are a foundation of mission success**

# Materials for the Future: Solutions through controlled functionality of materials

The Laboratory's "Materials for the Future" Pillar emphasizes performance prediction and controlled functionality in key areas of leadership

## Focus Areas

- Materials Dynamics
- Energetic Materials
- Integrated Nanomaterials
- Complex Functional Materials
- Actinides and Correlated Electron Materials
- Materials in Harsh Environments
- Manufacturing Science

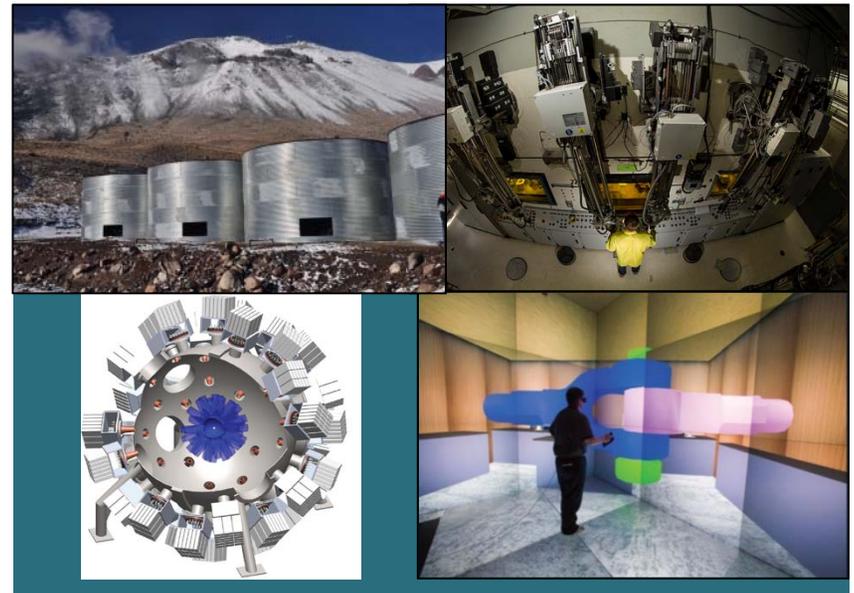
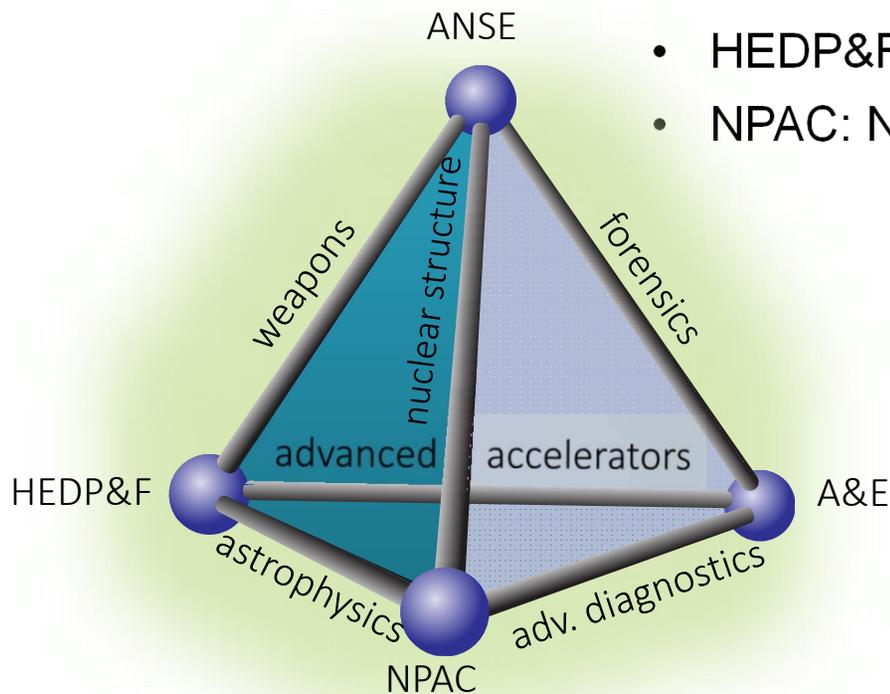


