

STUDENTS, STEWARDS, AND THE STOCKPILE

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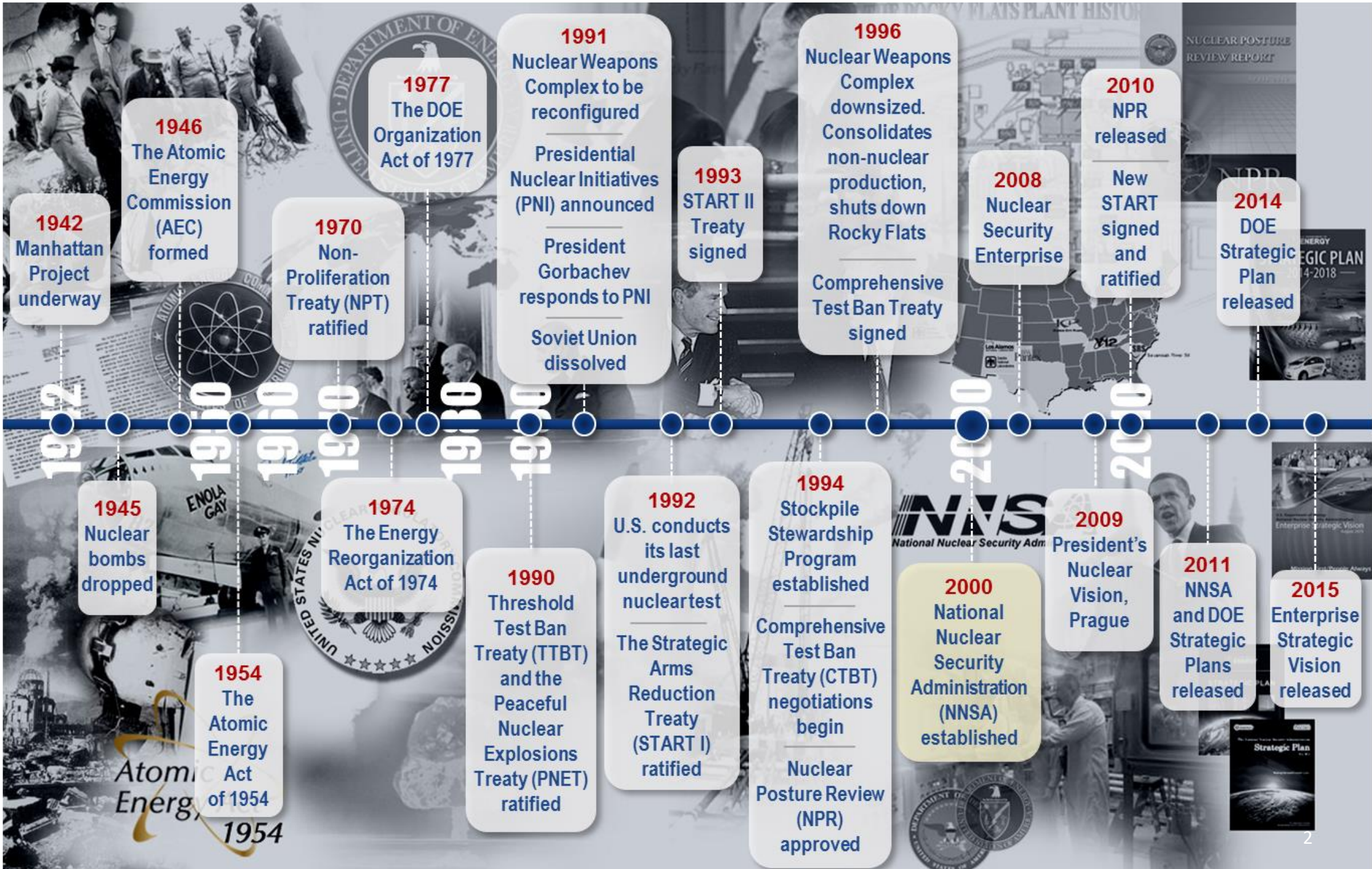
DIRECTOR

OFFICE OF EXPERIMENTAL SCIENCES

Presented at the 2019 SSGF/LRGF Annual Program Review

6/26/2019





1942
Manhattan Project underway

1946
The Atomic Energy Commission (AEC) formed

1970
Non-Proliferation Treaty (NPT) ratified

1977
The DOE Organization Act of 1977

1991
Nuclear Weapons Complex to be reconfigured
Presidential Nuclear Initiatives (PNI) announced
President Gorbachev responds to PNI
Soviet Union dissolved

1993
START II Treaty signed

1996
Nuclear Weapons Complex downsized. Consolidates non-nuclear production, shuts down Rocky Flats
Comprehensive Test Ban Treaty signed

2008
Nuclear Security Enterprise

2010
NPR released
New START signed and ratified

2014
DOE Strategic Plan released

1942

1945

1946

1970

1974

1977

1990

1991

1992

1993

1994

1996

2000

2008

2009

2010

2011

2014

2015

1945
Nuclear bombs dropped

1954
The Atomic Energy Act of 1954

1974
The Energy Reorganization Act of 1974

1990
Threshold Test Ban Treaty (TTBT) and the Peaceful Nuclear Explosions Treaty (PNET) ratified

1992
U.S. conducts its last underground nuclear test
The Strategic Arms Reduction Treaty (START I) ratified

1994
Stockpile Stewardship Program established
Comprehensive Test Ban Treaty (CTBT) negotiations begin
Nuclear Posture Review (NPR) approved

