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Title: NNSA Complex and LANL Weapons Program Overview

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Los Alamos
NATIONAL LABORATORY

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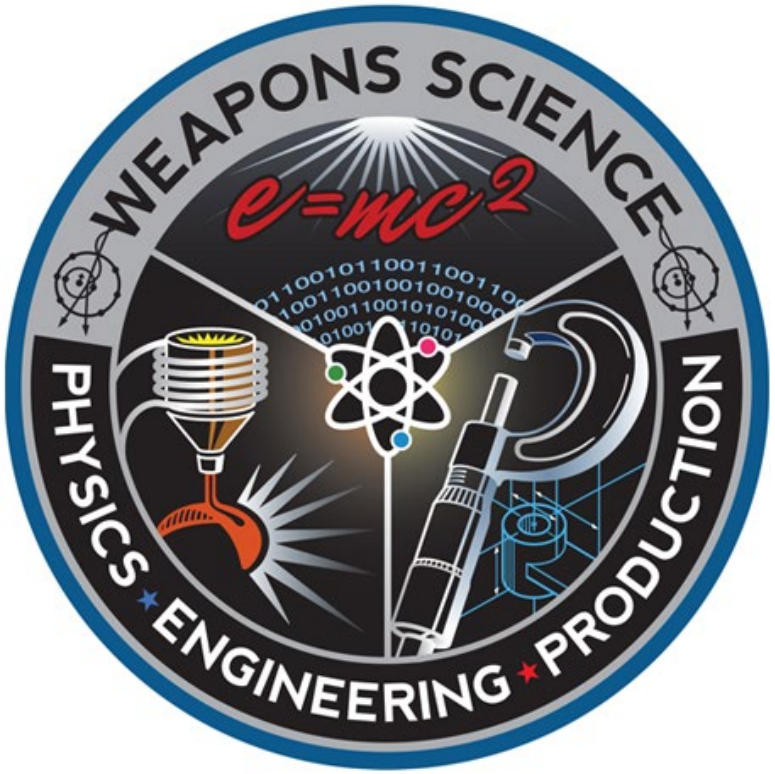
Nuclear Fundamentals Orientation Module 1

NNSA Complex and LANL Weapons Program Overview

Los Alamos NATIONAL LABORATORY EST. 1943

Managed by Triad National Security, LLC for the U.S. Department of Energy's NNSA

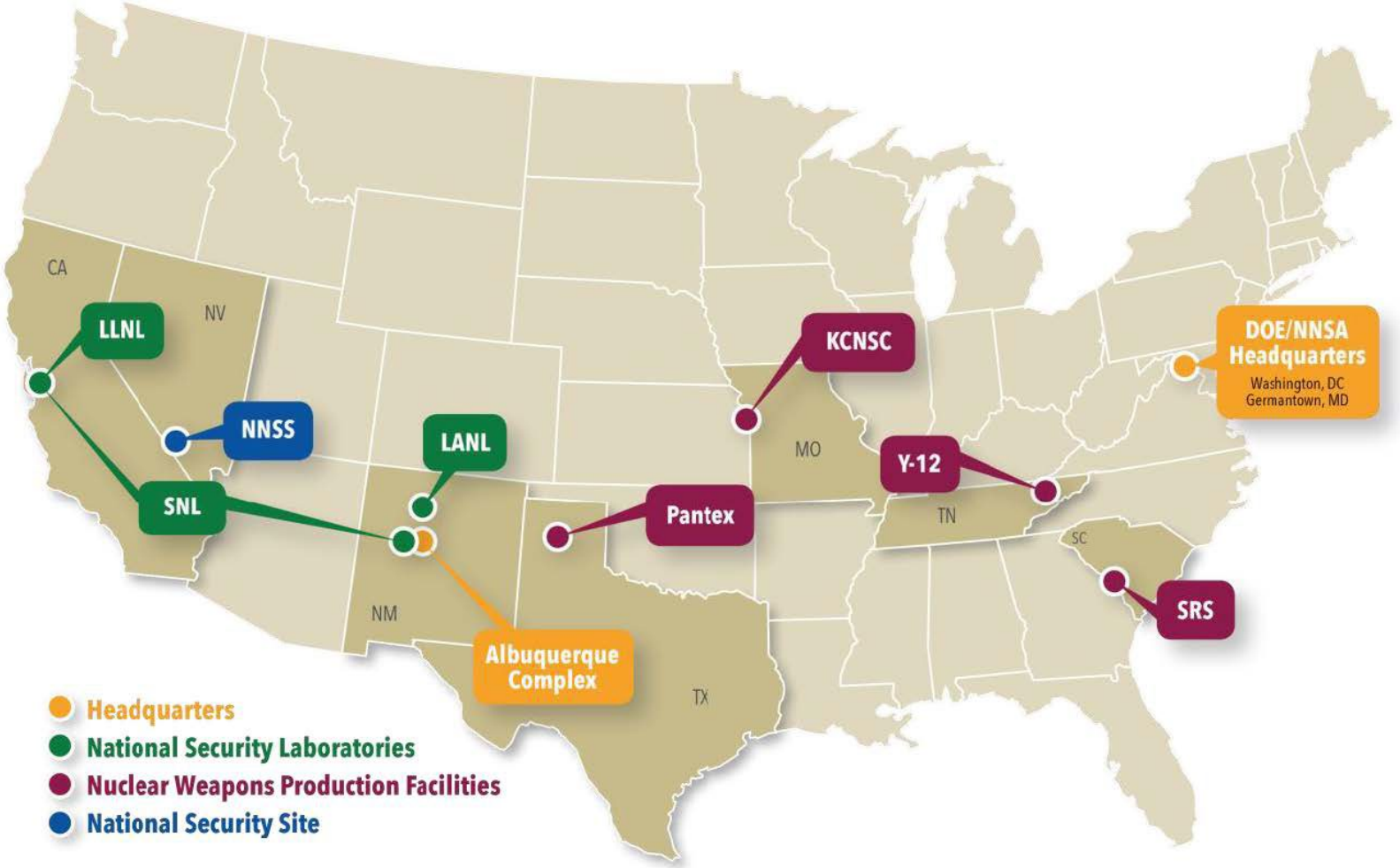
LANL Weapons Program Overview



Presentation Overview:

- NNSA Complex
  - Design Agencies
  - Production Agencies
- Guiding Principle of Los Alamos
- Weapons Mission
- Science, Engineering and Computations
- Future Weapons Program R&D
- Aging Weapons
- A Final Thought
- Questions and Answers

