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# Nuclear Fundamentals Orientation

## LANL Weapons Program Overview



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

# LANL Weapons Program Overview



## **Presentation Overview:**

- Our Science
- Guiding Principle of Los Alamos
- LANL the Design Laboratory
- Weapons Mission
- Science, Engineering and Computations
- Future Weapons Program R&D
- NNSA
- Aging Weapons
- A Final Thought
- Questions and Answers

# Our Science

# Guiding Principle of Los Alamos

“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



# LANL is 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 and will continue to play a critical role in deterring nuclear attack and in preventing large scale conventional warfare between nuclear armed states...”

- Former Secretary of Defense Jim Mattis, Nuclear Posture Review

# Los Alamos National Laboratory: A National Security Science Resource for the Nation

- To date, Los Alamos has designed and certified 46 of the 63 nuclear weapon systems put into the U.S. Stockpile
- Today's stockpile consists of 7 types of weapons
  - W76\* & W88\* are carried on Trident submarines
  - W78\* & W87 are carried on ICBMs
  - B61\* / B83 /W80\* are carried on an aircraft
- Annual Assessment Process
  - Technical assessment developed every year, presented in LANL briefings to the Deputy Director Weapons (DDW) and LANL Director
  - Leads to Director's Letter to DOE, DOD, President, on the state of LANL weapons

\* **LANL Designed Weapons**



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



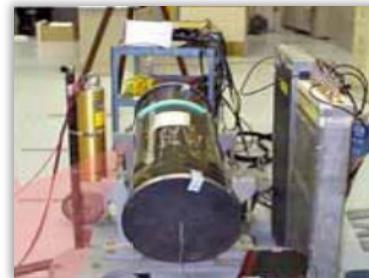
# Weapons Mission

A key component of the Weapon's mission is to provide expertise and tools for technical assessment in broader Global Nuclear Security

FOREIGN NUCLEAR



NUCLEAR COUNTERTERRORISM



NUCLEAR NONPROLIFERATION



NUCLEAR EMERGENCY RESPONSE



NUCLEAR FORENSICS



NUCLEAR CONSEQUENCE MANAGEMENT



- What are the other countries pursuing regarding nuclear weapons?
- How do we ensure we are providing accurate assessments in a timely manner?
- What response options should the U.S. have available?