2000
National Nuclear Security Administration (NNSA) established

2009
President's Nuclear Vision, Prague

2011
NNSA and DOE Strategic Plans released

2015
Enterprise Strategic Vision released

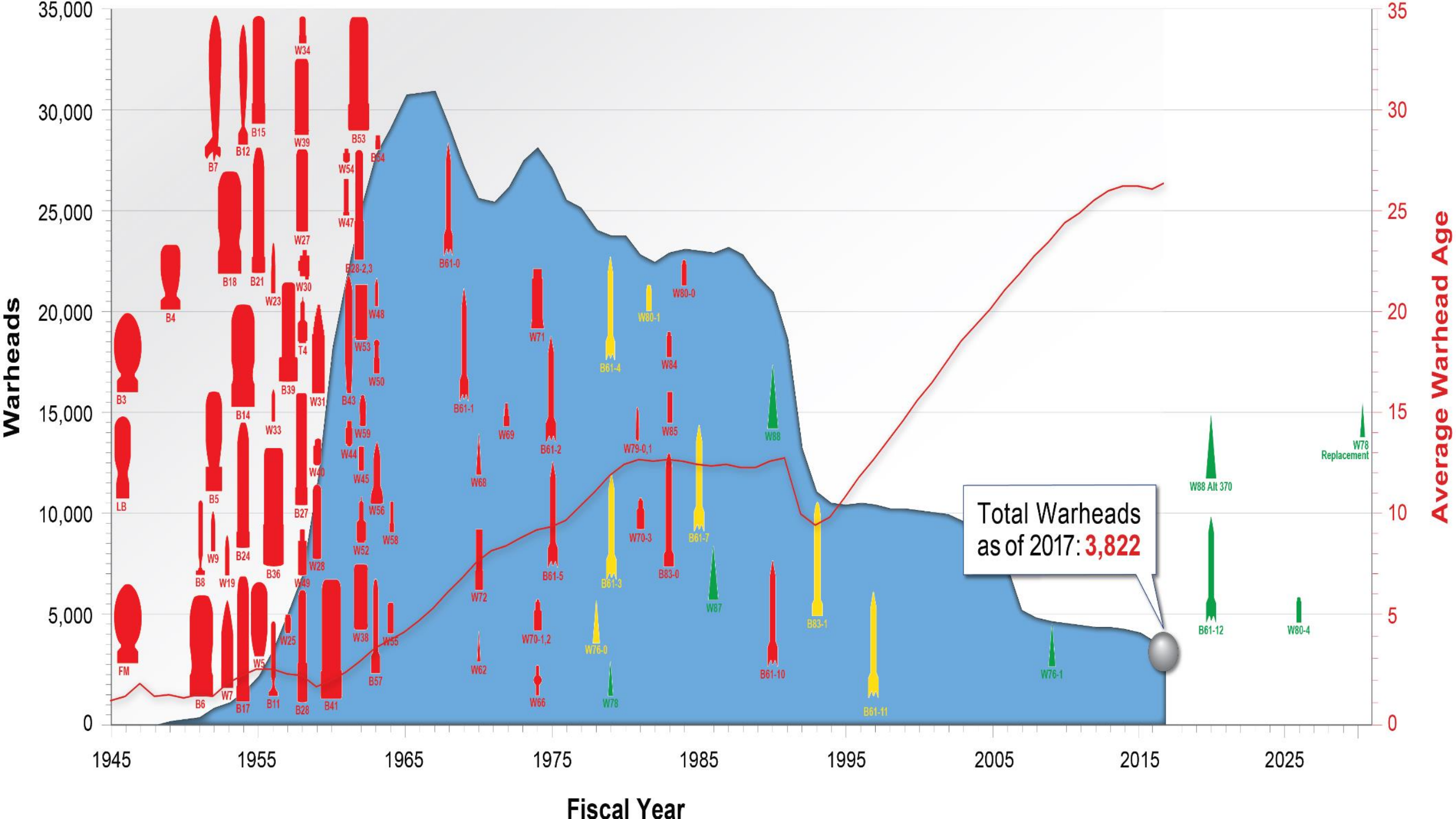
Atomic Energy 1954

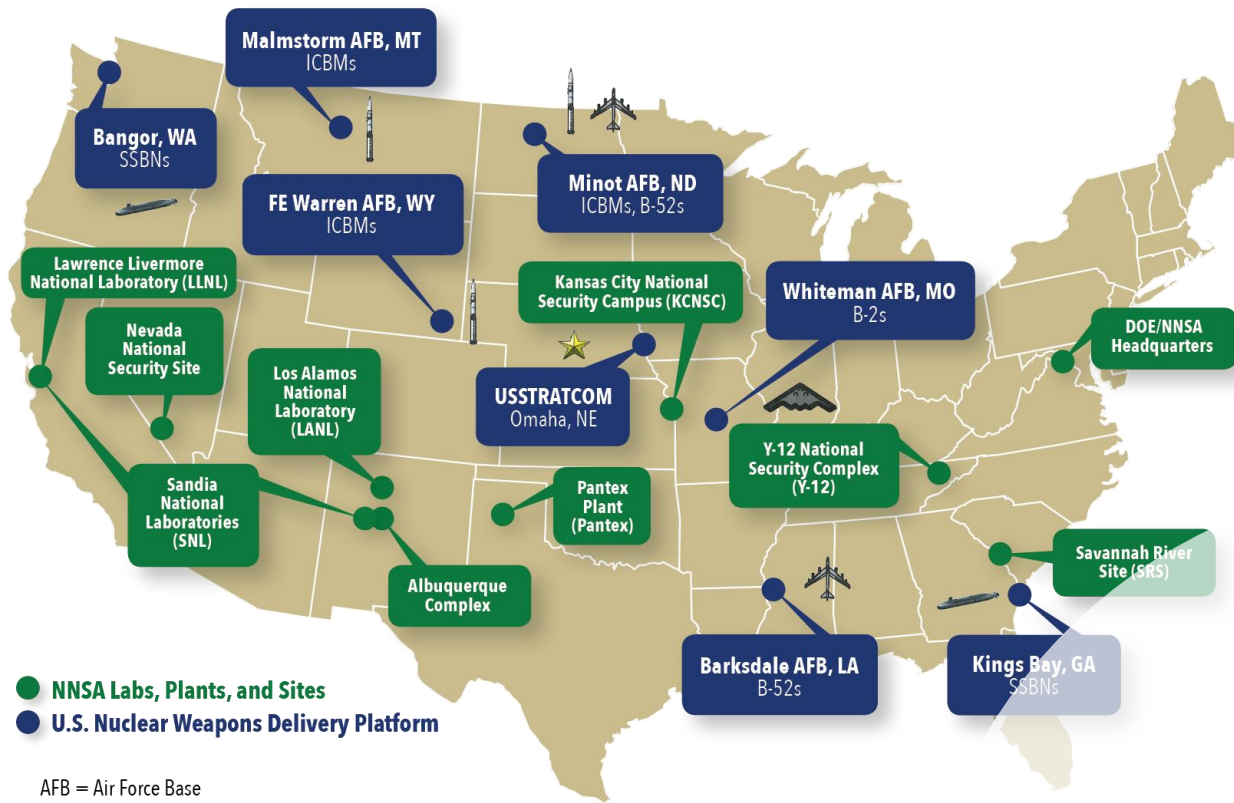
NUCLEAR POSTURE REVIEW REPORT

ENERGY STRATEGIC PLAN 2014-2018

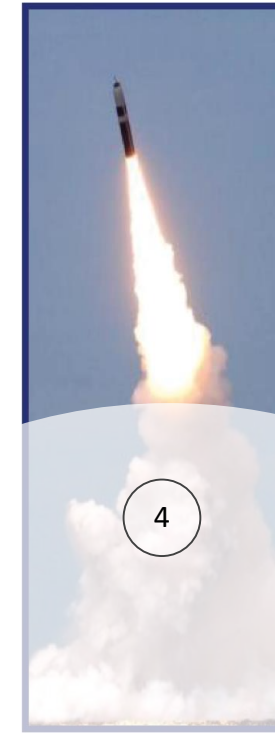
NNSA National Nuclear Security Administration







AFB = Air Force Base
 ICBM = intercontinental ballistic missile
 SSBN = ship, submersible, ballistic, nuclear (ballistic missile submarine)
 USSTRATCOM = U.S. Strategic Command



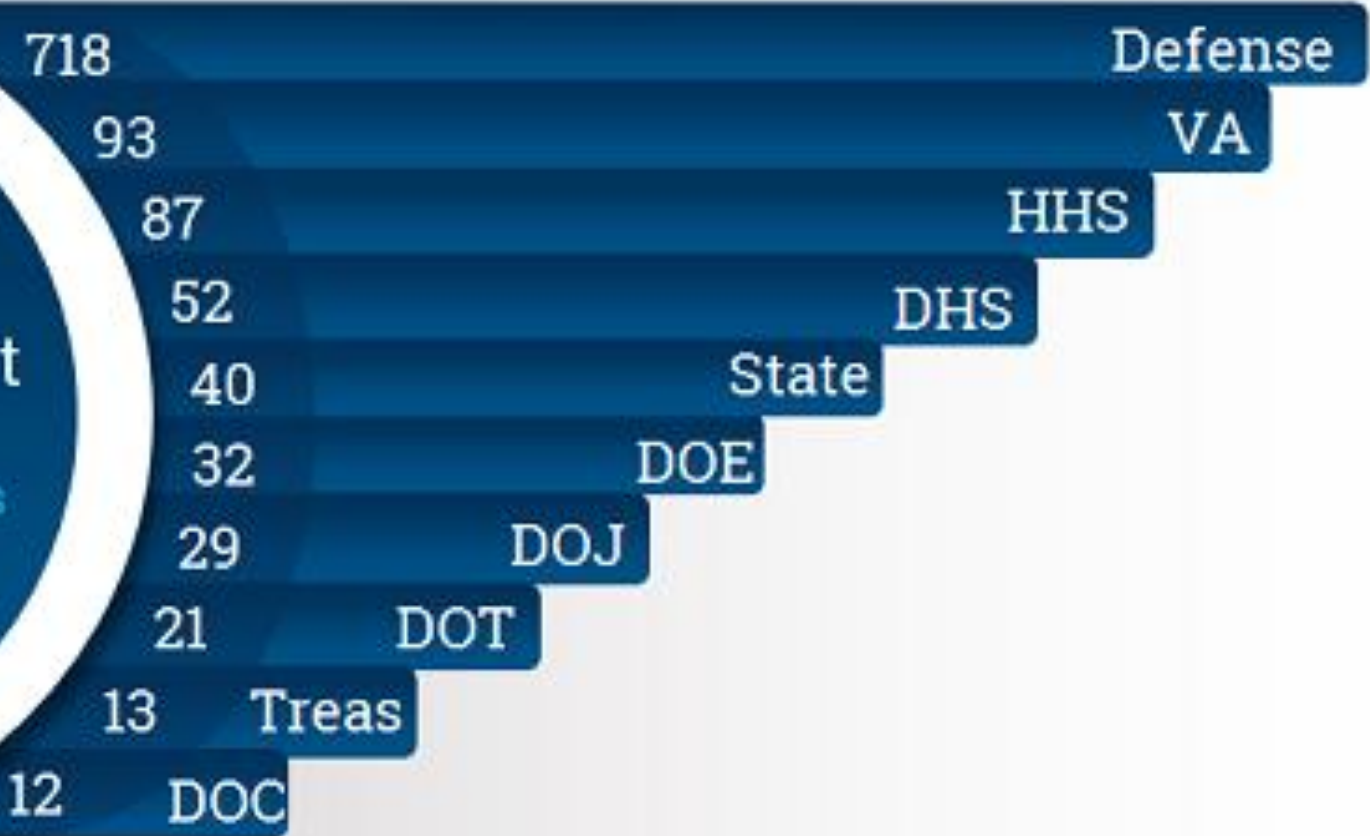
U.S. Nuclear Weapons and Delivery Platforms

- Establish military requirements
- Design, develop, test, and produce delivery system
- Operate complete nuclear weapons system
- Secure and maintain nuclear weapons
- Train personnel and plan for employment



- Maintain safety, security, and effectiveness of the stockpile
- Research and develop nuclear weapon science, technology, and engineering
- Support stockpile levels
- Validate warhead safety and assess reliability
- Produce and manage nuclear materials





Source: OMB, Deltek



U.S. DEPARTMENT OF
ENERGY



Senate Energy and Water Development
Senate Committee on Armed Services



House Energy and Water Development, and Related Agencies
House Committee on Armed Services



Nuclear Deterrence: the
cornerstone of our nation's
security posture

Rick Perry

- 14th United States Secretary of Energy
- Tasked with maintaining a safe, secure and effective nuclear deterrent and reducing the threat of nuclear proliferation, overseeing the United States' energy supply, carrying out the environmental clean-up from the Cold War nuclear mission, and managing the 17 National Laboratories
- Confirmed – March 2, 2017
- Former Governor of Texas (2000-2015), former Lieutenant Governor of Texas (1998-2000)