Today: Current NNSA Complex



KCNSC = Kansas City National Security Campus
LANL = Los Alamos National Laboratory
LLNL = Lawrence Livermore National Laboratory
NNSS = Nevada National Security Site
Pantex = Pantex Plant
SNL = Sandia National Laboratories
SRS = Savannah River Site
Y-12 = Y-12 National Security Complex

Today: NSE Complex

Los Alamos National Laboratory

Lawrence Livermore National Laboratory

Sandia National Laboratories

Kansas City National Security Campus

Federal government (DOE/NNSA), with input from labs and plants, provides scope & budgets to these organizations every year, creating an environment of cooperation and competition

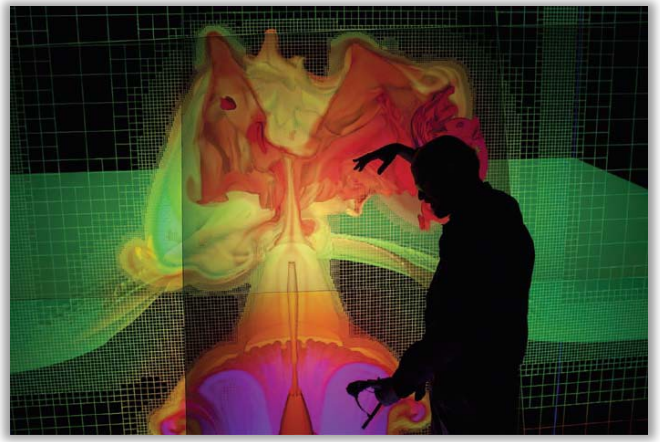
Y-12 National Security Complex

Savannah River Site

Pantex Plant

Nevada National Security Site

Today: Design Agencies and Production Agencies



DESIGN

LANL

LLNL

SNL

PRODUCTION

LANL

KCNSC

SRS

Y-12

Pantex

Lawrence Livermore National Laboratory (LLNL)

Multi-Program National Security Laboratory

- **Design Agency**
  - Nuclear explosives package
- **Surveillance**
- **Home of the National Ignition Facility**

Sandia National Laboratories (SNL)

Multi-Mission National Security Laboratory

Albuquerque, NM

- **Design Agency**
  - Non-nuclear components
- **Production Agency**
  - Neutron generators
  - Electronics fabrication
- **Systems Integration**

Y-12 National Security Complex

Manufacturing Facility

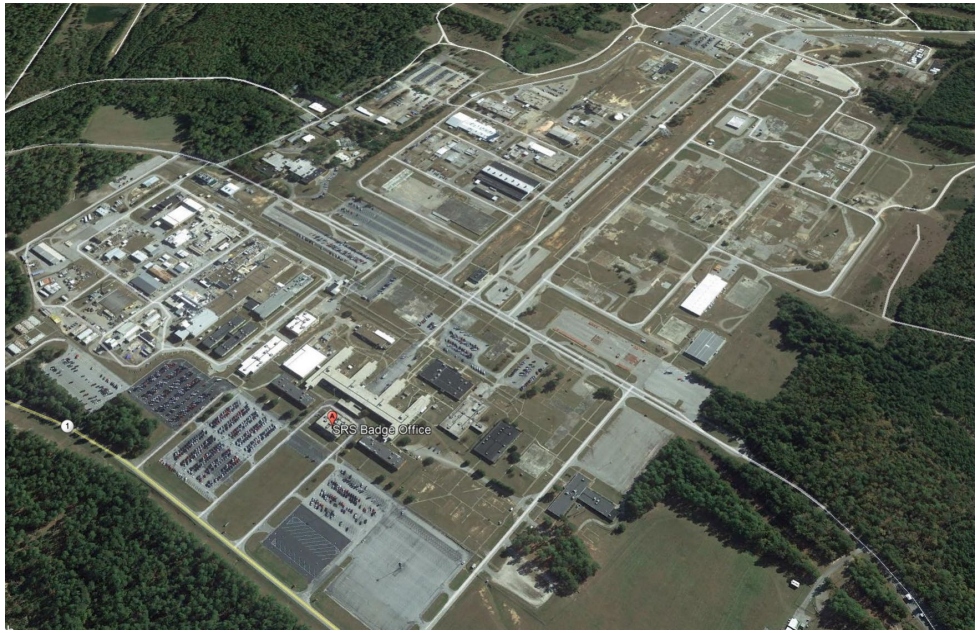
- **Uranium & other components**
  - Production, surveillance, dismantlement, storage

Savannah River Site (SRS)

Industrial Complex (includes Savannah River National Laboratory)

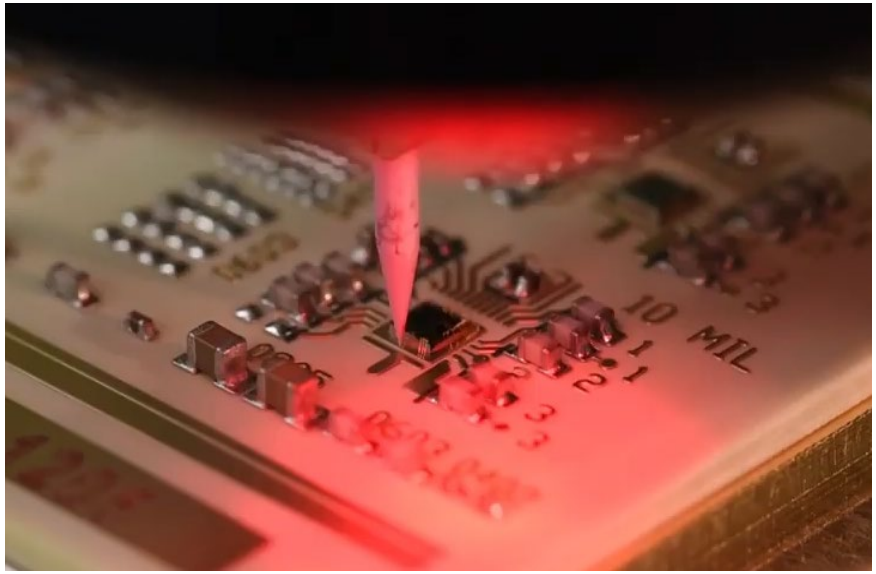
- **Tritium and gas-transfer systems**
- **Future pit production mission**
  - In partnership with Los Alamos