# The mission demands the Laboratory's excellence for solutions to national security

In 2021

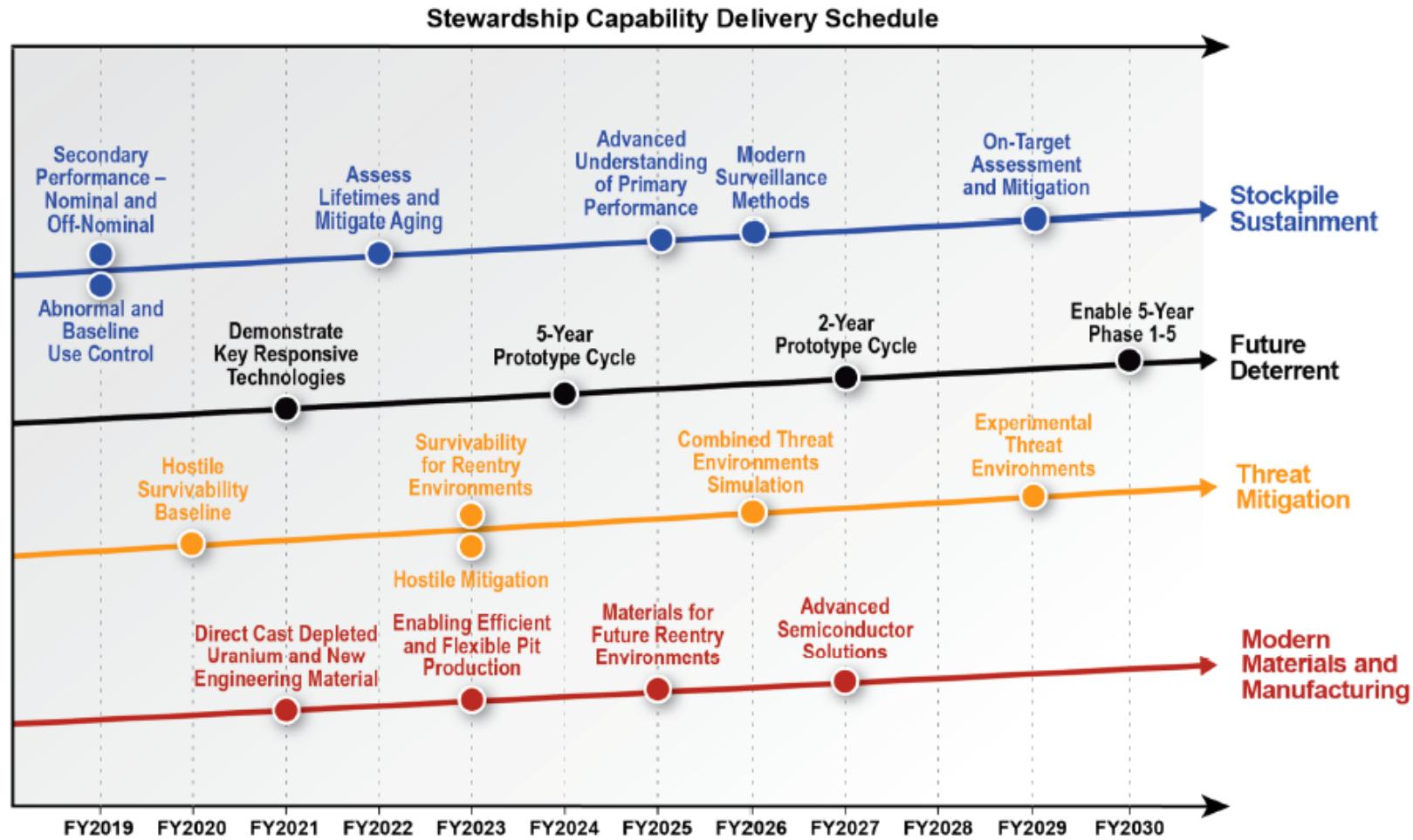
- ~ 13,400 employees
  - ~40% annual hires = PhDs
  - ~1,100 veterans
  - ~1,800 summer students
- ~\$3.8B Budget

- 36 square miles
- 47 technical areas
- 1,280 buildings/9M sq. ft.
- 11 nuclear facilities
- 268 miles of roads

**LANL is hiring @ 1,000 new employees annually**

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



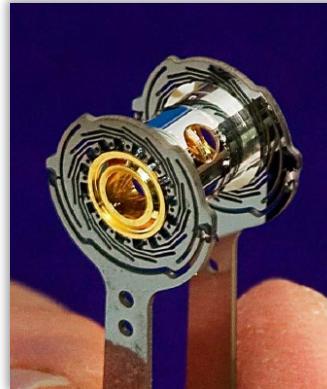
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# Science, engineering and computations underpins all national security work of the laboratory

- **Experiments:**

1,000s of experiments conducted annually to further our understanding and confidence in the stockpile



High Energy Density (HED) Experiments



- **Modeling and Simulation:**

World class computing hardware/software



- **Designer Judgement:**

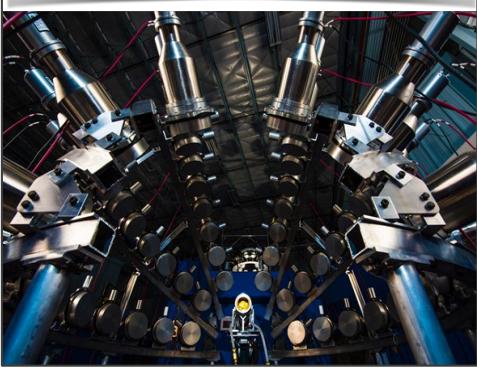
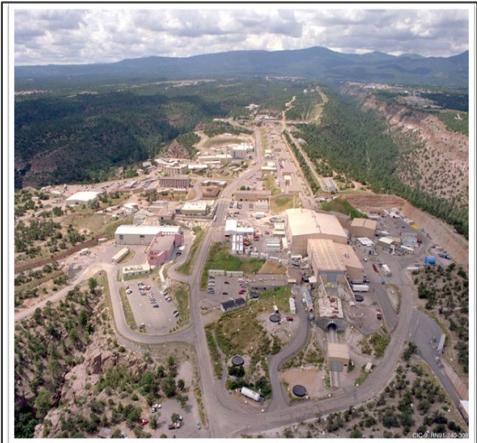
- Experimental data used to check judgement
- Train next generation