“Nuclear deterrence has been, and remains, the cornerstone of our nation’s security posture and among the highest priority missions at the Department of Energy”

- Energy Secretary Rick Perry

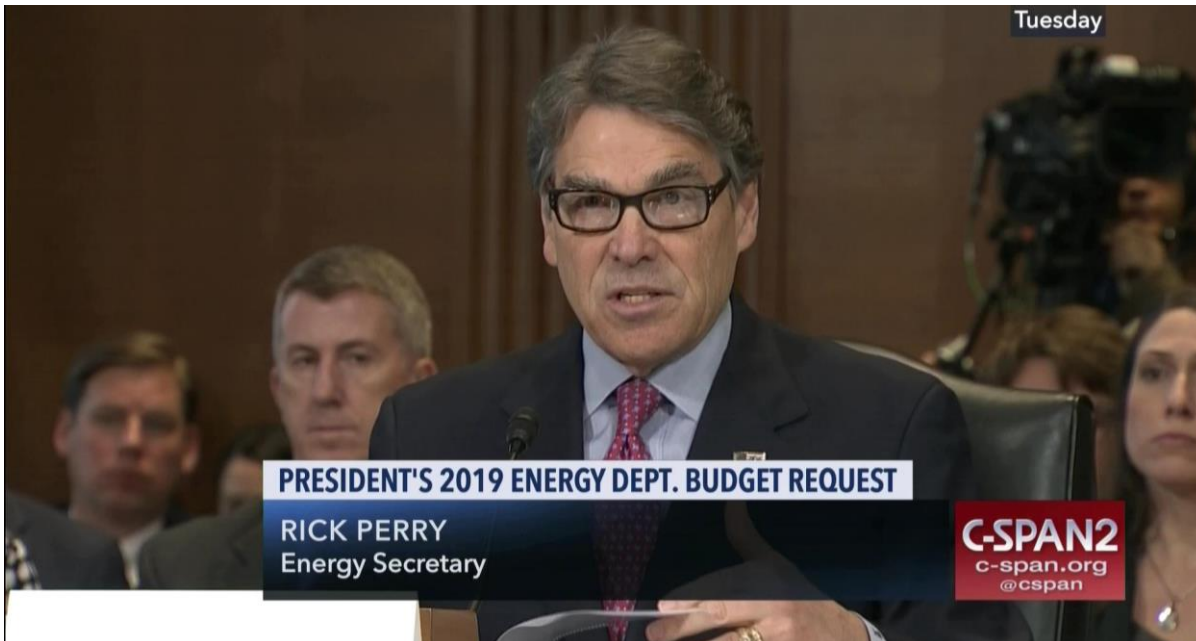
DEPARTMENT OF ENERGY

DOE Programs

• National Nuclear Security Administration	15,091
• Science	5,391
• Energy	2,515
• Environmental Management	6,601
• Other Defense Activities	853
• Administration and Oversight	293
• <i>Savings and Receipts</i>	-137

DOE Total

FY19 (\$M)
30,609



PRESIDENT'S 2019 ENERGY DEPT. BUDGET REQUEST

RICK PERRY
Energy Secretary

C-SPAN2
c-span.org
@cspan

NNSA's enduring missions remain vital to the national security of the United States

Lisa E. Gordon-Hagerty

- Under Secretary for Nuclear Security of the U.S. Department of Energy and Administrator of the National Nuclear Security Administration
- Responsible for the management and operations of NNSA in support of the Administrations nuclear agenda.
- Confirmed – February 15, 2018
- 30 Years of National Security Experience, including Director of Combating Terrorism, National Security Council; health physicist at DOE Livermore Laboratory; President, Tier Tech International, Inc. and CEO of LEG, Inc.





NATIONAL NUCLEAR SECURITY ADMINISTRATION

NNSA Programs	FY19 (\$M)
• Weapons Activities	11,017
• Defense Nuclear Nonproliferation	1,863
• Naval Reactors	1,789
• Federal Salaries and Expenses	423
NNSA Total	15,091



DOE/NNSA Mission Pillars and Cross-cutting Capabilities





Creating a more responsive
and resilient NNSA enterprise

Dr. Charles P. Verdon

- NNSA Deputy Administrator for Defense Programs
- Leads the team that directs the Stockpile Stewardship Program
- Confirmed – Sept. 18, 2018
- Sworn in – Oct. 9, 2018
- Former Principal Associate Director, Weapons and Complex Integration Directorate, LLNL

Goal: **To develop a vision, strategy, and execution plan for a more responsive and resilient NNSA enterprise**



NUCLEAR POSTURE REVIEW



2018

A Posture of “Continuity Plus”

- Continuity – Current Weapons Activities:
 - Continuing Warhead Life Extensions
 - Restoring Strategic Materials Capabilities
 - Modernizing and Recapitalizing Infrastructure
- Plus -- The FY 2019 Request positions NNSA to support new NPR initiatives
 - W76-2 Low-Yield SLBM
 - Sea-Launched Cruise Missile (SLCM)
 - B83-1
 - W78 Replacement
- To achieve – A modern, robust, flexible, resilient, ready, and tailored deterrent; and provide the President with maximum strategic flexibility.

Defining responsive and resilient

- **Responsive** – The capability and capacity of the NNSA nuclear enterprise to respond in a timely manner to technical and/or geopolitical surprise
- **Resilient** – The capability of the NNSA nuclear enterprise to recover from an insult (repair or production outage) in a timely manner



Investing in a Responsive Nuclear Security Enterprise



Los Alamos National Laboratory



Los Alamos, NM

- 7,574 M&O Employees
- 77 Federal Employees
- Nuclear design/physics lab
- Pit production
- Pu sustainment
- Design agency for the B61, W76, W78, and W88



Lawrence Livermore National Laboratory



Livermore, CA

- 5,196 M&O Employees
- 74 Federal Employees
- Nuclear design/physics lab
- High explosive R&D Center of Excellence
- Design agency for the W80, W87, and B83



Sandia National Laboratories



Albuquerque, NM and Livermore, CA

- 11,358 M&O Employees
- 84 Federal Employees
- Systems engineering
- Neutron generator design and production
- Non-nuclear component design



Nevada National Security Site



Nevada

- 2,426 M&O Employees
- 76 Federal Employees
- Experimental site
- "Subcritical" nuclear material experiments



Pantex Plant



Amarillo, TX

- 3,246 M&O Employees
- 61 Federal Employees
- Weapons assembly/disassembly
- High explosive production Center of Excellence



Y-12 National Security Complex



Oak Ridge, TN

- 4,501 M&O Employees
- 65 Federal Employees
- Uranium component and sub-assembly production
- Uranium Center of Excellence



Kansas City National Security Campus



Kansas City, MO

- 2,574 M&O Employees
- 38 Federal Employees
- Nonnuclear component manufacturing/procurement



Savannah River Site



Aiken, SC

- 1,641 M&O Employees
- 25 Federal Employees
- Tritium operations
- TPBAR extraction
- Reservoir change-out



01

Ensuring confidence in the currently deployed stockpile

02

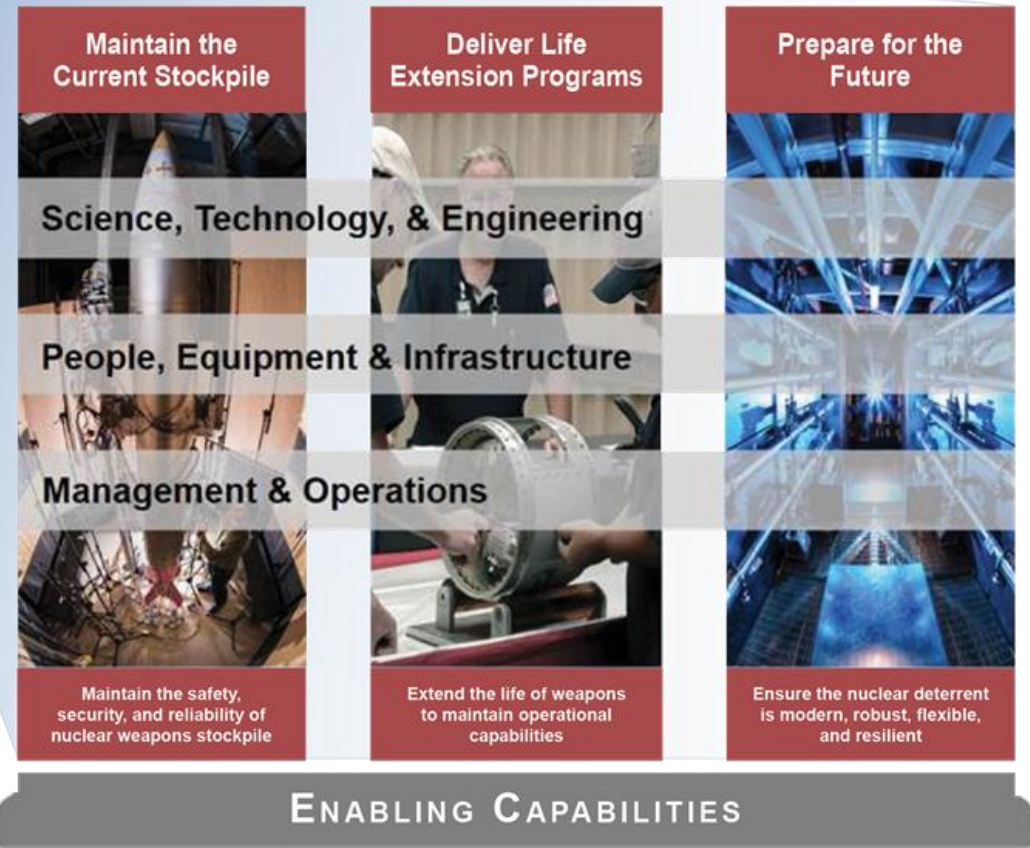
Carrying out life extension programs and major MODs as required