Near Aiken, SC



Kansas City National Security Campus (KCNSC)

Kansas City, MO



Production, Manufacturing, and Supply Chain Management

- **Production Agency**
  - For non-nuclear components

Pantex Plant

Amarillo, TX

Production Facility

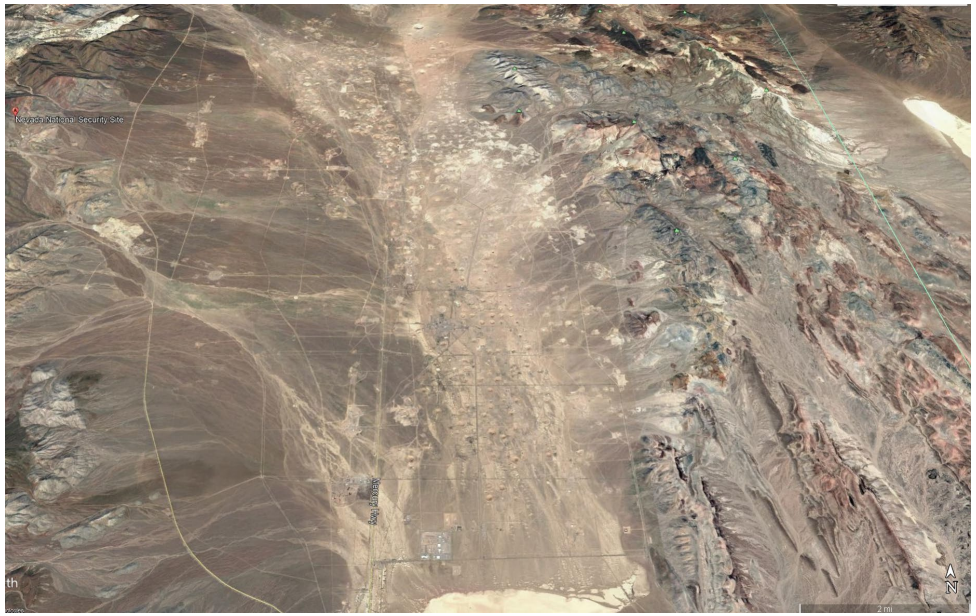
Assembly, disassembly, retro-fit, & life extension center

- **Weapons Production**
- **Stockpile Surveillance**
- **High Explosive Manufacturing**

Nevada National Security Site (NNSS)

An outdoor/indoor/underground national laboratory

- Integrated subcritical plutonium experiments
- High-hazard work
- “Exercises” involving counter-terrorism



NW of Las Vegas, NV

Los Alamos National Laboratory (LANL)

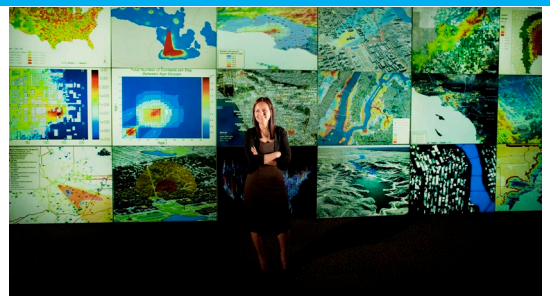
Multi-Program National Security Laboratory

Los Alamos, NM

- **Design Agency**
  - Nuclear explosives packages
- **Production Agency**
  - Plutonium pits, detonators and power sources
- **Home of LANSCE, DARHT, PF4, SIGMA**
- **Surveillance**

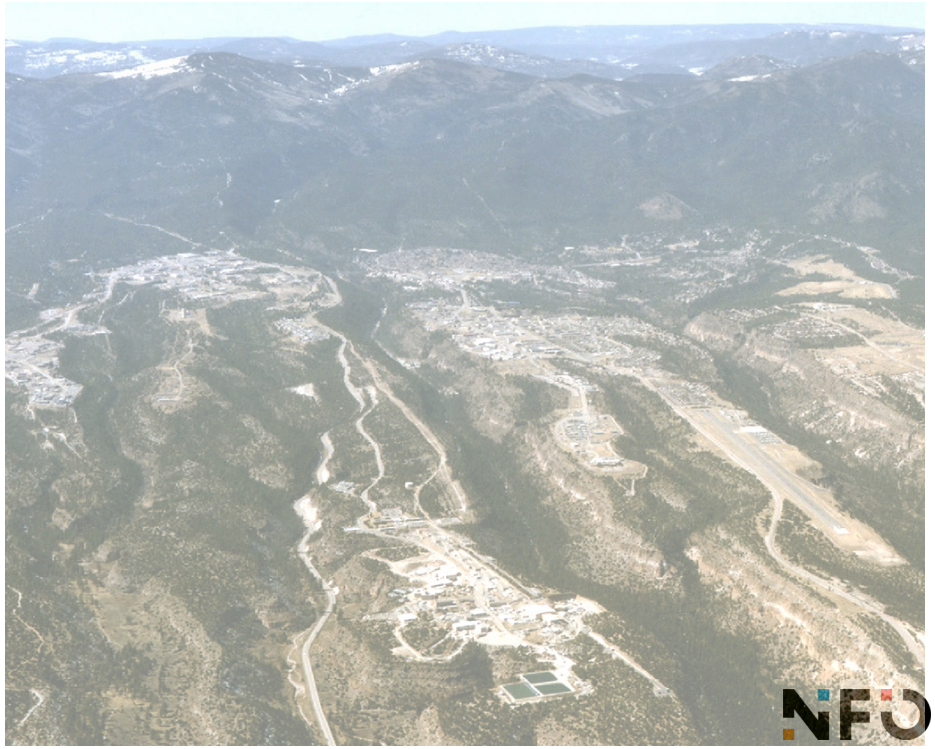
Better Science = Better National Security

2021-2022



- **$4.1B budget**
- **13,400 Employees**
  - 40% Annual Hires = PhDs
  - 1,100 Veterans
  - 1,800 Summer Students
  - 47 Technical Areas
  - 1,280 Buildings
  - 11 Nuclear Facilities
  - 268 Miles of Roads

