years of Success

SCIENCE, TECHNOLOGY, AND THE NUCLEAR WEAPONS STOCKPILE

"Today, I am announcing my decision to negotiate a true zero-yield comprehensive test ban."

U.S. President Bill Clinton, August 11, 1995

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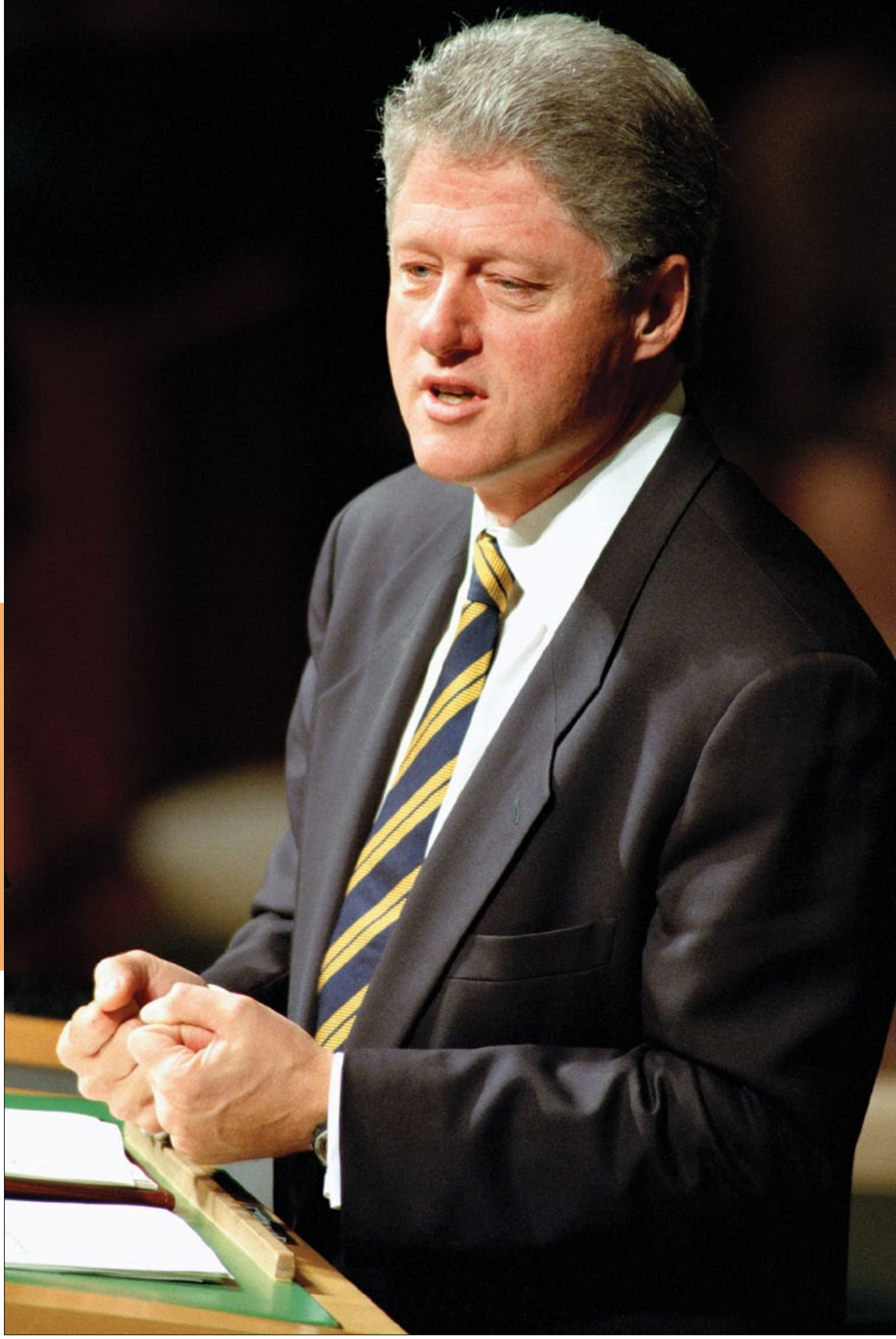
The National Defense Authorization Act for fiscal year 1994 (P.L. 103-160) established the Stockpile Stewardship Program (SSP) to sustain the nuclear deterrent in the absence of nuclear explosive testing. The SSP supports U.S. national security missions through leading-edge scientific, engineering, and technical tools and expertise – a U.S. response to the end of the Cold War and the need to remake the global nuclear landscape.