03

Implementing additional deterrent options as directed

NNSA responsibility requires a sustained ST&E investment

Defense Programs Mission Pillars and Cross-cutting Capabilities





Defense Programs Mission Pillars
and Cross-cutting Capabilities are
essential to Stewardship

Assistant Deputy Administrator for Research, Development, Test and Evaluation for Defense Programs, NNSA

Science Supporting Weapons Activities

Enduring Stockpile

- Advances scientific methods for nuclear weapons assessments
- Develops advanced capabilities to enable the resolution of significant finding investigations

Life Extension and Responsiveness

- Explores initial concepts to enable life-extension modifications to the stockpile
- Researches and develops new technologies for future stockpile needs

Knowledge Base and Infrastructure

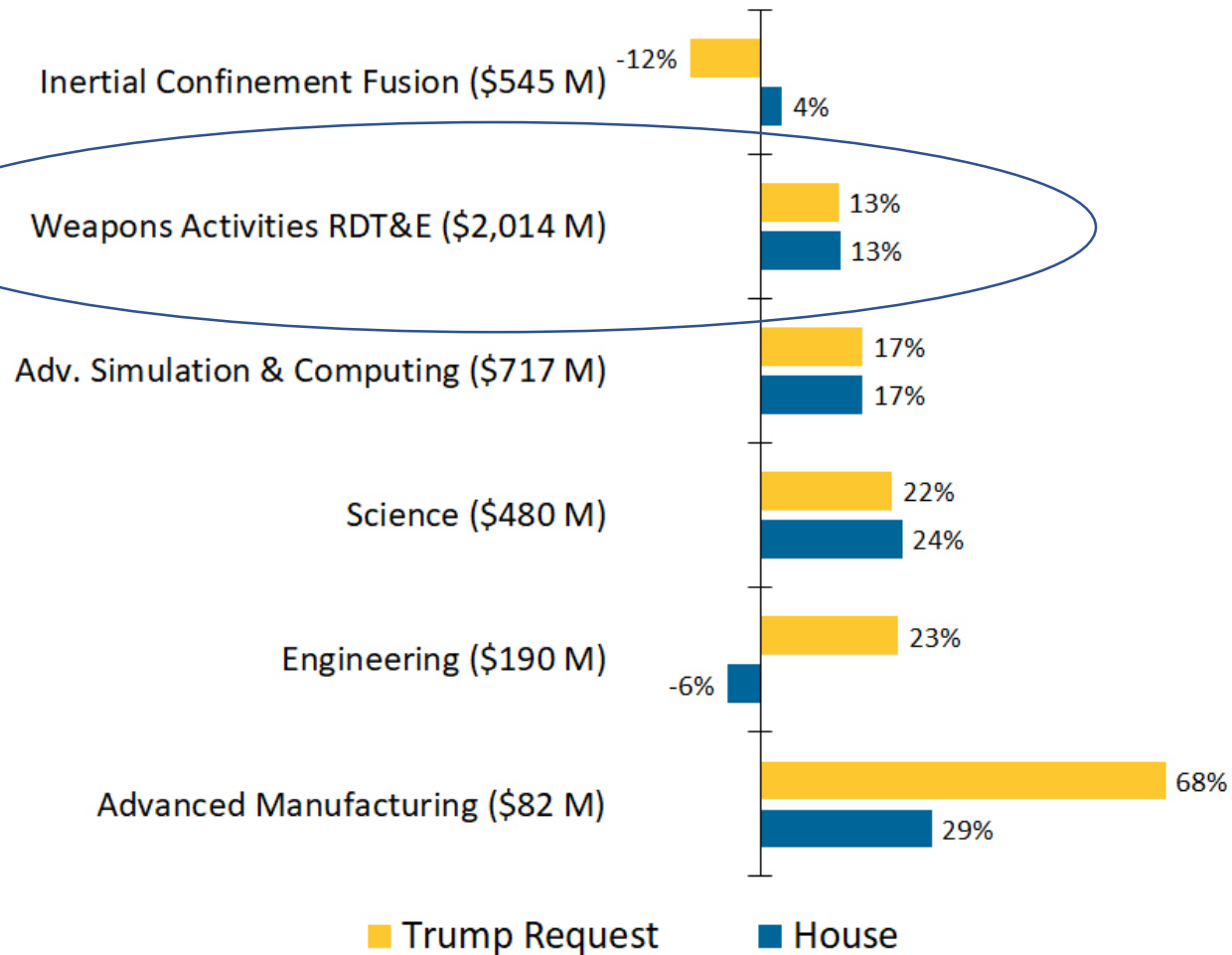
- Preserves the U.S. core intellectual and technical competencies in nuclear weapons
- Recruits and trains new generation of scientists, engineers, and technicians

Broad National Security Mission

- Leverages resources to address emerging nuclear security threats
- Supports the assessment of foreign and adversary nuclear weapons for intelligence activities

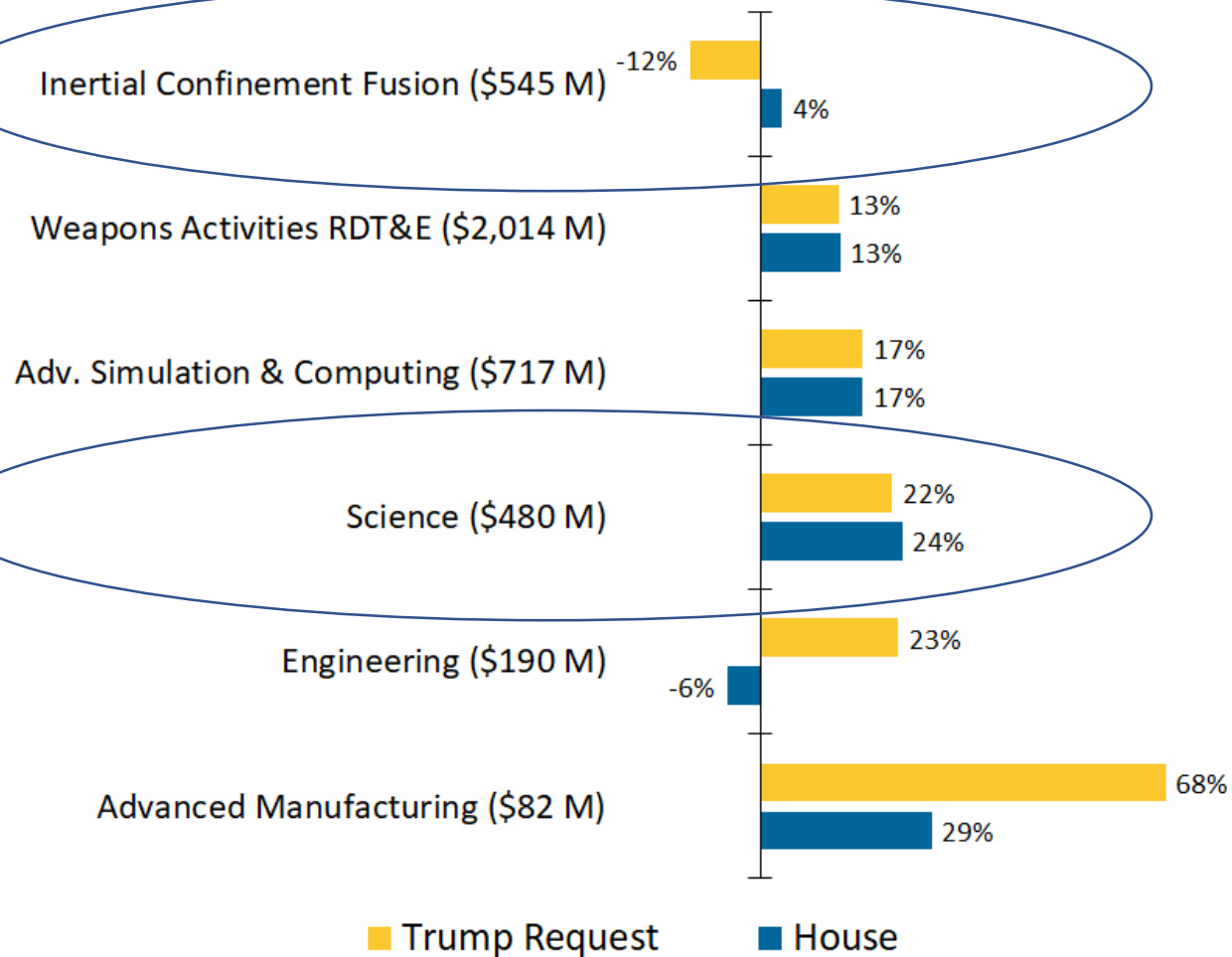
FY20 Budget Proposal: NNSA Weapons RDT&E