LANL covers 36 sq miles



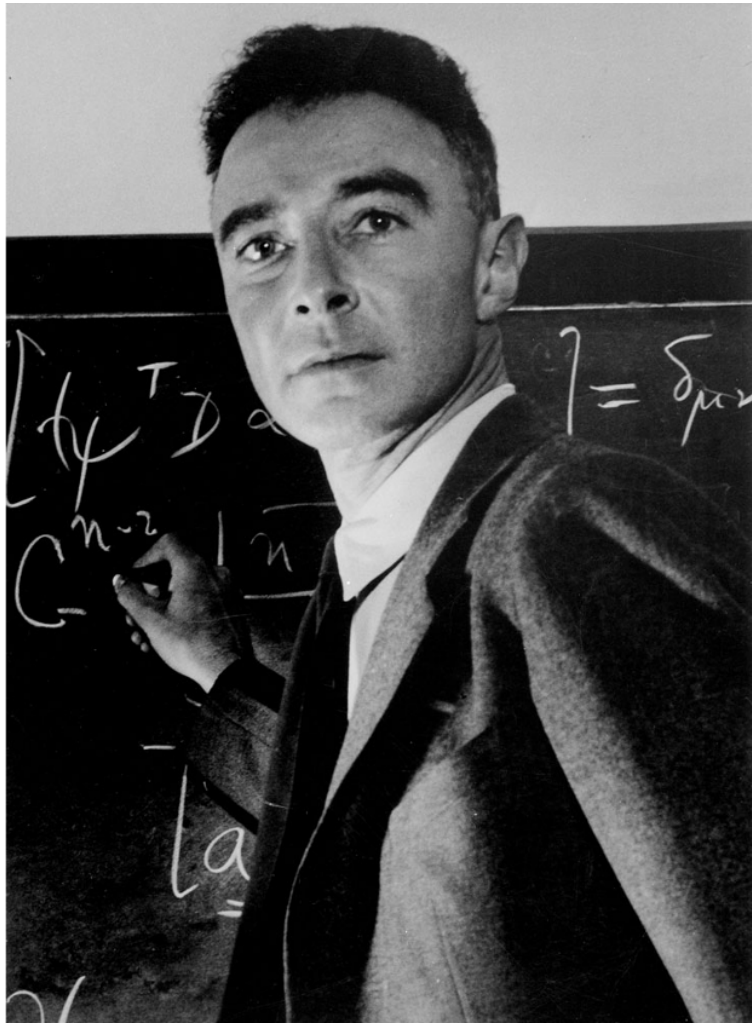
Since 1943: Our Guiding Principle

"There must be no barriers for freedom of inquiry.

There is no place for dogma in science.

The scientist is free, and must be free, to ask any question, to doubt any assertion, to seek for any evidence, to correct any errors."

- J. Robert Oppenheimer



DDW Weapons Mission

Ensure our nuclear deterrent is safe, secure, and effective

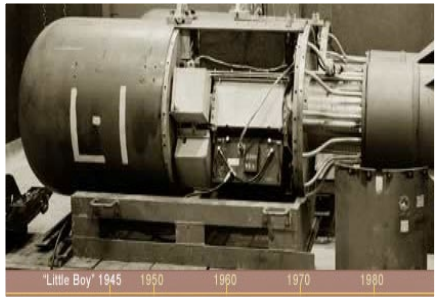
Provide expertise & tools for technical assessment of the global nuclear security environment

FOREIGN NUCLEAR THREATS

NUCLEAR COUNTERTERRORISM

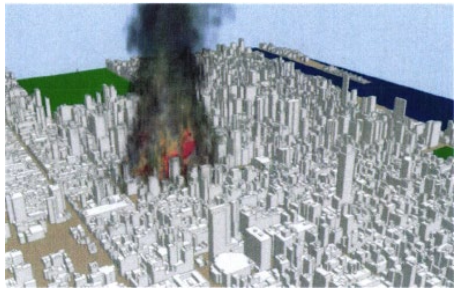
NUCLEAR NONPROLIFERATION

NUCLEAR EMERGENCY RESPONSE



NUCLEAR FORENSICS

NUCLEAR CONSEQUENCE MANAGEMENT



Los Alamos:
The design laboratory for the majority of the Nation's on-alert deterrent

W76
W88
} US Navy

W78
B61
} US Air Force

"Nuclear weapons have & will continue to play a critical role in deterring nuclear attack & in preventing large scale conventional warfare between nuclear armed states…"

- Former Secretary of Defense Jim Mattis

Los Alamos National Laboratory:
A national security science resource for the Nation

- **Designed and certified 46 of the 63 nuclear weapon systems in the U.S. stockpile**
  - Today's stockpile consists of 7 types of weapons
    - W76* & W88* Ohio Class Strategic Ballistic Missile Submarines (SSBN)
    - W78* & W87 Minuteman III Intercontinental Ballistic Missile (ICBM)
    - B61* / B83 /W80* gravity bomb/cruise missile deployed by aircraft
      - B-2, B-52, F-15, F-16, F-35
- **Annual Assessment Process**
  - Yearly technical assessment briefed to DDW and the Lab Director
  - Director sends letter to DOE, DOD, & President, on state of LANL weapons

The nation's "go-to" laboratory to solve some of the most vexing national security science problems

*** LANL designed weapons**

By law, Los Alamos Director reports on the state and health of the Nation's deterrent

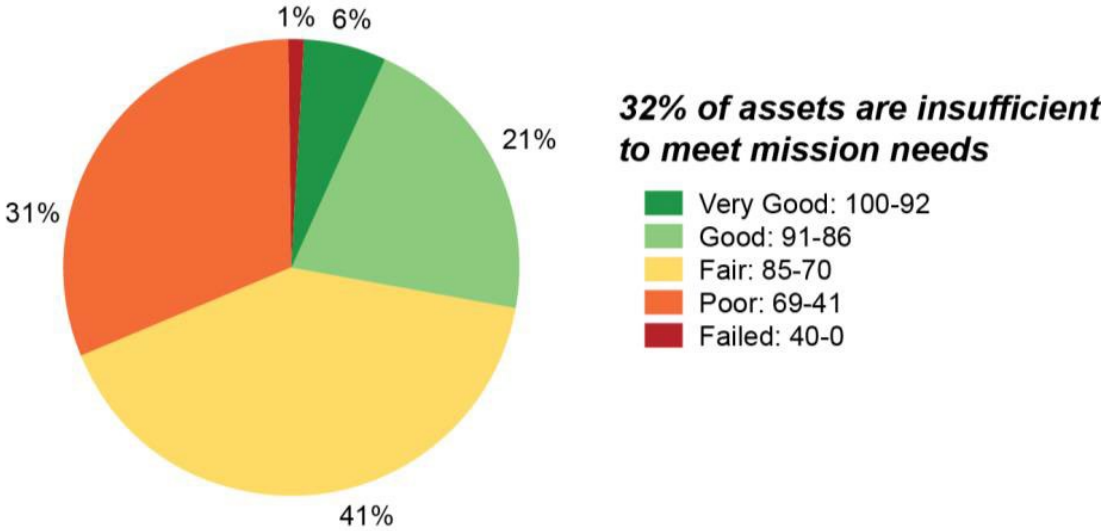
LANL's multidisciplinary science and engineering capability