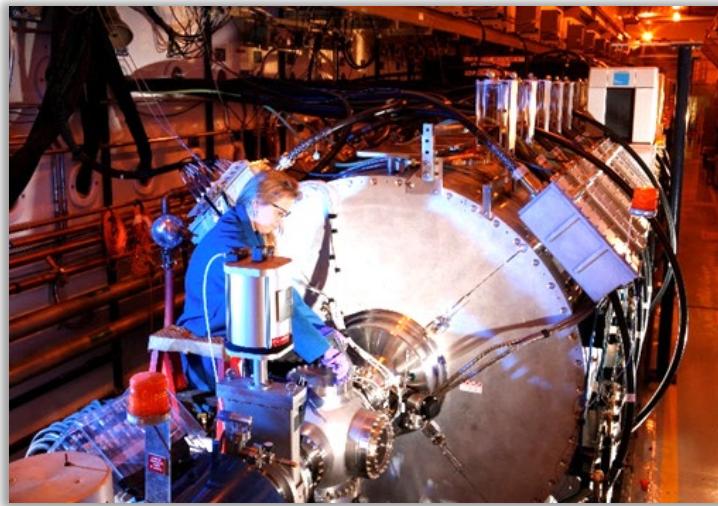
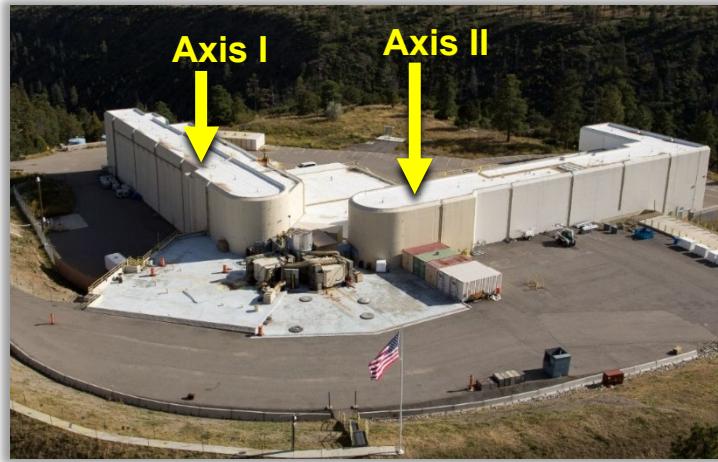
Large bore powder gun – measures differences in performance of weapon materials of interest.

# 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



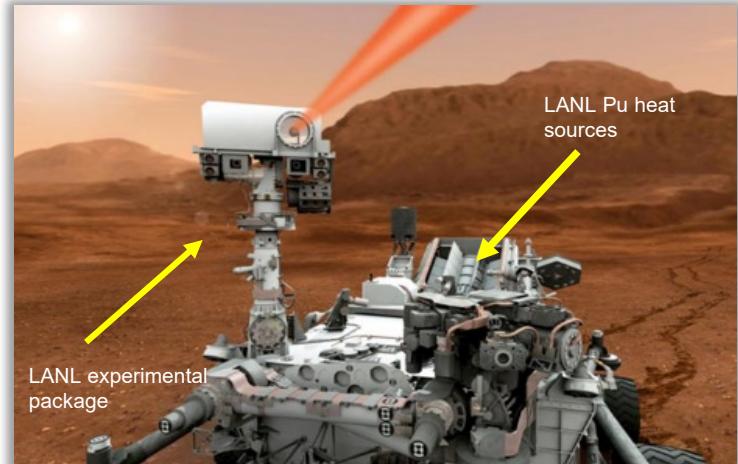
# Petascale Supercomputing is critical to Los Alamos' national security missions