\$ in () are the FY19 amounts



FY20 Budget Proposal: NNSA Weapons RDT&E

\$ in () are the FY19 amounts



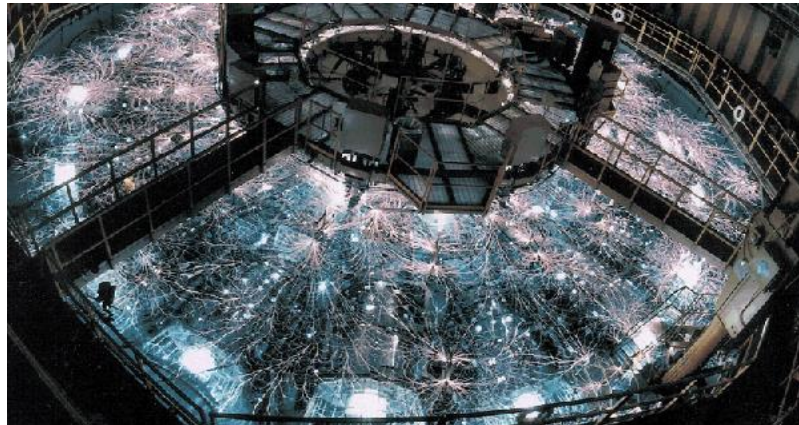
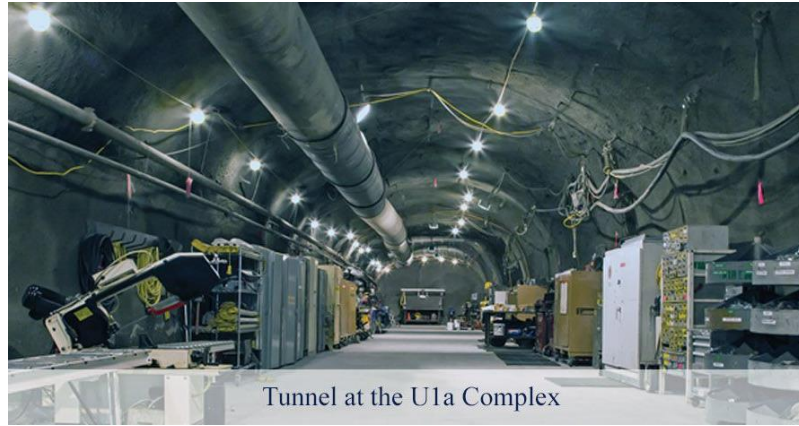
The **Office of Experimental Sciences** manages new scientific research and combines it with existing data from stockpile surveillance, past nuclear tests, and computer simulations to improve NNSA's models of nuclear weapons phenomena and performance.

Experimental Sciences Snapshot

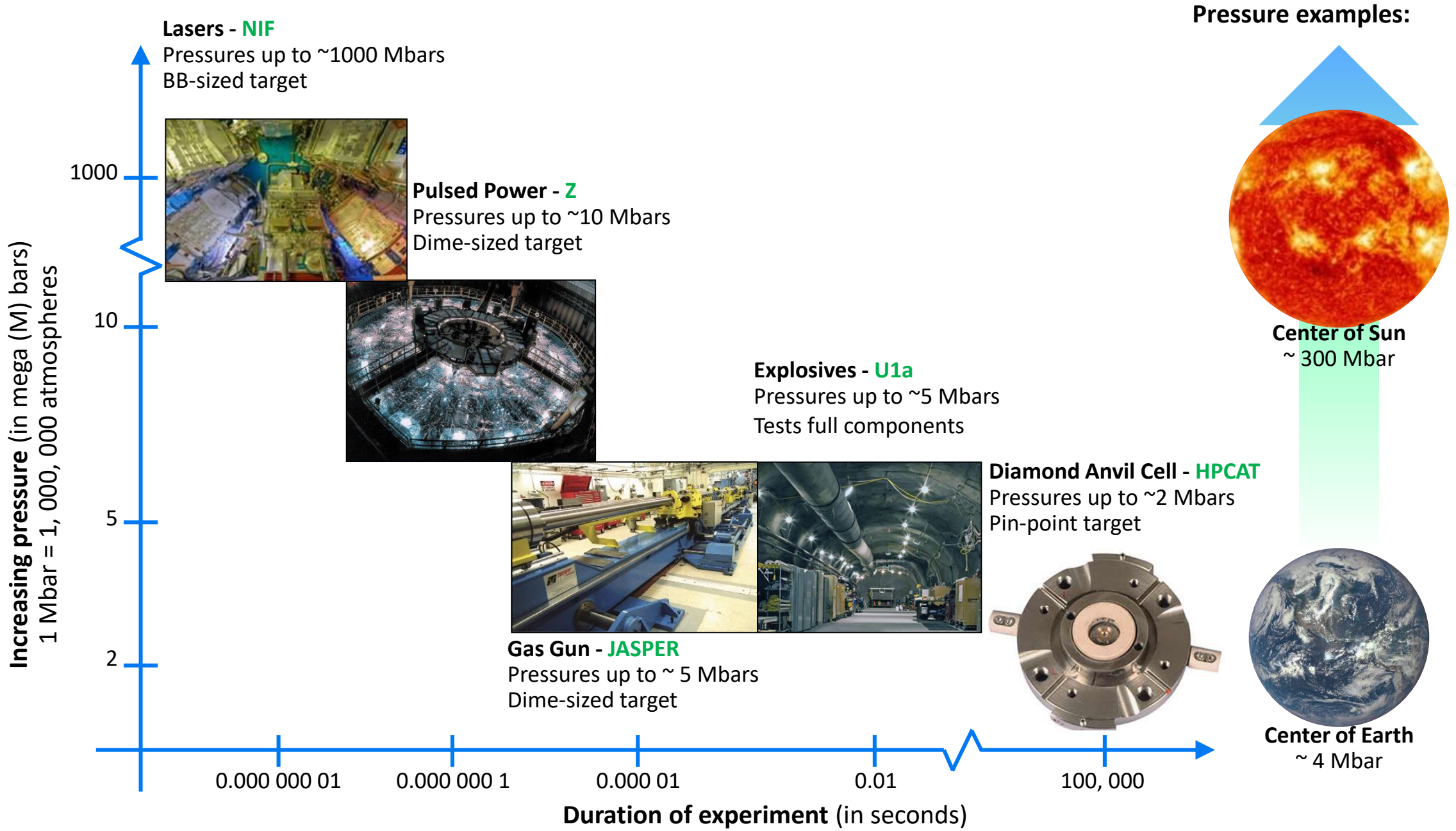


- ▤ HED Facility O&M
- ▣ ECSE
- Ignition R&D
- Science R&D

- The OES supports stockpile stewardship through:
 - Understanding primary and secondary performance for stewardship of the evolving stockpile.
 - Studying dynamic material response under extreme conditions.
 - Providing diagnostics to maintain confidence in current and future stockpile.
 - Conducting hydrodynamic experiments, including Sub-Critical Experiments to advance and validate primary models.
 - Providing certifiable design options
 - Enabling the assessment and certification of stockpile life-extension options
 - Expanding the understanding of impacts of new material processing and plutonium (Pu) aging



Multiple NNSA High Pressure Research Facilities are required to verify material response over stockpile-relevant conditions



Academic Programs are a gateway to NNSA ...

- 1) Stewardship Science Academic Alliances
- 2) National Laser Users' Facility
- 3) Predictive Science Academic Alliance Program
- 4) Minority Serving Institution Partnership Program
- 5) Stewardship Science Graduate Fellowship
- 6) High Energy Density Laboratory Plasmas*
- 7) Computational Science Graduate Fellowship*

**Joint programs with DOE Office of Science*

Why SSAP is critical to SSP

- Sustaining the deterrent through stockpile stewardship requires a workforce at the cutting edge of weapons science problems:
 - Experimentalists, diagnosticians, and theorists to discover the physics underlying the stockpile
 - Experimental and engineering teams to operate the facilities
 - A cadre of people to develop a predictive capability with large unique computers
- The SSAP will train the next generation of stockpile stewards
 - Trains students in key areas relevant to stewardship not supported by other agencies
 - Offers the highest caliber of education and hands-on training and experience to the next generation of scientist and physicists; provides exposure to NNSA mission challenges
 - Recruits superior candidates for DOE/NNSA labs
- Contributes to the Nation's base of scientists and engineers leading in their fields
 - Over 6,000 peer-reviewed articles published since 2002



Supporting Research and Researchers

- Academic Fellowships

- Stewardship Science Graduate Fellowship (SSGF)
- New in FY18 - Laboratory Residency Graduate Fellowship (LRGF)
- Computational Science Graduate Fellowship (CSGF, with DOE Office of Science)



Approximately half of the 38 alumni from the SSGF program have gone on to careers at one of the national laboratories or other government agencies