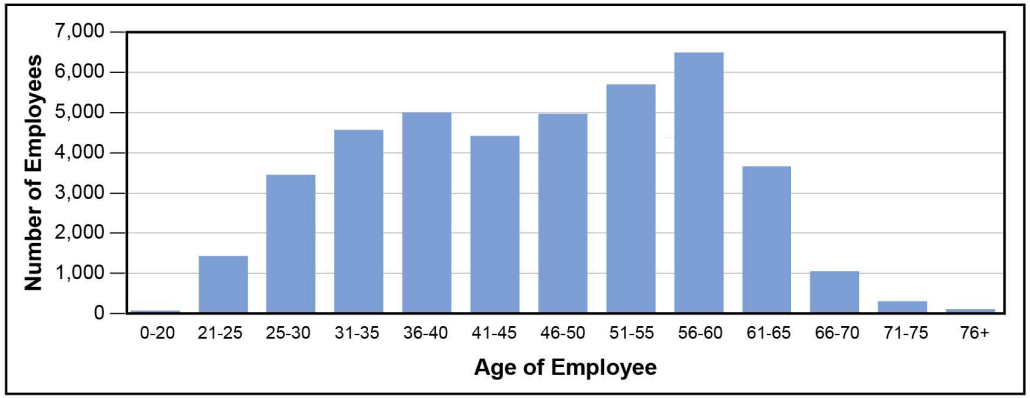
Los Alamos
NATIONAL LABORATORY

NFO

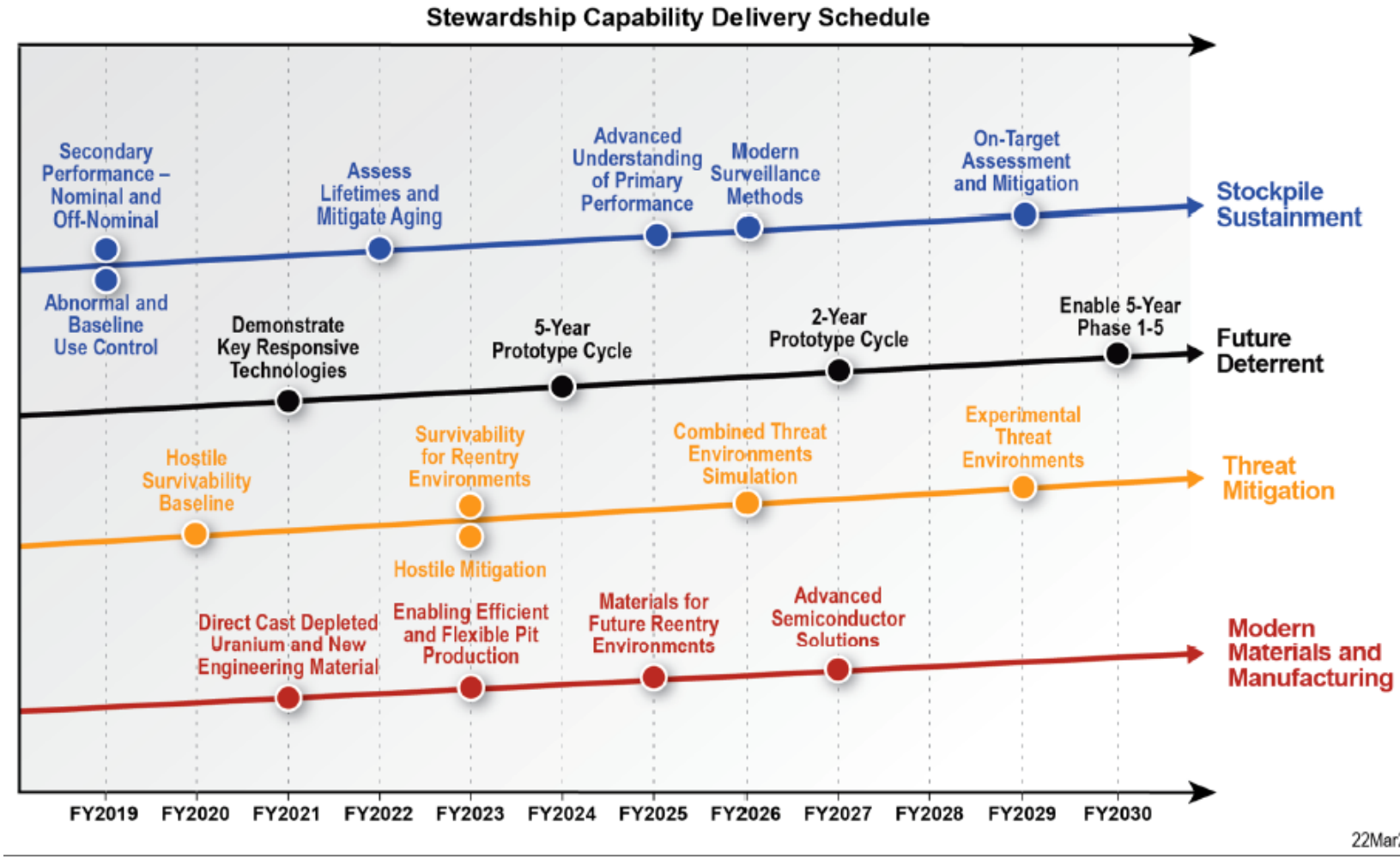
Today: Complex Challenges

- Workforce
- Aging Infrastructure
- New Facilities
- Modernization of Stockpile
- Threat Spectrum Changing
- Waste Management



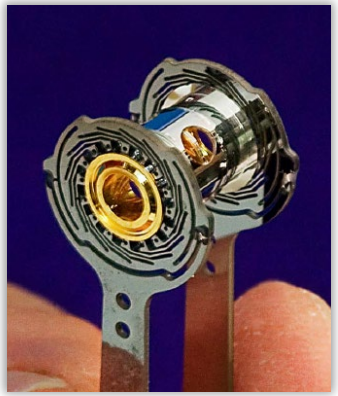


These objectives guide our weapons programs work (NNSA and labs maintain the guidance)