- Stockpile challenges are increasingly complex as systems continue to age
- DARHT, LANSCE etc. provide large data sets to resolve stockpile challenges
- Data sets require ever more capable machines that can quickly process information
- Capacity and Capability machines
  - Trinity
  - Fire, Ice

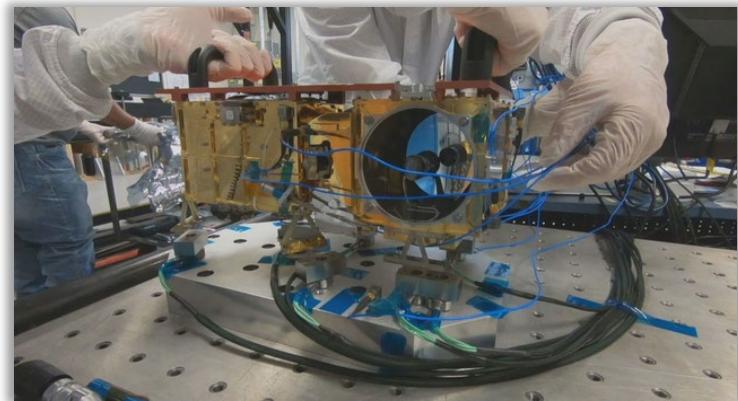


# Los Alamos: center for plutonium excellence and critical to science and security

- Deliver parts for LANL experimental science
- Deliver parts for DoD Mission
  - 30 pits per year 2026
  - Partner with STRATCOM, Global Strike, USAF, USN...
- Deliver parts for NASA and other federal agencies
- Provide technical options to meet new and emerging challenges
  - International Atomic Energy Agency (IAEA) training
  - Additive manufacturing



Mars Curiosity Rover



SuperCam for Mars 2020 mission

# Two recently published documents are suggesting some broadening of future Weapons Program R&D

**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.

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

### **The complex is being engaged to:**

- Identify both “evolutionary” improvements and “revolutionary” changes to current production processes
- Seek out innovations that would enable increased production throughput
- Develop more material-efficient production processes (lessen waste streams)

### **At the Labs, we are beginning to 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

**As the weapons enter their 4<sup>th</sup> decade of life, it is becoming increasingly more challenging to assess the weapons and project when they age out.**

## As weapons age:

- Components can deteriorate due to operational environments
  - Vibrations
  - Temperature cycling
  - Humidity
- Materials can change as a result of intrinsic radiation and chemical reactions
  - Plastics can become brittle
  - Adhesives can weaken
  - Metals can corrode, metal coatings can deteriorate
- Material physical properties can change.  
Loss of ductility, elasticity or strength

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

- Increasing number of materials in original weapon builds no longer commercially available
- Reuse of components can imply reemploying decades-old components
- Processes for remanufacturing components have evolved
- Experience base with particular replacement components may be limited
- Weapon performance must be certified under hostile nuclear threat environments