One year later, on August 11, 1995, President Bill Clinton announced that the United States would support a "zero yield" Comprehensive Nuclear-Test-Ban Treaty (CTBT):

"I am assured by the Secretary of Energy and the Directors of our nuclear weapons labs that we can meet the challenge of maintaining our nuclear deterrent under a Comprehensive Test-Ban Treaty through a Science-Based Stockpile Stewardship program without nuclear testing."



1995

This year, the Nation and the Department of Energy (DOE) celebrate the 20th anniversary of that announcement and the scientific and technical capabilities that have developed to support this policy direction.

The national investment in stockpile stewardship has enabled resolution of many stockpile issues and provided more detailed knowledge than what could have been attained through nuclear explosive testing. SSP scientists and engineers have established a solid record of success in computing, hydrodynamic and subcritical experiments, High-Energy Density (HED) physics, and materials and weapon-effects science.

The SSP is a remarkable accomplishment in national security and remains central to U.S. nuclear weapons policy and nuclear arms control goals now and for the foreseeable future.

2009

In April 2009, during a speech in Prague, President Barack Obama outlined an ambitious agenda to achieve a global ban on nuclear explosive testing and a world without nuclear weapons. He asserted his commitment to a safe, secure, and effective nuclear deterrent for as long as nuclear weapons exist. One year later, President Obama returned to Prague with Russian President Dmitry Medvedev to sign the New START Treaty, under which the United States and Russia agree to reduce their arsenals of deployed strategic nuclear warheads to the lowest level since the 1950s.

"So today, I state clearly and with conviction America's commitment to seek the peace and security of a world without nuclear weapons… First, the United States will take concrete steps towards a world without nuclear weapons. To put an end to Cold War thinking, we will reduce the role of nuclear weapons in our national security strategy, and urge others to do the same. Make no mistake: As long as these weapons exist, the United States will maintain a safe, secure and effective arsenal to deter any adversary, and guarantee that defense to our allies…"

President Barack Obama,
April 2009

1958

1958 GENEVA CONFERENCE ON THE DISCONTINUATION OF NUCLEAR WEAPONS TESTS

After the Soviet Union launched the first satellite in 1957, President Dwight Eisenhower's Science Advisory Committee was elevated to a more prominent position. These scientists had long advocated a moratorium on nuclear explosive testing and believed that it would be scientifically possible to verify compliance with such a ban. The Soviet Union actually initiated the moratorium first, so President Eisenhower proposed an international conference of top scientists from the three nuclear powers of the time: the United States, the United Kingdom, and the Soviet Union. They met in the summer of 1958 in Geneva to develop a report on possible scientific means of verification.

The U.S. delegation was led by Nobel Prize winner Ernest Lawrence, for whom Lawrence Livermore National Laboratory was named. By the end of that summer, this group of experts had developed a report that noted a network of 170 control posts, in and around Eurasia and North America, would be able to detect atmospheric tests even for very small yields. All three powers agreed to an explosive test ban while they worked out the details in Geneva. The test ban ended when the Soviet Union conducted a nuclear explosive test on September 1, 1961.

1963

1963 LIMITED TEST BAN TREATY

To address concern about radioactive fallout as a result of nuclear explosive testing, the Limited Test Ban Treaty (LTBT) was signed by the United States, the United Kingdom, and the Soviet Union in August 1963. The Treaty stipulated that signatory states could not carry out "any nuclear weapon test explosion, or any other nuclear explosion…in the atmosphere; beyond its limits, including outer space; or under water, including territorial waters or high seas." This historic milestone in arms control represented demonstrable international progress towards a nuclear explosive test ban among the world's great powers.

In the spring of 1974, the United States and the Soviet Union agreed to pursue the possibility of further restrictions on nuclear testing, and a team of experts was sent to Moscow for technical talks. The Treaty on the Limitation of Underground Nuclear Weapon Tests, also known as the Threshold Test Ban Treaty (TTBT) was signed in July 1974. It established a nuclear "threshold" by prohibiting a nuclear yield in excess of 150 kilotons. The mutual restraint imposed by the Treaty reduced the explosive force of new nuclear warheads and bombs that would otherwise be tested. For many years neither the United States nor the Soviet Union ratified the Treaty, although in 1976 both sides announced their intention to observe the yield limitations contained in the agreement. The TTBT finally entered into force on December 11, 1990.