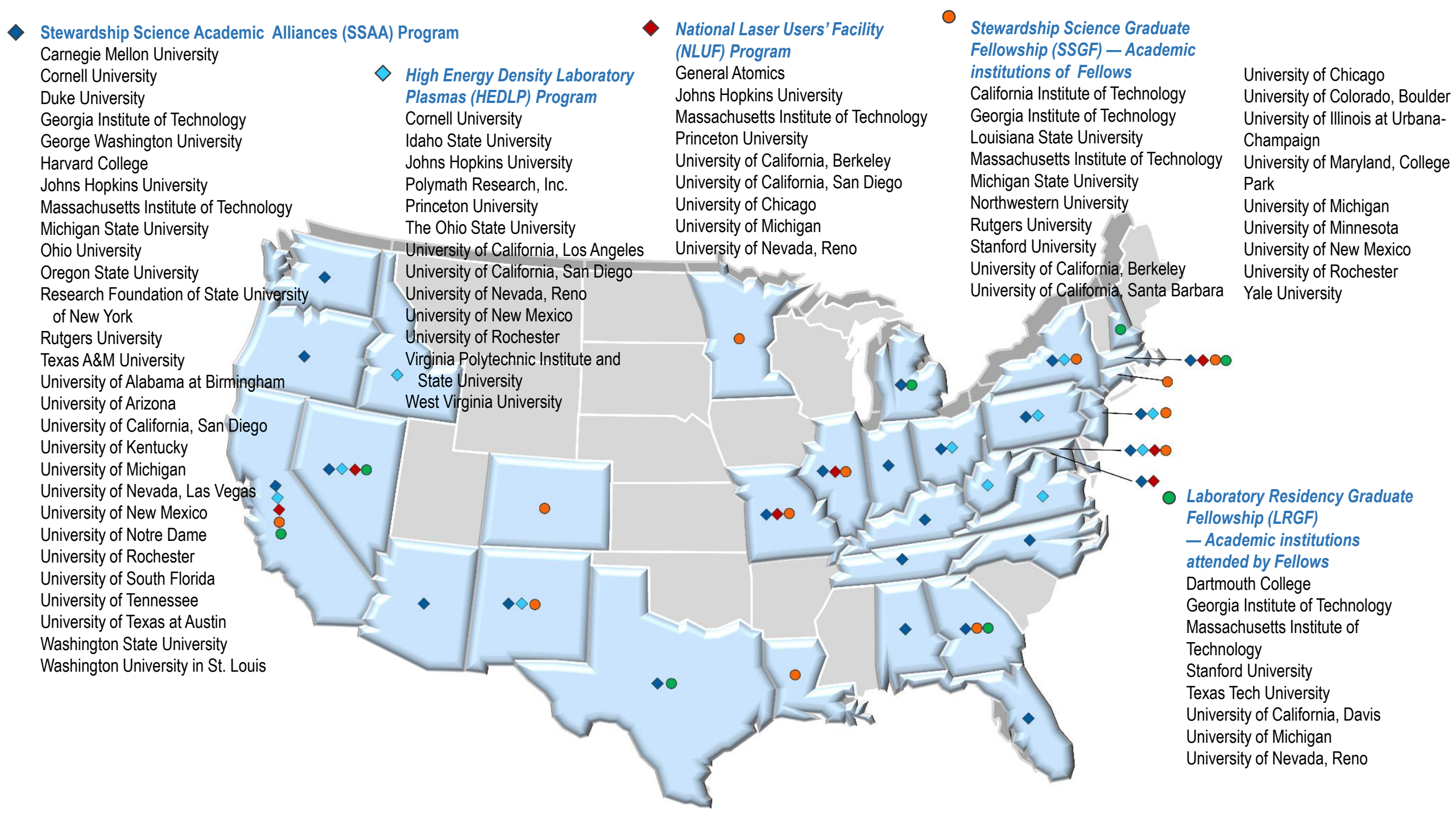
- Academic Research Grants and Centers

- SSAA Centers of Excellence

- Cornell University
- George Washington University
- Texas A&M University (LENS)
- Texas A&M University (Materials)
- University of California, San Diego
- University of Notre Dame
- University of Texas at Austin
- University of Michigan
- MIT

- PSAAP Centers of Excellence

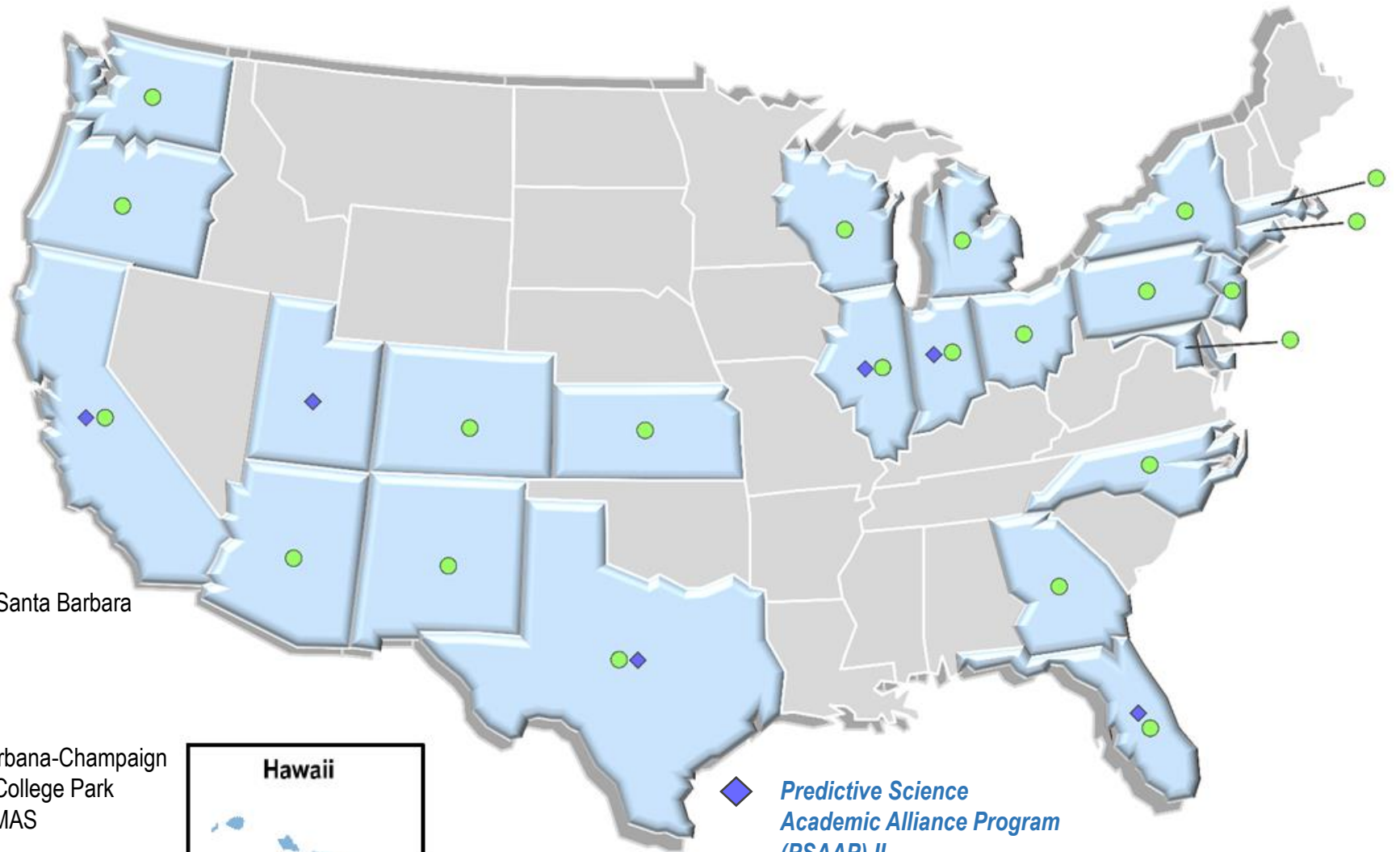
- Stanford
- Texas A&M
- University of Florida
- Notre Dame
- University of Utah
- University of Illinois, Urbana-Champaign




● **Computational Science Graduate Fellowship (CSGF)**
 Joint Program with the DOE Office of Science

- California Institute of Technology
- Carnegie Mellon University
- Colorado State University
- Columbia University
- Cornell University
- Duke University
- Georgia Institute of Technology
- Harvard University
- Kansas State University
- Massachusetts Institute of Technology
- Michigan State University
- New York University
- Northwestern University
- Ohio State University
- Oregon State University
- Princeton University
- Purdue University
- Stanford University
- Stony Brook University
- Texas A&M University
- University of Arizona
- University of California, Berkeley

- University of California, Santa Barbara
- University of Chicago
- University of Colorado
- University of Georgia
- University of Hawaii
- University of Illinois at Urbana-Champaign
- University of Maryland, College Park
- University of Miami, RSMAS
- University of Michigan
- University of New Mexico
- University of Pennsylvania
- University of Rochester
- University of Southern California
- University of Texas
- University of Washington
- University of Wisconsin-Madison
- Yale University