# Nuclear and Particle Futures: Extensive capabilities in nuclear facilities, experiment, theory, and simulation

The “Nuclear & Particle Futures” Pillar leverages the synergy among four scientifically coupled focus areas, integrating discovery frontiers for mission delivery

## Focus Areas

- ANSE: Applied Nuclear Science & Engineering
- A&E: Accelerators & Electrodynamics
- HEDP&F: High Energy Density Physics & Fluids
- NPAC: Nuclear-, Particle-, Astro-Physics & Cosmology

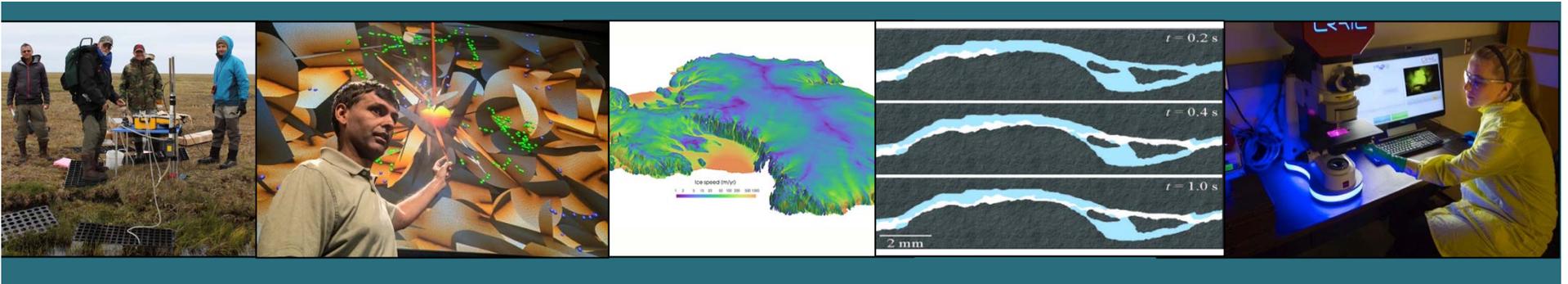


# Science of Signatures: Discovering new signatures, revolutionizing measurement, and deploying technologies

The Laboratory's "Science of Signatures" Pillar plays a key role in predicting systems behavior and developing responses to national security challenges and threats

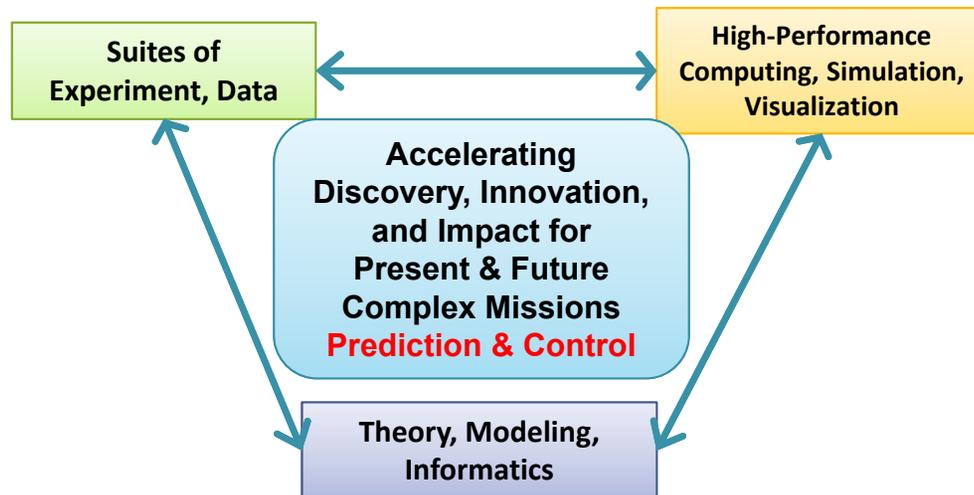
## Focus Areas

- Discover Signatures
- Revolutionize Measurements
- Forward Technology Deployment