1974

1991 USSR TO RUSSIA

The dissolution of the Soviet Union in 1991 ended the Cold War and reshaped the primary driver of U.S. nuclear strategy. This dissolution resulted in new governments having nuclear weapons on their territories (Ukraine, Belarus, and Kazakhstan); command and control problems; and regional instability. Following the events of 1991 and 1992, the

1991

United States and the Russian Federation began to reduce weapons and initiated nonproliferation and nuclear security cooperation – with the signing of the START Treaty in 1991 and Reciprocal Unilateral Measures, detargeting, and Cooperative Threat Reduction.

The 1992 congressionally mandated one-year test moratorium was signed into law by President George H.W. Bush and continued by President Bill Clinton. This required the DOE's nuclear weapons stewards to develop a much deeper understanding of the nuclear explosive process than was necessary during the era of nuclear explosive testing.

Before 1992, developing and maintaining the nuclear deterrent was largely accomplished by a continual cycle of weapon design, nuclear explosive testing, and the incorporation of lessons learned. A critical step in this process was conducting nuclear explosive tests.

To enable the transition to the SSP, DOE scientists broke down the operation of a weapon into a sequence of individual steps. These steps were studied using computational models and experiments, and then reintegrated through large-scale weapon simulation codes establishing confidence in the stockpile.

During 40 years of the Cold War, the United States produced approximately 70,000 warheads, deployed over 70 different types of nuclear weapons, and conducted more than 1,000 nuclear explosive tests—mostly at the Nevada Test Site. The majority of these integrated nuclear explosive tests focused on design concepts, physics, and engineering details such as safety and radiation effects.

This was accomplished with the nuclear security enterprise, which employed a skilled workforce, exceeding a quarter of a million people at its peak, at sites including: Hanford, Washington; Oak Ridge, Tennessee; Rocky Flats, Colorado; Savannah River, South Carolina; Pantex, Texas; Kansas City, Missouri; Pinellas, Florida; Paducah, Kentucky; and Fernald, Ohio. At the heart of this enterprise, however, were the three DOE National Laboratories responsible for nuclear weapons: Los Alamos National Laboratory (LANL) and Lawrence Livermore National Laboratory (LLNL) provided competitive solutions to weapons design requirements, while Sandia National Laboratories provided engineering and weaponization expertise. These labs were – and remain – the epitome of science and engineering excellence. They continue to operate as the largest of the U.S. government Federally Funded Research and Development Centers (FFRDC).

1996

COMPREHENSIVE NUCLEAR-TEST-BAN TREATY

After three years of not testing, originally mandated by the Hatfield-Exon-Mitchell legislation, President Clinton made his 1995 announcement to support CTBT.

On September 24, 1996, the United States was the first nation to sign the CTBT. Although the United States Senate has not yet provided its consent to ratify the Treaty, the Nation has invested in an SSP that is at the forefront of modern science and engineering.

This commitment to maintain the stockpile without testing required transitioning from underground nuclear explosive tests to understanding and being able to simulate every aspect of a nuclear weapon from nuclear detonation to explosive yield and output.

"This Comprehensive Test-Ban Treaty will help to prevent the nuclear powers from developing more advanced and more dangerous weapons. It will limit the ability of other states to acquire such devices themselves. It points us toward a century in which the roles and risks of nuclear weapons can be further reduced and ultimately eliminated."

President Bill Clinton,
September 1996

SAFEGUARDS

The CTBT ratification package sent to the U.S. Senate included six safeguards (conditions to be maintained indefinitely after U.S. ratification):

- *The conduct of a Science Based Stockpile Stewardship program to ensure a high level of confidence in the safety and reliability of nuclear weapons in the active stockpile, including the conduct of a broad range of effective and continuing experimental programs.*

- *The maintenance of modern nuclear laboratory facilities and programs in theoretical and exploratory nuclear technology that will attract, retain, and ensure the continued application of our human scientific resources to those programs on which continued progress in nuclear technology depends.*

- *The maintenance of the basic capability to resume nuclear test activities prohibited by the CTBT should the United States cease to be bound to adhere to this Treaty.*