Science, engineering and computations underpin all laboratory national security work

- **Experiments:** 1,000s of experiments conducted annually to further our understanding and confidence in the stockpile
- **Modeling and Simulation:** World class computing hardware/software
- **Designer Judgement:**
  - Experimental data used to check judgement
  - Train next generation

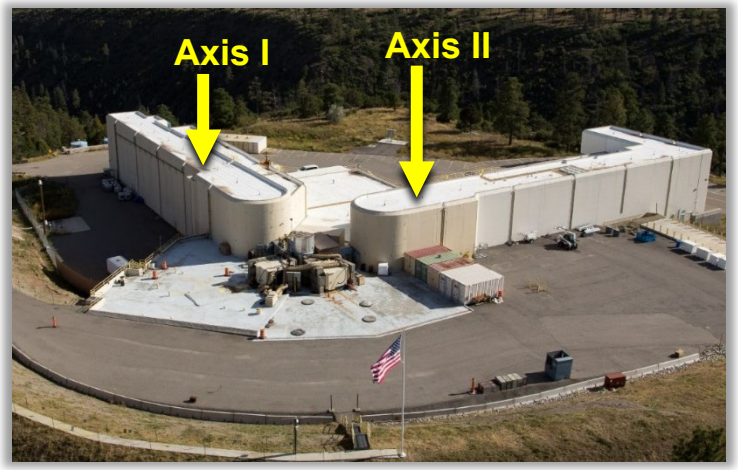


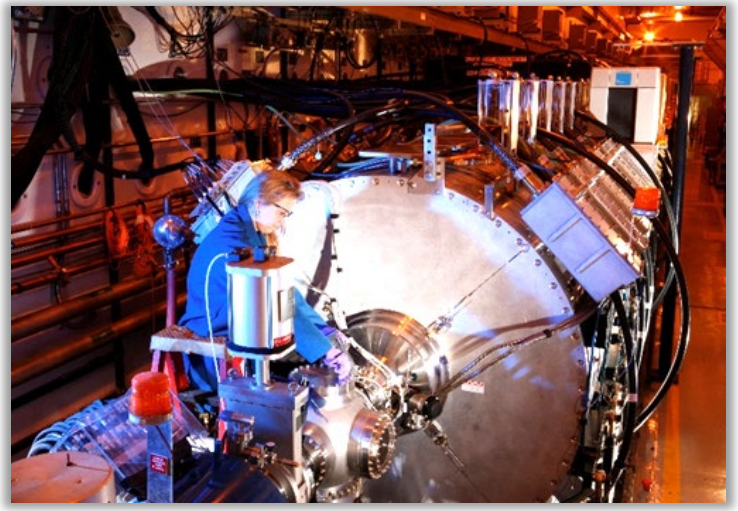
High Energy Density (HED) Experiments

Large bore powder gun – measures differences in performance of weapon materials of interest.

World class radiographic capabilities supports LANL/LLNL weapons and global security programs

- DARHT world-class X-ray radiography for dynamic non-nuclear tests
- Axis I: single image; Axis II: four images
- Experiments contained to reduce environmental impacts and increase shot rate
- LANSCE pRad accelerator provides dynamic proton imaging (>17 frames)





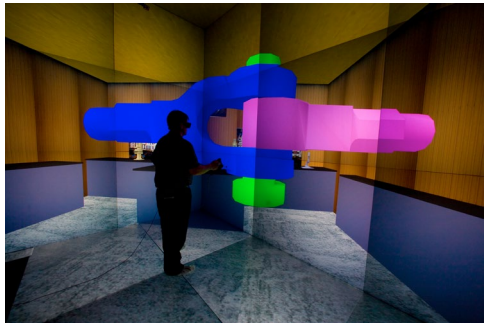
LANSCE

DARHT

Petascale Supercomputing:
Critical to LANL's national security missions

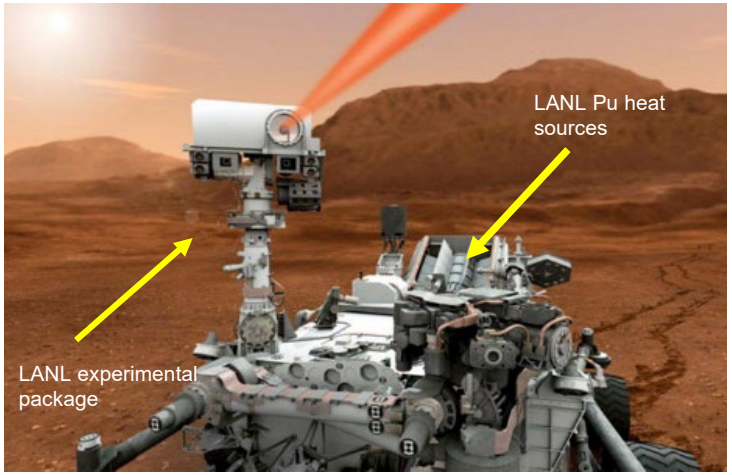
National security computing challenges are increasingly complex

- **Improve understanding, controlling, predicting complex natural and engineered systems**
  - Weapons, Non-proliferation, Biosciences
  - Drive 3D simulations
  - For example: DARHT & LANSCE provide large data sets to resolve stockpile challenges
- **Capacity and capability machines**
  - Trinity, Fire, Ice
- **Exascale and quantum**
  - Further simulation scale and fidelity

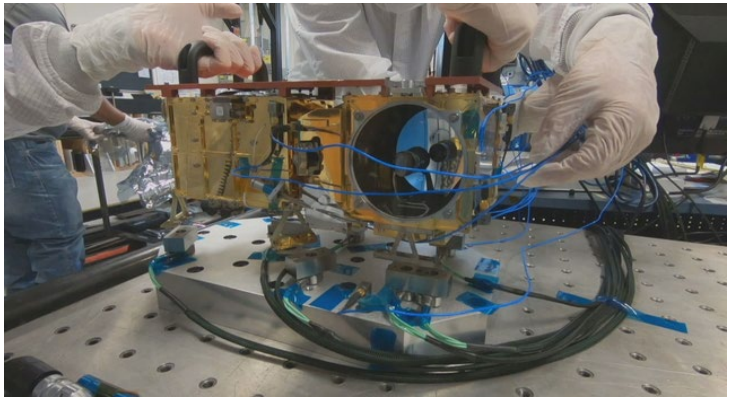


Los Alamos:
The center for plutonium excellence

- **Components for LANL experimental science**
- **DOD nuclear deterrence mission support**
  – 30 pits per year 2026
- **Support to NASA and other federal agencies**
- **Provide technical options to meet new & emerging challenges**
  – International Atomic Energy Agency (IAEA) training
  – Additive manufacturing