# Integrating Information, Science, and Technology for Prediction: Leveraging advances in theory, algorithms, & HPC

The “Information Science & Technology” Pillar leverages advances in theory, algorithms, and the exponential growth of high–performance computing and data science to accelerate prediction



## Focus Areas

- Computational Co-Design
- Data Science at Scale
- Complex Networks



# Unique science and engineering infrastructure is critical for national security work



**Metropolis Center for Modeling & Simulation**



**Los Alamos Neutron Science Center**



**Dual Axis Radiographic Hydrotest Facility**



**Plutonium Processing Facility (TA-55)**



**National High Magnetic Field Laboratory**



**Center for Integrated Nanotechnologies**

- » 40 square miles
- » 47 technical areas
- » 2,000 structures
- » 1,280 buildings
- » 13 nuclear facilities



**High Explosive Laboratories**



**CMR Replacement (CMRR) Building**

# LANL is a National Nuclear Security Administration (NNSA) Laboratory in the U.S. Department of Energy (DOE)

## Office of Science Laboratories

- 1 Ames Laboratory  
Ames, Iowa
- 2 Argonne National Laboratory  
Argonne, Illinois
- 3 Brookhaven National Laboratory  
Upton, New York
- 4 Fermi National Accelerator Laboratory  
Batavia, Illinois
- 5 Lawrence Berkeley National Laboratory  
Berkeley, California
- 6 Oak Ridge National Laboratory  
Oak Ridge, Tennessee
- 7 Pacific Northwest National Laboratory  
Richland, Washington
- 8 Princeton Plasma Physics Laboratory  
Princeton, New Jersey
- 9 SLAC National Accelerator Laboratory  
Menlo Park, California
- 10 Thomas Jefferson National Accelerator Facility  
Newport News, Virginia

## Other DOE Laboratories

- 1 Idaho National Laboratory  
Idaho Falls, Idaho
- 2 National Energy Technology Laboratory  
Morgantown, West Virginia  
Pittsburgh, Pennsylvania  
Albany, Oregon
- 3 National Renewable Energy Laboratory  
Golden, Colorado
- 4 Savannah River National Laboratory  
Aiken, South Carolina

## NNSA Laboratories

- 1 Lawrence Livermore National Laboratory  
Livermore, California
- 2 Los Alamos National Laboratory  
Los Alamos, New Mexico
- 3 Sandia National Laboratory  
Albuquerque, New Mexico  
Livermore, California

## Nuclear Security Enterprise

- 1. Kansas City Plant
- 2. Lawrence Livermore National Laboratory
- 3. Los Alamos National Laboratory
- 4. Nevada National Security Site
- 5. Pantex Plant
- 6. Sandia National Laboratories
- 7. Savannah River Site
- 8. Y-12 National Security Complex



We are in northern New Mexico, 35 miles from Santa Fe



# The Laboratory's mission is aligned with DOE and NNSA

## DOE mission areas:

- National Security
- Science
- Energy
- Environmental Management



*Rick Perry*  
Secretary of Energy

## The role of National Labs:

- DOE is a powerhouse of national science and technology
- National labs are principal agents of execution on missions of national importance
- Focus is on public service

## NNSA Commitments:

- Sustain the nuclear weapons stockpile
- Conduct leading-edge scientific research
- Help prevent nuclear materials from falling into the hands of terrorists
- Support the Navy's nuclear reactor program
- Repair and modernize our aging infrastructure
- Protect the safety and security of our sites, employees, and the public