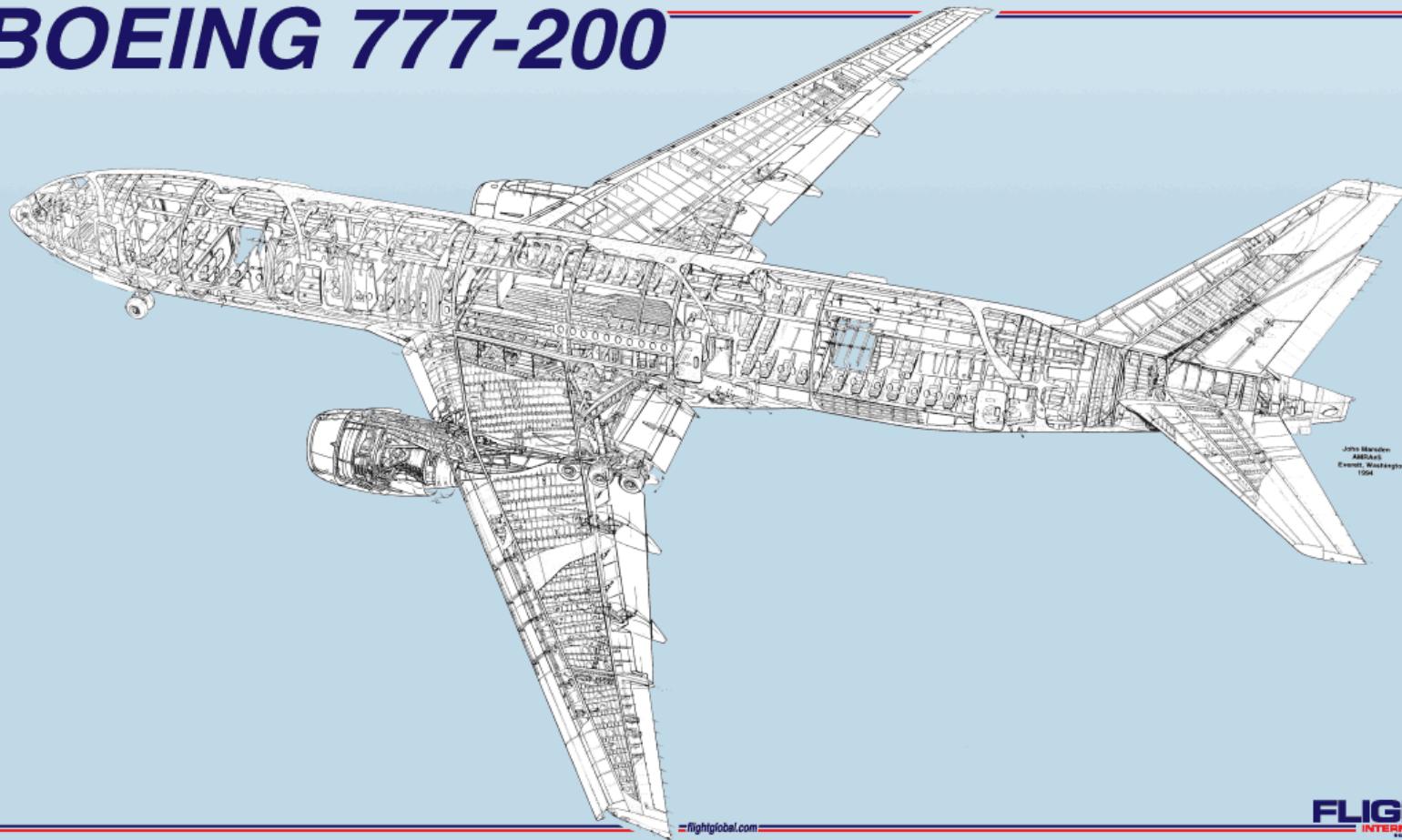
How long will a weapon be viable? What is its lifetime?