Mars Curiosity Rover



SuperCam for Mars 2020 mission

Rationale for Future Weapons Program R&D

2018 NPR

"The United States is observing a return to Great Power competition…**potential adversaries have expanded and modernized their nuclear forces.**"

SRP

"The Secretary of Energy…shall carry out a stockpile responsiveness program…**to continually exercise all capabilities required to conceptualize, study, design, develop**…"

Ability to completely design, certify, qualify, and if appropriate, produce a nuclear weapon for stockpile that is **responsive to an emergent need, in a timely manner.**

NNSA Strategy:
Providing guidance to the NSE

Building off of the current program and assessment of evolving threats, establish a strategy for a more responsive and resilient enterprise

The complex is being engaged to:

- Identify “evolutionary” improvements & “revolutionary” changes to current production processes
- Seek out innovations to enable increased production throughput
- Develop more material-efficient production processes

At the Labs, think about concepts that trade between:

- Performance requirements (e.g. weight, volume, yield, degree of surety, etc.)
- Select performance margins (margin to “failure cliffs”)
- Ease of manufacture / manufacture throughput rate
- Cost
- Placement of risk (certification vs. manufacture vs. qualification)

Aging Weapons

Weapons in their 4th decade of life, challenge us to assess their viability and project when they age out

- **Components deteriorate due to operational environments**
  - Vibrations, temperature cycling, humidity
- **Materials change as a result of intrinsic radiation &chemical reactions**
  - Plastics get brittle
  - Adhesives weaken
  - Metals corrode, coatings deteriorate
- **Material physical properties change.**
  Loss of ductility, elasticity or strength

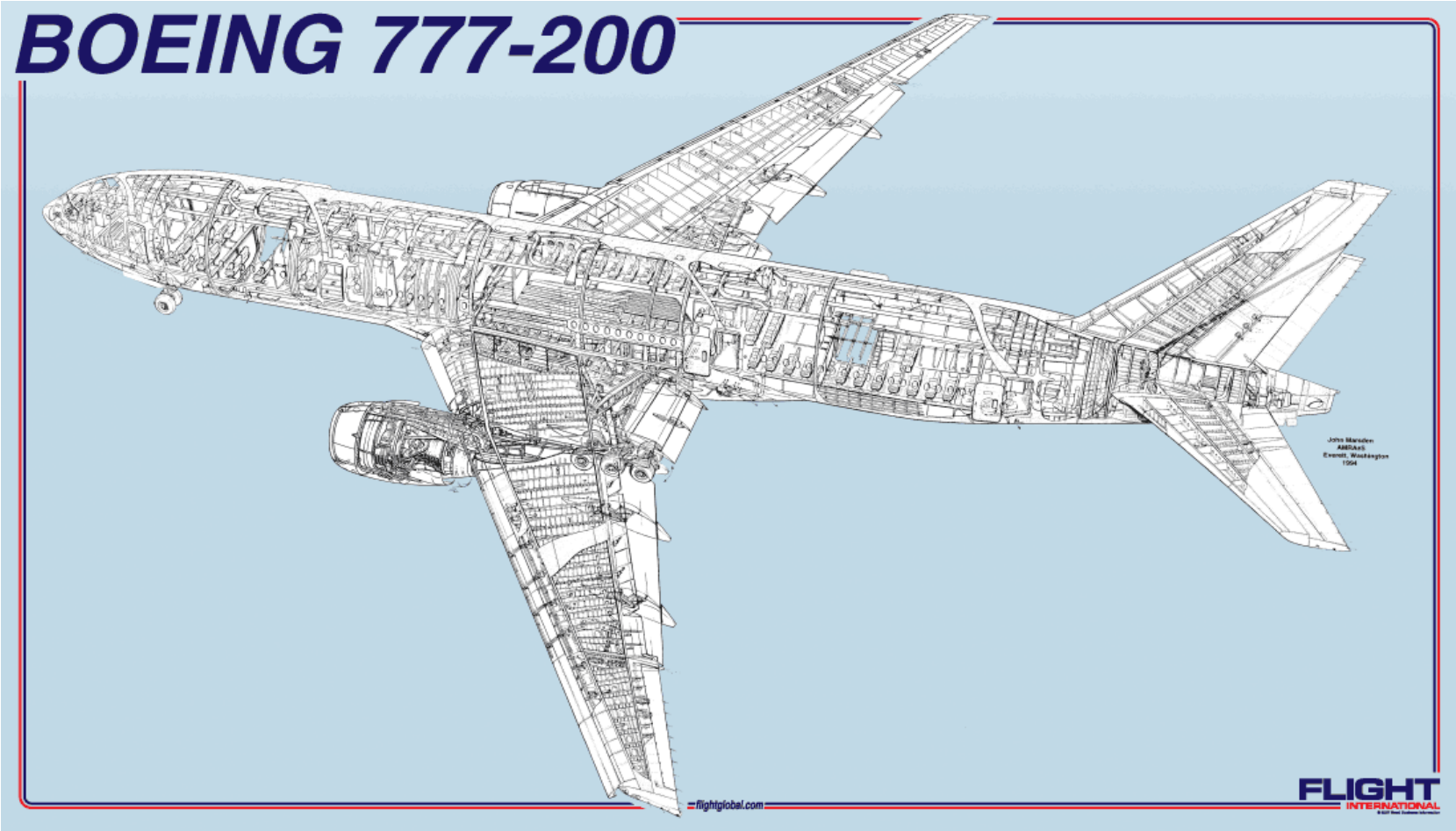
How long will a weapon be viable? What is its lifetime?