*Frank G. Klotz*  
NNSA Administrator

# The Los Alamos mission is to solve national security challenges through scientific excellence

## GOALS

Deliver national nuclear security and broader global security solutions

*and*

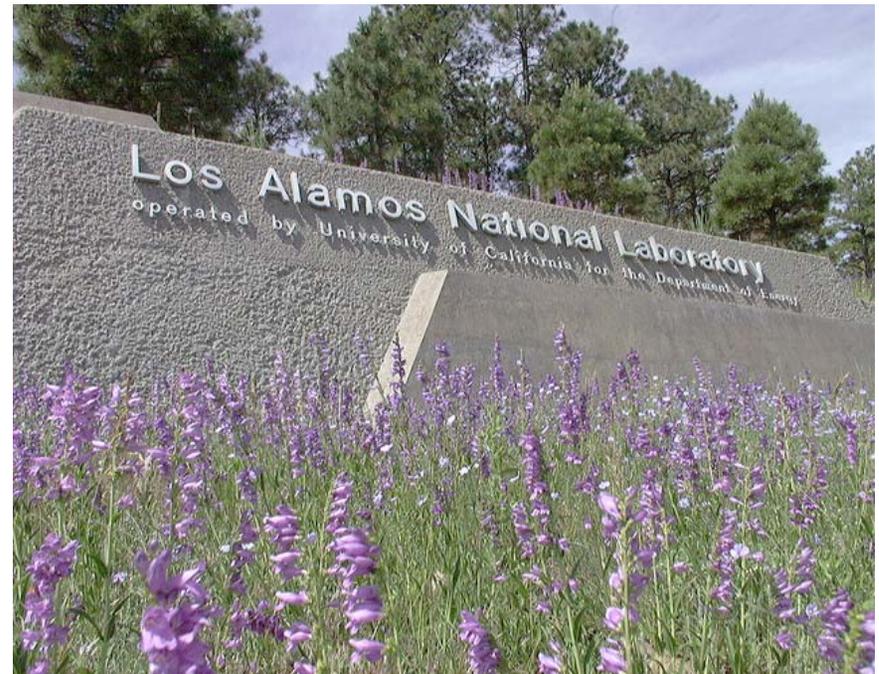
Foster excellence in science and engineering disciplines essential for national security missions

*by*

Attracting, inspiring and developing world-class talent to ensure a vital future workforce

*and*

Enabling mission delivery through next-generation facilities, infrastructure, and operational excellence