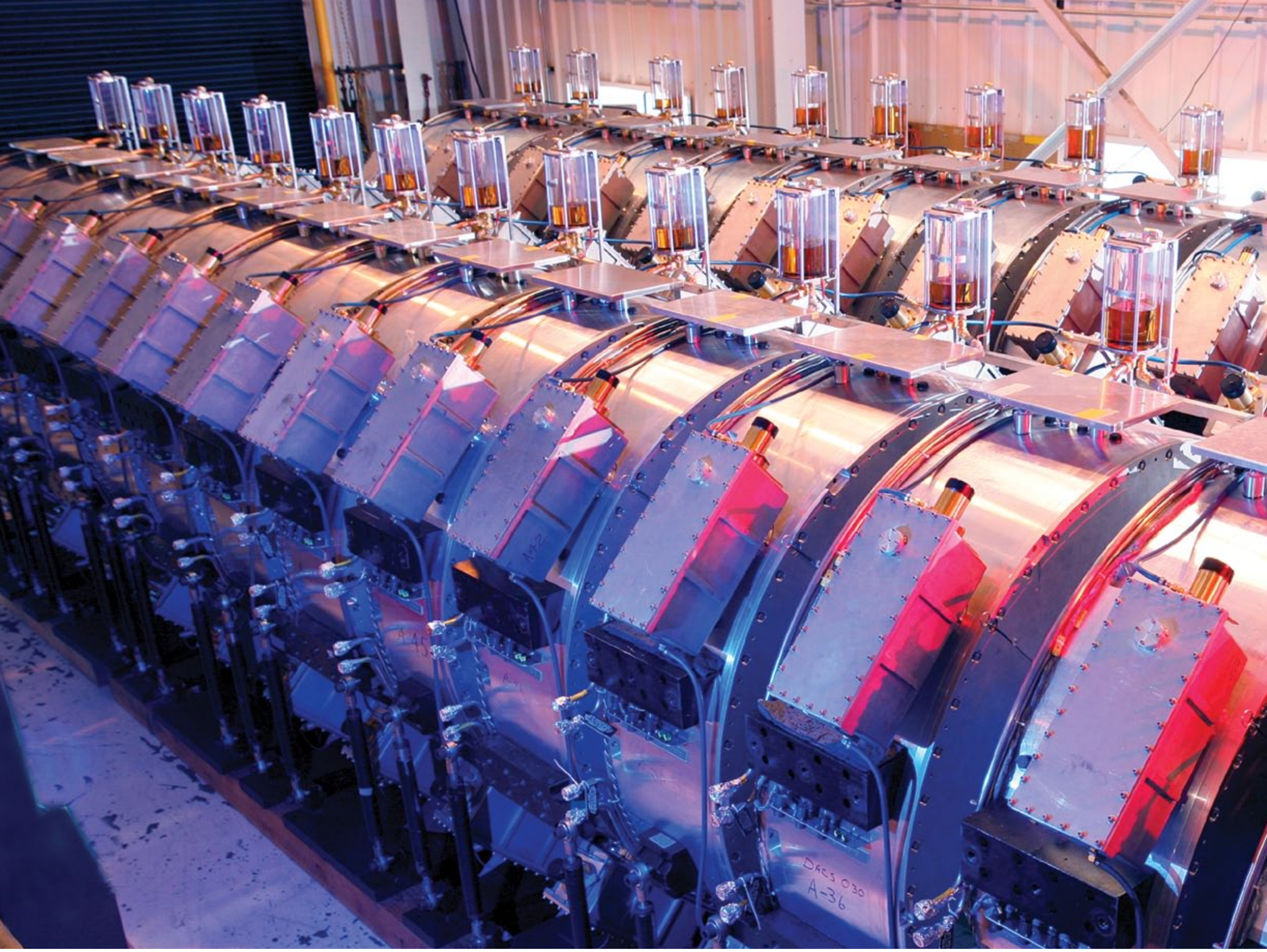
- *The continuation of a comprehensive research and development program to improve our treaty monitoring capabilities and operations.*

- *The continuing development of a broad range of intelligence gathering and analytical capabilities and operations to ensure accurate and comprehensive information on worldwide nuclear arsenals, nuclear weapons development programs, and related nuclear programs.*

- *The understanding that if the President of the United States is informed by the Secretary of Defense and the Secretary of Energy (DOE) – advised by the Nuclear Weapons Council, the Directors of DOE's nuclear weapons laboratories, and the Commander of the U.S. Strategic Command – that a high level of confidence in the safety or reliability of a nuclear weapon type that the two Secretaries consider to be critical to our nuclear deterrent could no longer be certified, the President, in consultation with the Congress, would be prepared to withdraw from the CTBT under the standard "supreme national interests" clause in order to conduct whatever testing might be required.*

When the Senate took up ratification of the CTBT in October 1999, it did not provide its consent to ratify the Treaty, and has not to this day. At the time of the ratification debate, there remained skepticism as to the viability of stockpile stewardship.