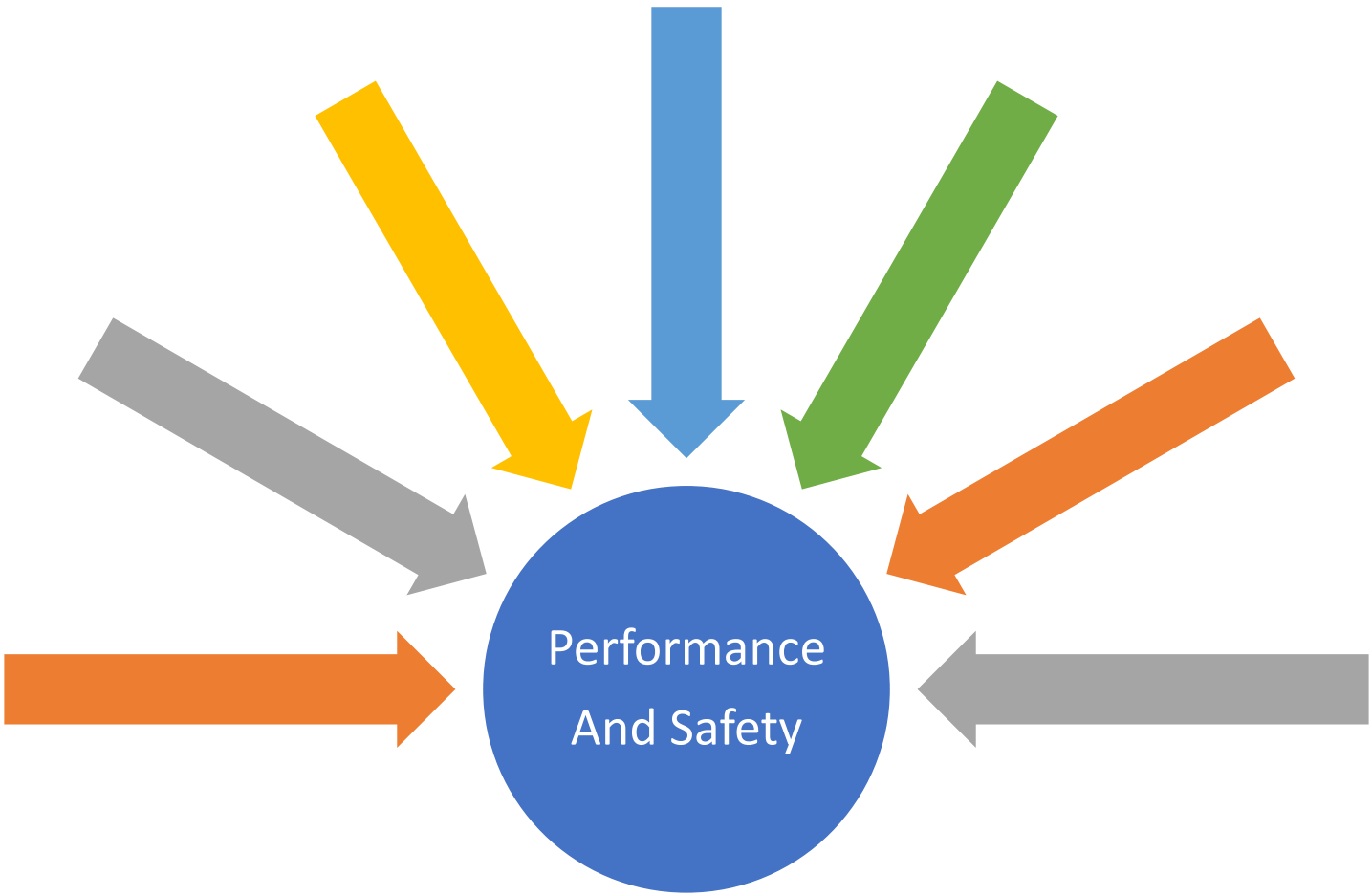


- ◆ **Predictive Science Academic Alliance Program (PSAAP) II**
 Stanford University
 Texas A&M University
 University of Florida
 University of Illinois at Urbana-Champaign
 University of Notre Dame
 University of Utah

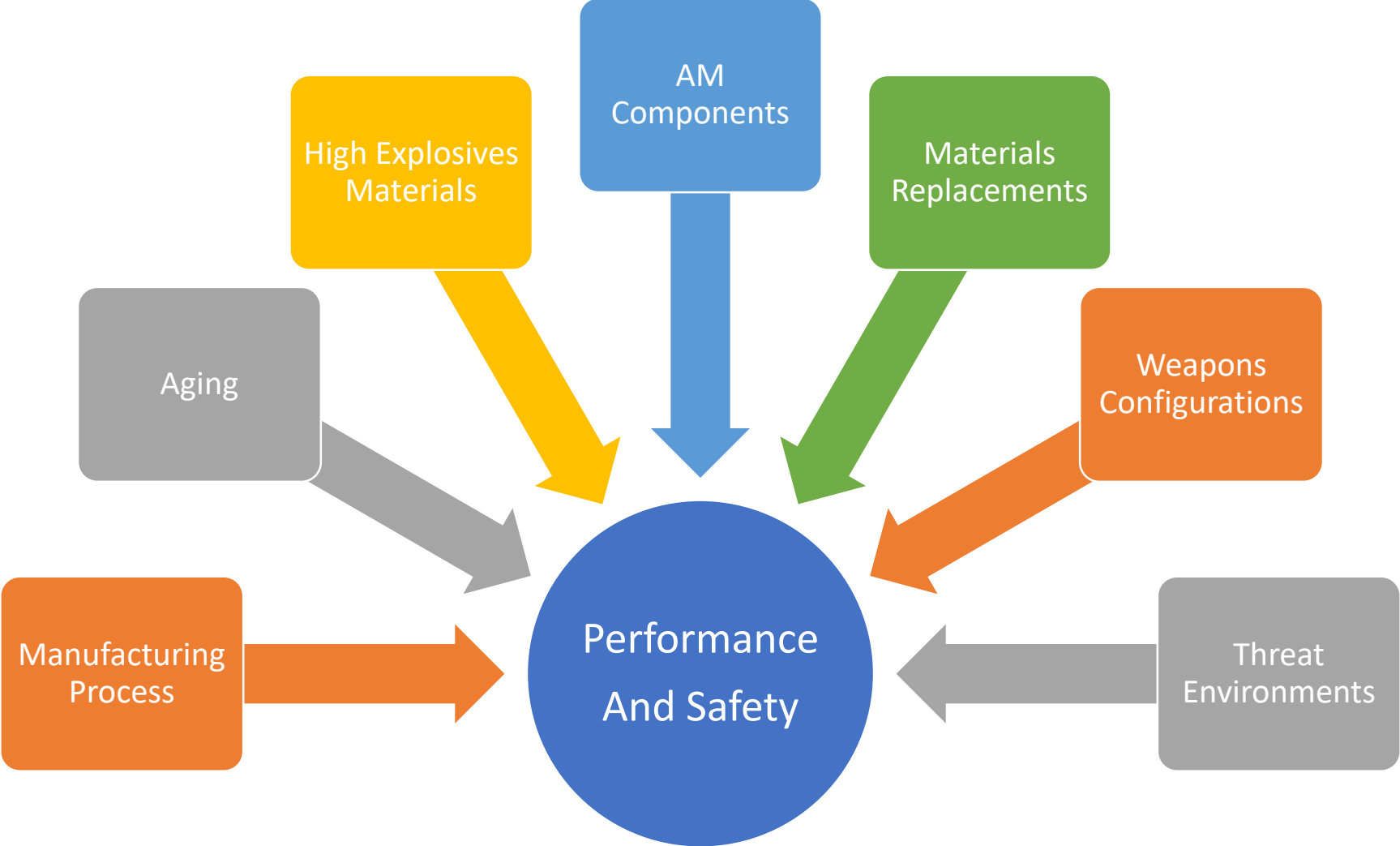
- 
- Why we're here
 - What we have
 - Speaking "Stockpile"

 - Building the argument
 - Next steps

The United States relies heavily on Science to assure the Safety & Performance of Current Weapons



Science is a required functionality to address changes that can occur in the Warhead



What we know...



By 2025 there will be no remaining personnel with actual underground nuclear test design and operation expertise



Sustaining the deterrent through stockpile stewardship requires a work force at the cutting edge of weapons physics problems



Theorists, experimentalists and engineering teams to operate the facilities



Experimentalists and diagnosticians to discover the physics underlying the stockpile



A cadre of scientists and engineers to develop a predictive capability on large, highly specialized, high performance computers