# We are managed by Los Alamos National Security, LLC



Managed and operated by the  
University of California  
*1943 to 2006*



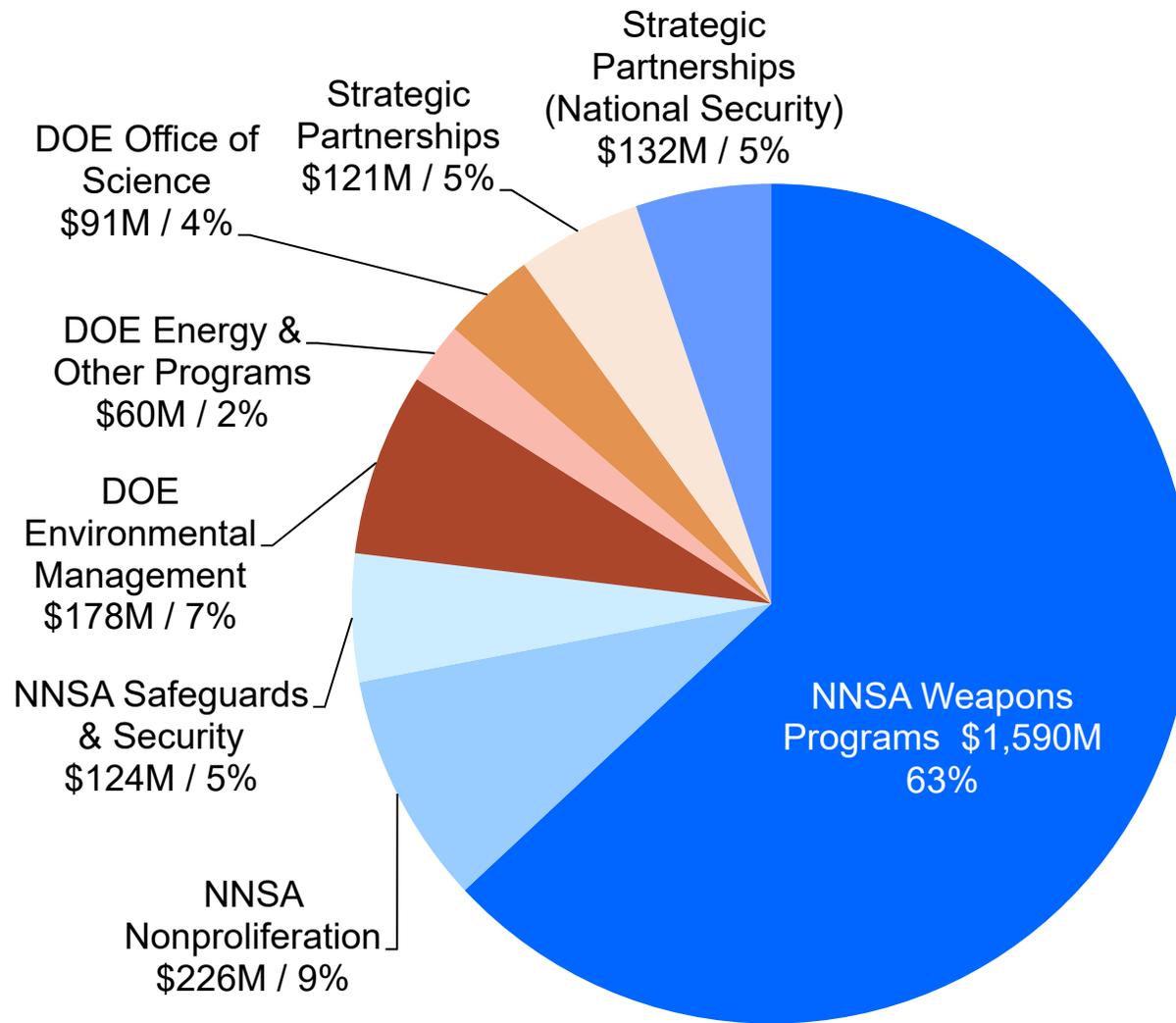
**AECOM**



**BWX**  
BWXT technologies, llc.

Now managed by Los Alamos  
National Security (LANS), LLC  
*2006 to present*

# The Laboratory's FY16 budget was \$2.5B



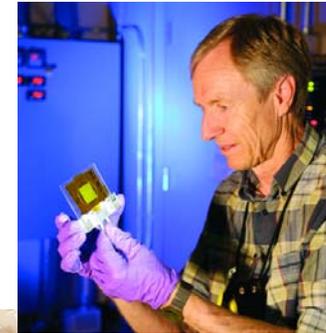
# We have a large, highly-educated workforce

Total employees, 10,827

- LANS, 7,465
- Students, 1,300
- Unionized craft workers, 943
- Contractors, 407
- Protective Force, 357
- Post doctoral researchers, 355

University degrees for LANS employees:

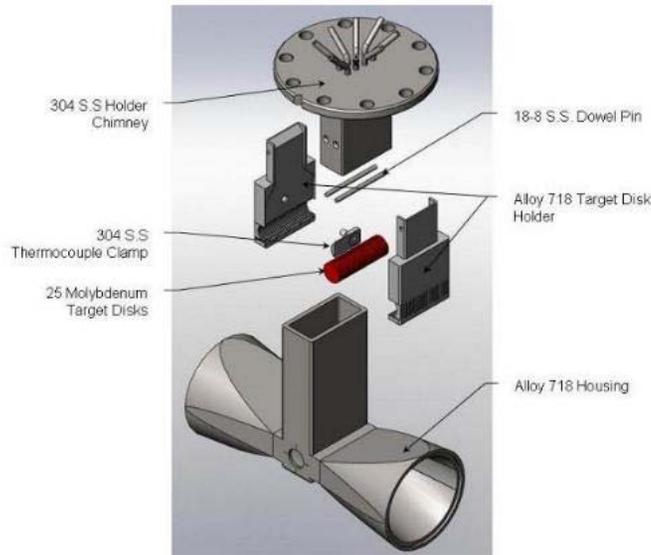
- 24% undergraduate
- 19% master's
- 22% PhD