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



# Would you fly in it after it's been parked for 20+ years?

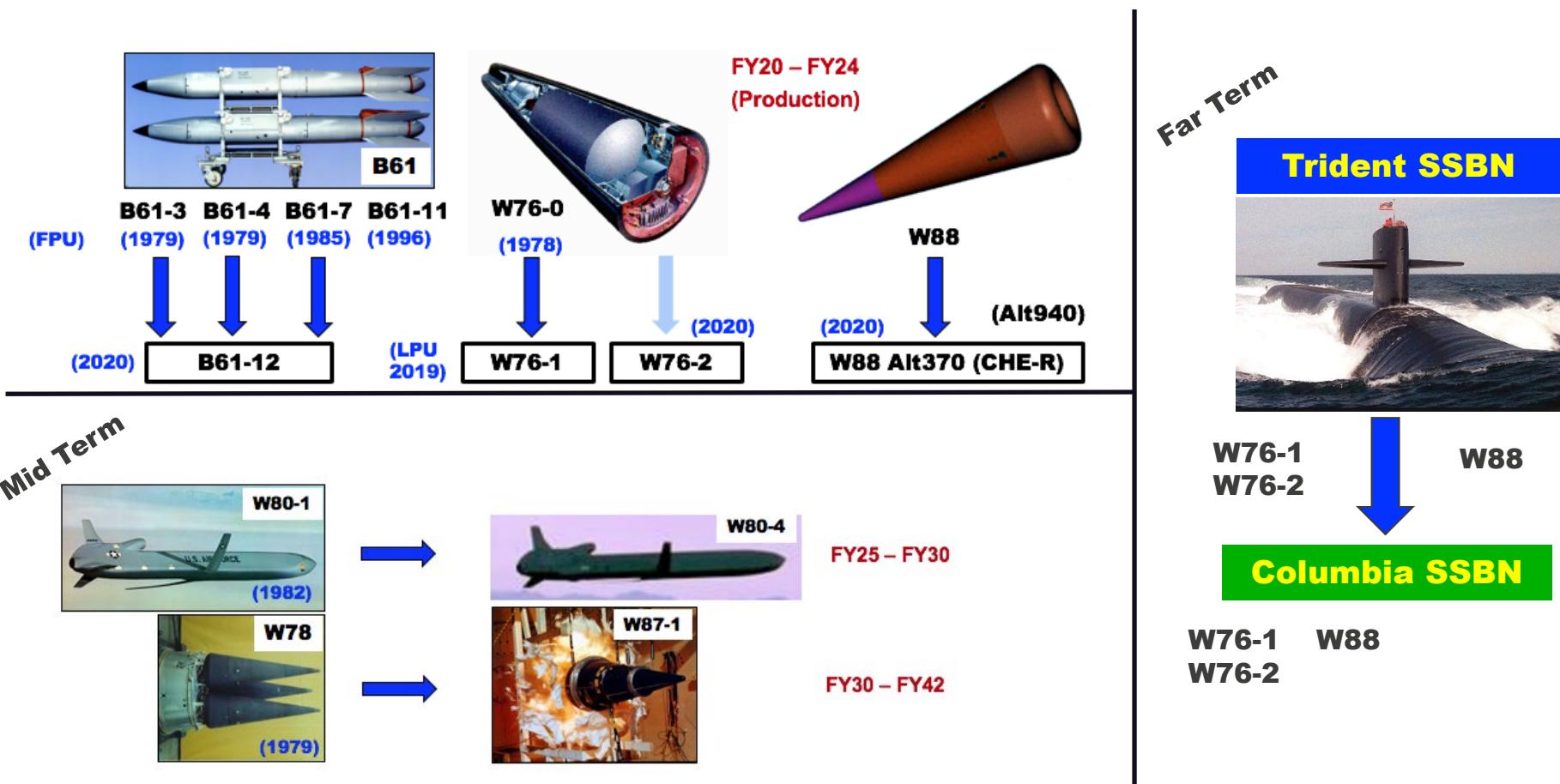
## BOEING 777-200



FLIGHT  
INTERNATIONAL  
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NFO

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

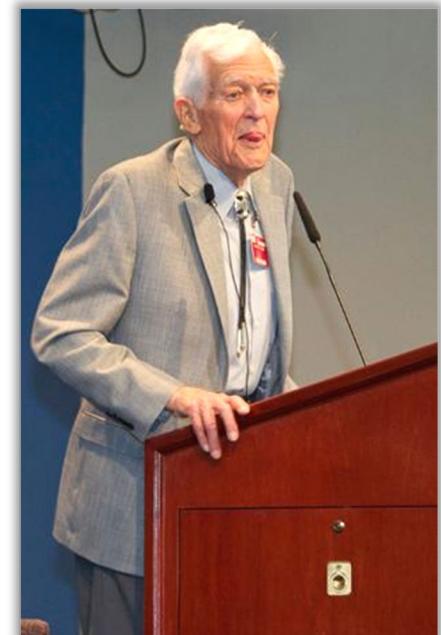


# We see an enduring future for an integrated Laboratory



# 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.”

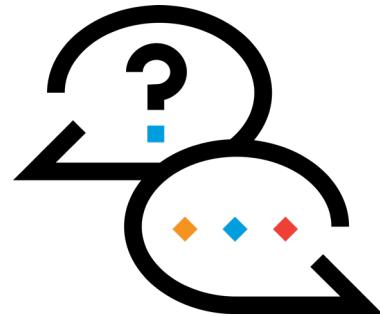


**Roger Rasmussen**  
Trinity eyewitness  
LANL employee 1944-2005

Rasmussen 1921-2017

# Thank you!

## Questions?



Email us: [NFO@lanl.gov](mailto:NFO@lanl.gov)