NUCLEAR POSTURE REVIEW

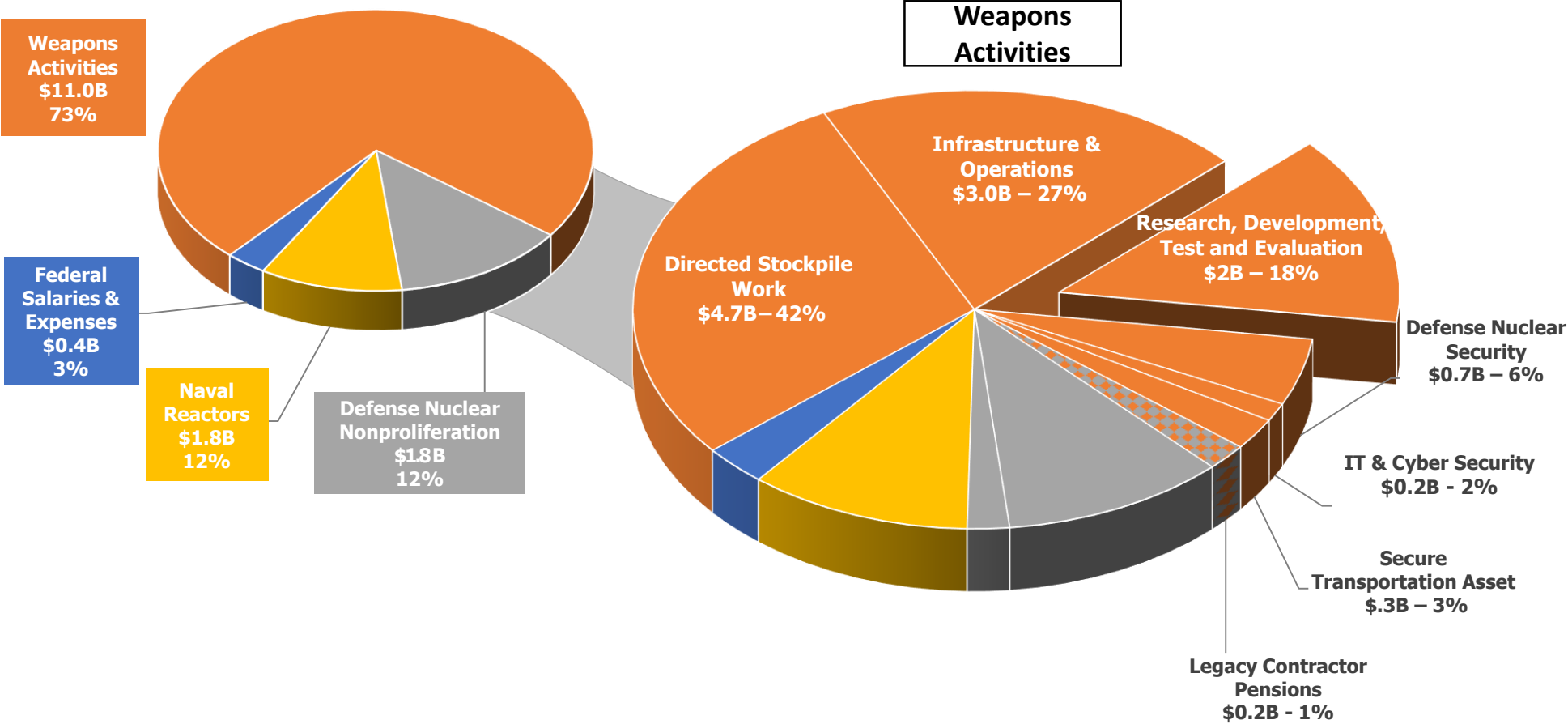


2018

NPR & Scientific Enterprise

- “Maintain and enhance the computational, experimental, and testing capabilities needed to annually assess nuclear weapons.”
- “It is now clear that the United States must have sufficient research, design, development, and production capacity to support the sustainment and replacement of its nuclear forces.”
- “To do so, the Department of Energy’s (DOE) National Nuclear Security Administration (NNSA) will continue to conduct robust nuclear weapons surveillance and experimental programs to identify issues early enough to help prevent technical breakdowns, operational shortfalls, and programmatic challenges.”
- “Finally, the United States will remain at the forefront of science and technology to reduce the likelihood of technological surprise.”

How much science do we *REALLY* need?



Assessment, Certification, and Qualification Requirements

DRIVER: Geopolitical and/or technological issue or event that shapes or motivates the nuclear security posture relative to the nuclear deterrence mission

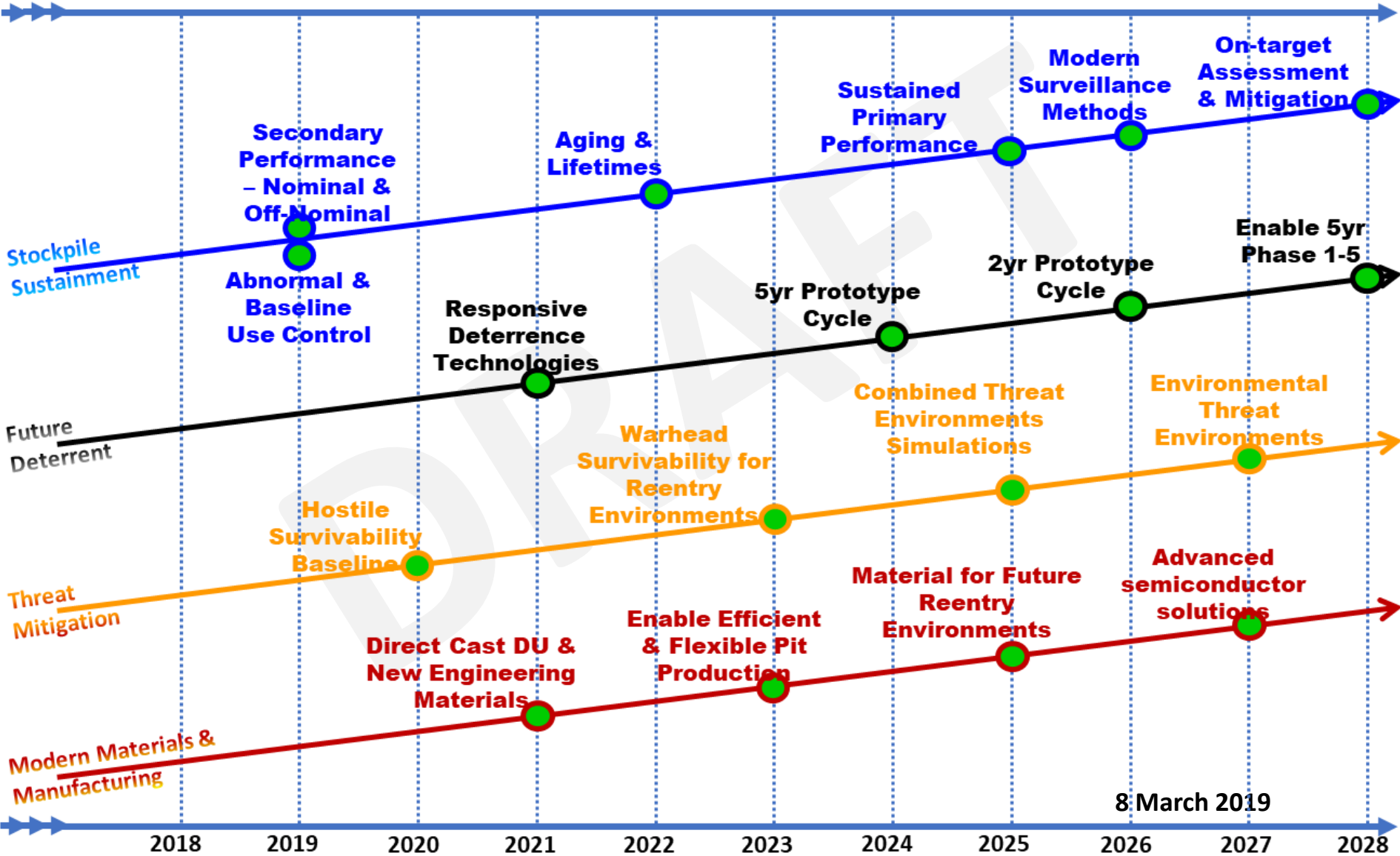
DELIVERABLE: Product or service that provides the basis for confidently meeting the nuclear deterrence mission

REQUIREMENT: Activity and/or function that is foundational to delivering on the nuclear deterrence mission

CAPABILITY: Infrastructure, knowledge, and expertise available to meet program requirements

TOOL: Hardware or Equipment used to deliver the data and understanding to support the required programmatic capabilities

Stewardship Capability Delivery Schedule



Annual Assessments/SFIs

Primaries

- A
- B
- C
- D
- E

Secondaries

- F
- G
- H
- I
- J

Outputs & Effects

- H
- I
- L
- K

+ Life Extension

Aging

- L
- M
- N

Features

- O
- P
- Q

+ Future Options

Processes

- R
- S
- T

Materials

- U
- V
- W

Science Capabilities Required for Stockpile Stewardship

A Robust Science-Based Requirements Case



STOCKPILE DRIVERS

Support for LEPs
Options for stockpile modernization
Scientific basis/certification/qualification for new technologies and reused components
Resolution of key weapons performance issues
Predictive physics models for design codes
Test readiness



SCIENTIFIC UNDERSTANDING

Thermonuclear Burn
Radiation Transport
Radiation Hydrodynamics
Material, Plasma, and Nuclear Properties
Outputs, Environments & Effects/ Nuclear Survivability



SCIENTIFIC CREDIBILITY

Weapons Physics Peer-review
Extreme pressure/temperature/ density Regimes
Developmental platforms
Multiple approaches to achieve multi-MJ yield
Advanced Technology R&D
Modeling & Simulation
Uncertainty Quantification



SCIENTIFIC TOOLS

Facilities
Targets
Optics
Diagnostics
HPC



SCIENTIFIC SUSTAINABILITY

Process Improvement
Facility Diversity
Recruitment, training, and retention of personnel
Strong Academic Pipeline

- (SSAA)
- (HEDLP)
- (NLUF)
- (PSAAP)
- **(SSGF/LRGF)**