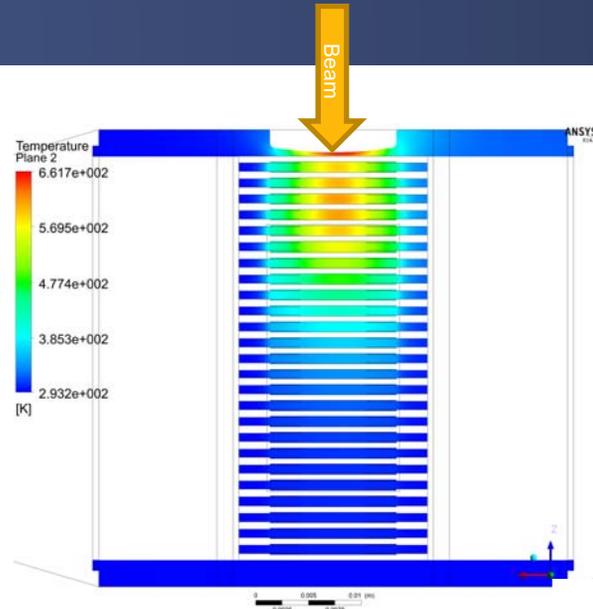
# LANL Support for Domestic $^{99}\text{Mo}$ Production

- **As part of the M<sup>3</sup> Program, LANL is supporting:**
  - NorthStar Medical Radioisotopes with the electron accelerator production of  $^{99}\text{Mo}$  from  $^{100}\text{Mo}(\gamma, n)^{99}\text{Mo}$ .
    - Present activities include designing target cooling systems, production and thermal optimizations, and advanced beam diagnostics.
  - Shine Medical Technologies with the production of fission product  $^{99}\text{Mo}$  from a DT accelerator driven subcritical uranium salt solution.
    - Present activities include coupled thermal hydraulic and Monte-Carlo neutron calculations and methods for uranium detection.

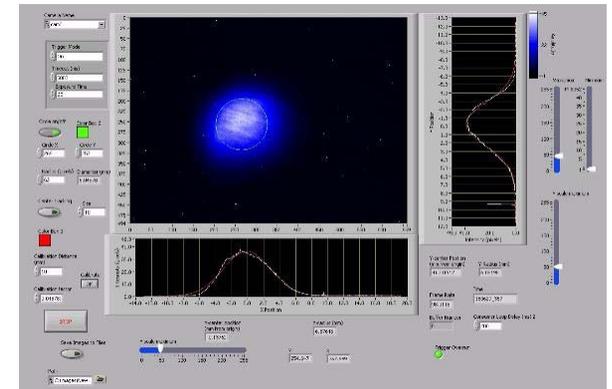
# LANL Support for NorthStar Mo-99 Production