A typical concern was evinced in the letter from Brent Scowcroft, Henry Kissinger, and John Deutch to the Senate Foreign Relations Committee: *"But the fact is that the scientific case simply has not been made that, over the long term, the United States can ensure the stockpile without nuclear testing. The United States is seeking to ensure the integrity of its nuclear deterrent through an ambitious effort called the Stockpile Stewardship Program. This program attempts to maintain adequate knowledge of nuclear weapons physics indirectly by computer modeling simulation and other experiments. We support this kind of scientific and analytic effort. But even with adequate funding – which is far from assured – the Stockpile Stewardship Program is not sufficiently mature to evaluate the extent to which it can be a suitable alternative to testing."*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To comply with the President's direction to end nuclear explosive testing, the U.S. nuclear weapons strategy needed to change from the Cold War model of aggressively competitive laboratories, the continuous design and production of new nuclear weapons, extensive underground nuclear explosive testing, and a budget consistent with the high priority accorded to deter an existential threat: the Soviet Union. The United States faced daunting uncertainties – how could the nuclear weapons strategy be changed and what were the alternatives to maintaining our confidence in the safety, reliability, and performance of our own weapons?

The answer was to attain sufficient detailed scientific understanding of the nuclear explosive process, to discover, understand, and correct any anomalies that might occur during the lifetimes of the stockpile weapons, and to be able to advise whether a return to testing would be useful, and if so, to be able to carry out such tests. This is the heart of stockpile stewardship, to shift from a nuclear explosive test-based confidence model to one of science-based "validated simulation." No new weapons production was anticipated, but the DOE weapons labs would maintain the capability to design new nuclear weapons.

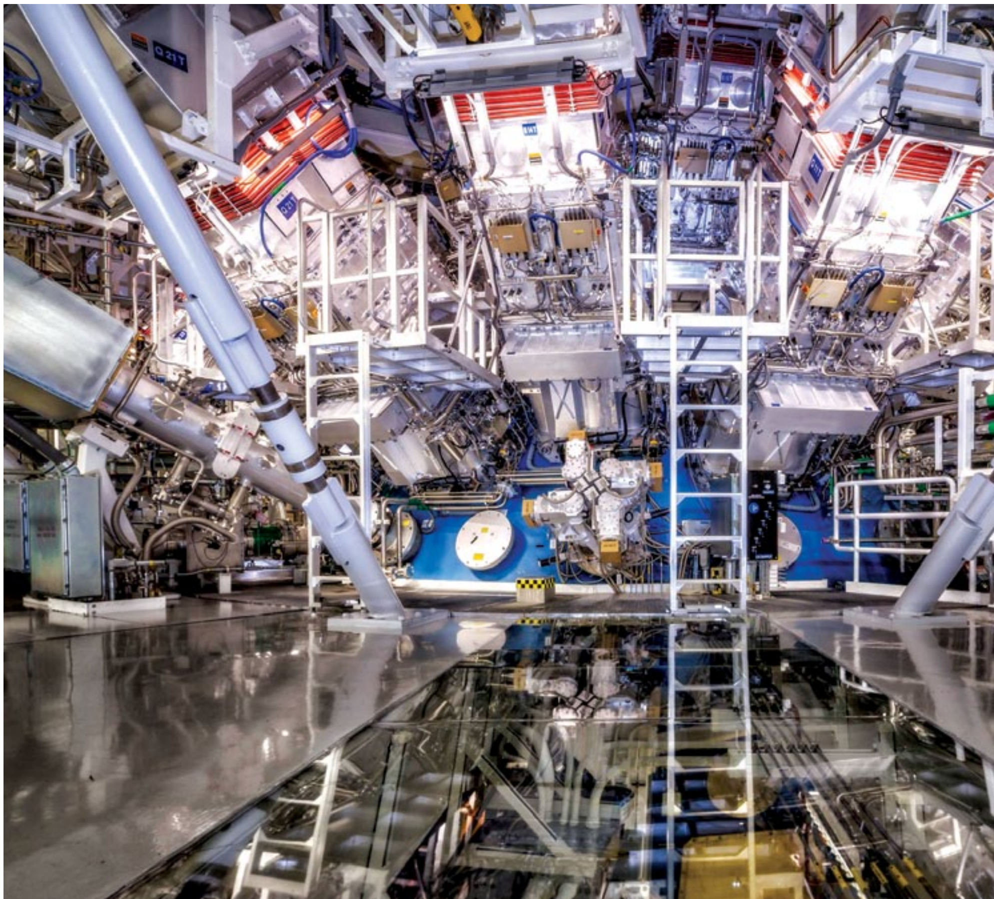
Despite the lack of CTBT ratification, the stockpile stewardship strategy has been successful beyond all expectations. Today, nuclear explosive testing has been replaced by an annual assessment process that examines each weapons system in scientific and engineering detail in a manner that is instilled with scientific rigor and allows peer review. To date, there have been 19 annual stockpile assessments, providing assurance regarding the safety and reliability of the U.S. nuclear deterrent.