Weapons refurbishments consist of a mixture of reused, remanufactured and replacement components. We confront issues such as:

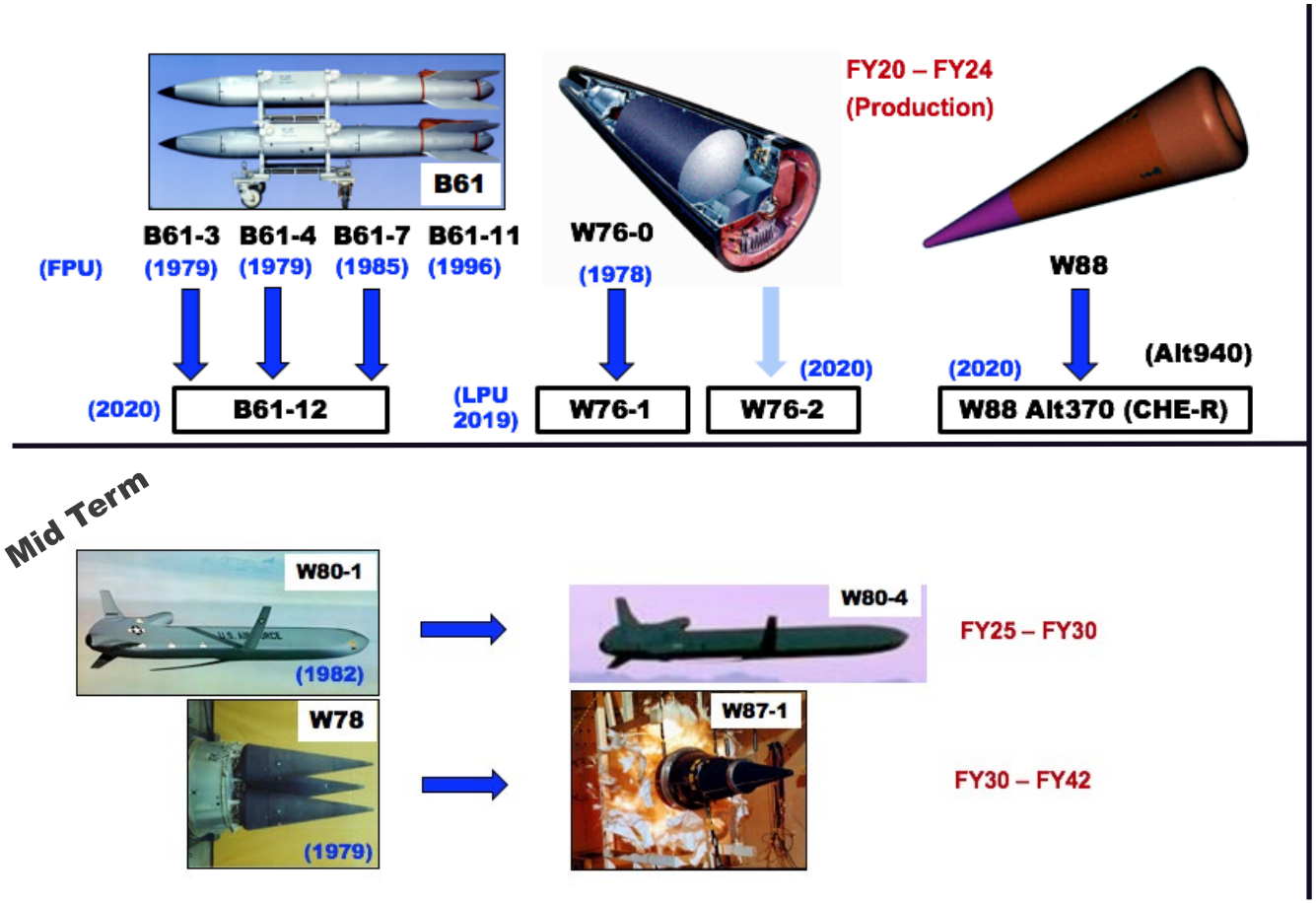
- **Commercial availability of materials**
- **Reemploying decades-old components**
- **Processes for remanufacturing components**
- **Limited experience base with some replacement components**
- **Certifying weapon performance under hostile nuclear threat environments**

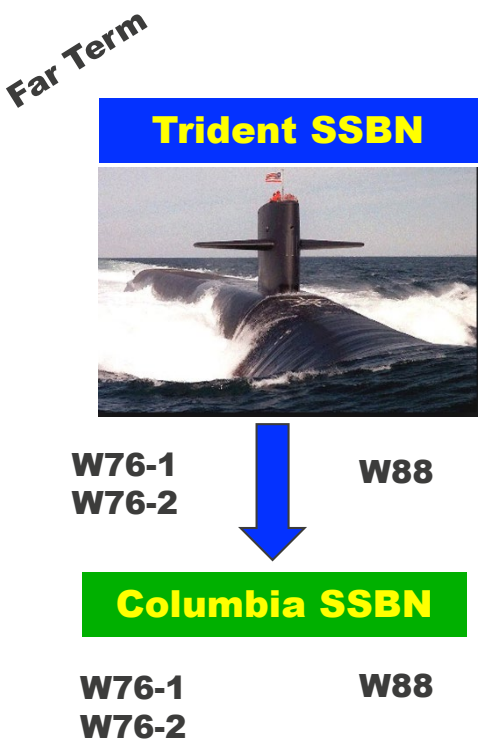
What options can be developed & certified w/o further nuclear testing?

Would you fly in it after its been parked for 20+ years?



Concept trades are being examined in the context of future weapon options





We see an enduring future for an integrated Laboratory

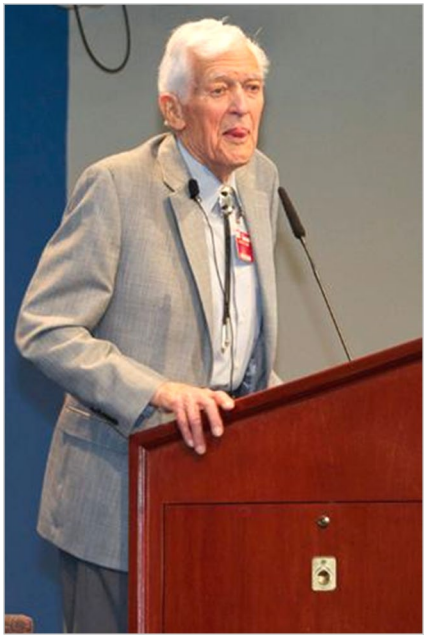
A Final Thought

"This Laboratory has always been something of a wonder.

Every one of you should be very proud that you are part of it.

Take note it does wonderful things.

Do well with it."



Rasmussen 1921-2017

Roger Rasmussen
Trinity eyewitness
LANL employee 1944-2005

Thank you!

Questions?

Email us: **NFO@lanl.gov**