Target Design



Target Modeling



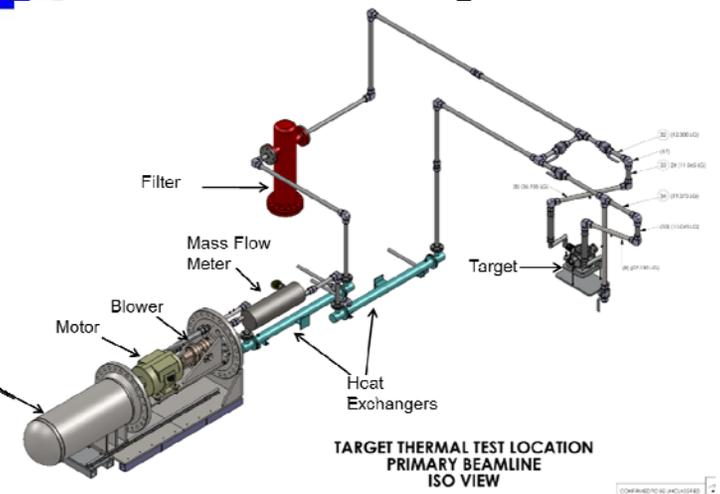
Beam Diagnostics



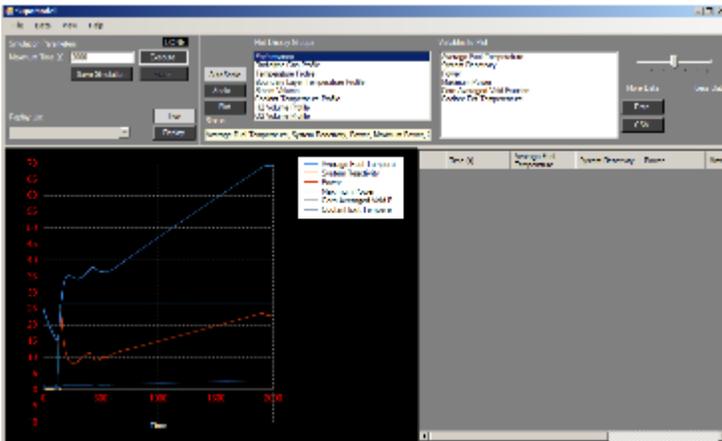
Target Fabrication



Helium Cooling System Design, Fabrication, and Testing



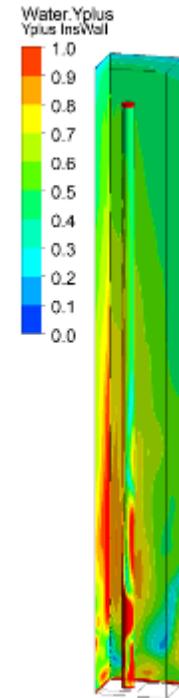
# LANL Support for SHINE



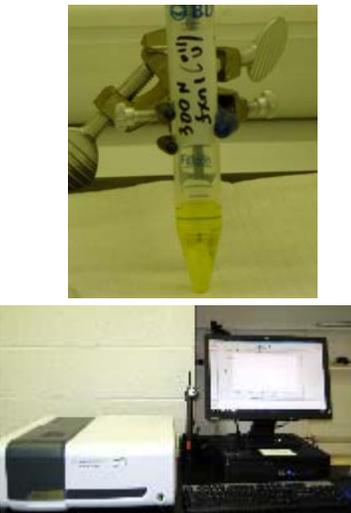
Dynamic System Simulation



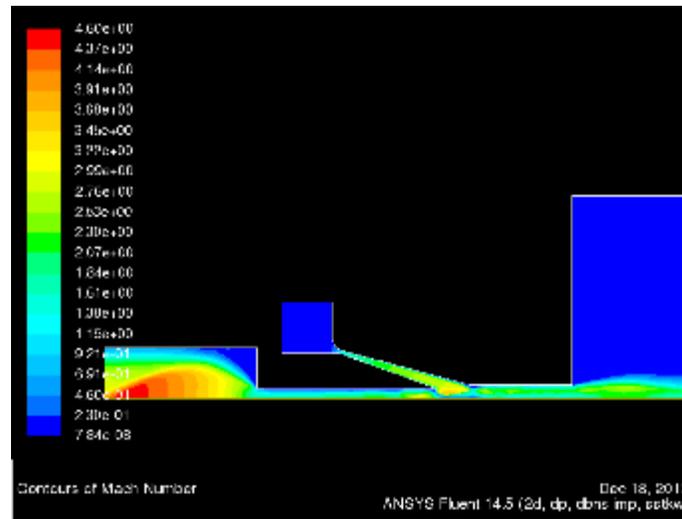
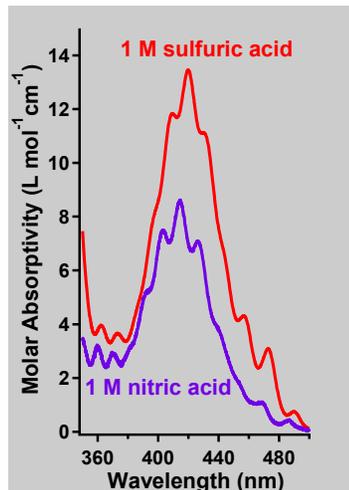
Zr Clad DU Disk Fabrication



Coupled Thermal Hydraulic and Neutronic Modeling



Uranium Control and Accountancy through UV Spectroscopy



SHINE Target Gas Nozzle Design