SAME MISSION, DIFFERENT PARADIGM:
SSP required major capital investments. Among these were the National Ignition Facility (NIF, lower left) at Lawrence Livermore, the Dual-Axis Radiographic Hydrodynamic Test Facility (DARHT, upper left) at Los Alamos, and the Microsystems Engineering Sciences Application (MESA, above) facility at Sandia. In addition, the Accelerated Strategic Computing Initiative (ASCI) program was initiated to lead in the development of high-performance computing required by SSP. The labs also established the program of subcritical plutonium experiments at the Nevada National Security Site (formerly the Nevada Test Site). Designing, building, and operating these new experimental and computational tools would not only be directed toward solving anticipated issues with the current stockpile, but would challenge the laboratories' scientific and technical expertise and demonstrate their continued nuclear competence, adding to the Nation's long term deterrent posture.

TOP LEFT:
Sandia National Laboratories' High Energy Radiation Megavolt Electron Source (HERMES) III pulsed power facility uses Sulfur Hexaflouride as an electrical insulator for high-voltage switching devices, such as spark gaps and cascade switches. The accelerators create X-ray and gamma ray environments powerful enough to simulate some conditions created by nuclear explosions, allowing researchers to conduct radiation-effects testing in a laboratory setting.

TOP RIGHT:
This spherical hohlraum target, about to be blasted by lasers sufficient to ignite a nuclear fusion event, contains a polished capsule about two millimeters in diameter, filled with cryogenic hydrogen fuel – deuterium and tritium super-cooled to 426°F below zero.

BOTTOM:
The preamplifiers of the National Ignition Facility are the first step in increasing the energy of laser beams as they make their way toward the target chamber.



Today, the DOE's National Nuclear Security Administration (NNSA) maintains the safety, security, and effectiveness of the U.S. nuclear weapons stockpile without nuclear explosive testing; works to reduce global danger from weapons of mass destruction; provides the U.S. Navy with safe and effective nuclear propulsion; and responds to nuclear and radiological emergencies in the U.S. and abroad. Much of this mission has been underpinned by sustained investments in research, development, testing, and evaluation (RDT&E) programs.

A number of documents provide the policy framework for the current DOE/NNSA stockpile mission. Chief among these are the Nuclear Posture Review (2010); the National Academy of Sciences study on CTBT (2012); the Presidential Policy Directive, Nuclear Weapons Employment Guidance, PPD-24 (2013); and the President's National Security Strategy (2015).

The 2010 Nuclear Posture Review details the national role of nuclear weapons in U.S. security strategy and is consistent with President Obama's 2009 Prague speech.

The Nuclear Posture Review stated the need for: strengthening the science, technology, and engineering base needed for conducting weapon system Life Extension Programs (LEP); maturing advanced technologies to increase weapons surety; qualification of weapon components and certifying weapons without nuclear explosive testing; and providing annual stockpile assessments through weapons surveillance. This includes developing and sustaining high-quality scientific staff and supporting computational and experimental capabilities.

A National Academy of Sciences study released in 2012 found that the "United States has the technical capabilities to maintain a safe, secure, and reliable stockpile of nuclear weapons into the foreseeable future without nuclear-explosion testing," provided that sufficient resources and a national commitment are in place.

On June 19, 2013, President Barack Obama announced a new Presidential Policy Directive (PPD-24) that aligns U.S. nuclear policies to

the 21st century security environment, which is also documented in the President's 2015 National Security Strategy. The President's new guidance to the nuclear stockpile mission:

- *Affirmed that the United States would maintain a credible deterrent to convince its adversaries that the consequences of attacking the Nation or its allies and partners would far outweigh any potential benefit to be gained through an attack.*

- *Modified the principles for hedging against technological or geopolitical risk to create more effective management of the stockpile.*

- *Reaffirmed that the United States would maintain a safe, secure, and effective deterrent for itself and its allies and partners for as long as nuclear weapons exist.*

The experimental facilities built in support of the DOE SSP include the Dual-Axis Radiographic Hydrodynamic Test (DARHT) facility at LANL, the National Ignition Facility (NIF) at LLNL, the U1a Complex (U1a) at the Nevada National Security Site, and the Microsystems and Engineering Sciences Applications (MESA) facility at Sandia National Laboratories.

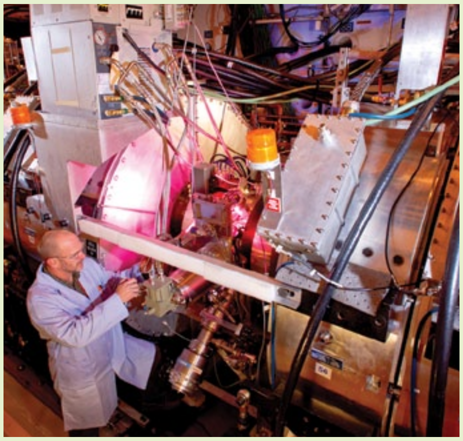
The quality and resolution of the data from these facilities is unparalleled. It is used to benchmark new physics models in the weapon simulation codes and supplement the physical data used in conjunction with the codes.

Facilities existing prior to 1992, such as the Z Pulsed Power Facility, Los Alamos Neutron Science Center (LANSCE), High Explosives Applications Facility (HEAF), and the Contained Firing Facility (CFF), also represent critical capabilities for the Complex and are maintained and upgraded such that they are able to make essential contributions to the Department's mission.

In order to remain safe, secure, and effective, the U.S. nuclear stockpile must be supported by a modern physical infrastructure – comprised of the national security laboratories and a complex of supporting facilities – and a highly capable workforce with the specialized skills needed to sustain the nuclear deterrent. As the United States reduces the numbers of nuclear weapons, the reli-

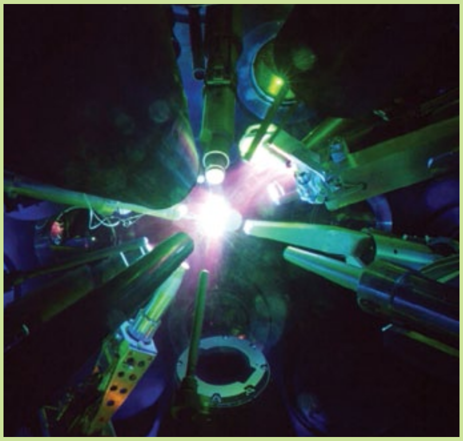
HIGH PERFORMANCE COMPUTING

Perhaps no part of the SSP was more challenging than achieving the high performance computing systems required to simulate the nuclear explosive process with enough fidelity to analyze potential weapon variances. Estimates for necessary computation were about a factor of 10,000 over the highest performing computers at the time – a factor of a million over those computers used routinely for nuclear calculations at the labs. To have such computing systems available for SSP in 10 years required a whole new program called the Accelerated Strategic Computing Initiative (ASCI). ASCI built upon the historic laboratory partnership with the U.S. computing industry to develop new hardware, software, and visualization at an unprecedented rate. Despite obstacles, program milestones were met, and a whole new computational model, based upon massively parallel processing, has now become a global high performance computing standard and an integral part of the SBSS Program and other DOE efforts – most notably in the DOE Office of Science.



HYDRODYNAMICS

Understanding how the plutonium pit is explosively compressed is a fundamental nuclear weapon design challenge. The Dual-Axis Radiographic Hydrodynamic Test Facility (DARHT) at Los Alamos National Laboratory provides multiple two dimensional, full-scale images of weapons primary design implosions with plutonium surrogates. Multi-lab plutonium implosion experiments at the Nevada National Security Site (NNSS, formerly the Nevada Test Site) study scaled (subcritical) configurations. The SSP has developed a set of advanced diagnostics for both DARHT and NNSS that provide a degree of precision well beyond that available during nuclear explosive tests. This capability tests the designs, the computer codes, and the potential of the designers to predict and understand results. The plutonium experiments at Nevada also exercise many of the skills required to return to full scale nuclear explosive testing, if such testing were ever called for (CTBT Safeguard C).

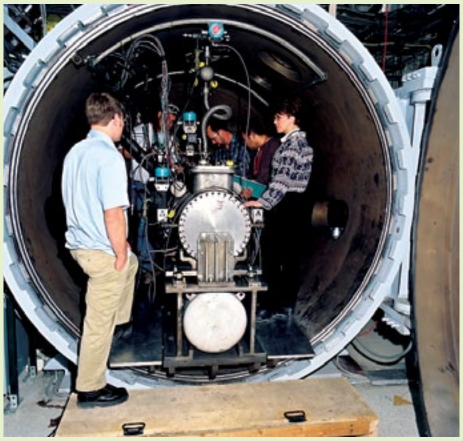


HIGH ENERGY DENSITY PHYSICS

Understanding boost, secondary performance, and weapons effects is fundamental to ensuring the effectiveness of nuclear weapons. While modeling these processes is heavily dependent upon advanced computing without underground nuclear explosive testing, the SSP relies upon high energy density physics (HEDP) experiments at the National Ignition Facility at LLNL, the Z machine at Sandia, and the Omega facility at the University of Rochester to validate codes and models and provide relevant physics experience to the designers, scientists, and engineers. Recent plutonium experiments, ignition experiments, and numerous classified experiments demonstrate the potential of this research to maintain essential capabilities in these areas of physics. Advanced capabilities for HEDP experiments maintain expertise in diagnostics and instrumentation that would be necessary in the case of a return to testing. As many experiments on these facilities are of broad scientific interest, they are a principal source of recruitment for the maintenance of critical expertise from growing national and international collaborators.

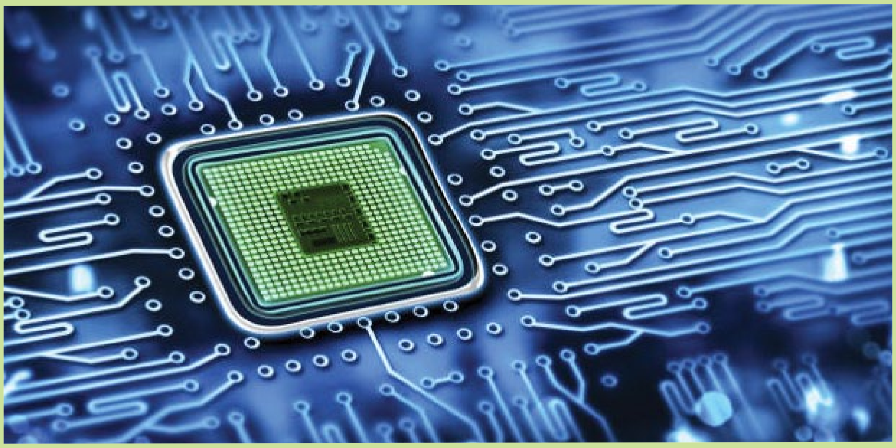
ability of the remaining weapons in the stockpile – and the quality of the facilities needed to sustain it – become more important.

In addition to facilities and infrastructure, execution of a science-based, or "virtual" nuclear explosive testing, approach to achieving predictive capability for weapons performance – that is the ability to compute the observables of an experiment or test within stated confidence intervals using verified and validated simulation tools – requires a long-term strategy and a tool by which we can measure progress toward achieving that capability. For NNSA, the Predictive Capability Framework (PCF) is that tool.



PLUTONIUM AGING

One major scientific issue for stockpile stewardship is the effect of plutonium aging on the nuclear explosive process. Plutonium is known to change its properties over time through self-irradiation, but there was a question as to when this change would begin to degrade the weapon performance. An extensive series of precision experiments using both naturally and artificially aged plutonium (and associated modeling) at both Los Alamos and Livermore demonstrated the safety and reliability of plutonium pits from current nuclear weapons throughout their life extension period. This remains an area of continued active investigation.



MICROELECTRONICS

Electronic systems for nuclear weapons must be highly integrated, reliable, and secure, and must be designed to operate in unique, high-radiation environments. Sandia National Laboratories, working with an industrial partner (Intel Corporation), developed the Permafrost Application Specific Integrated Circuit (ASIC) for use in the W76-1 LEP and produced some 3,000 units for the Navy using its MESA facility.

The B61-12, on its way to an LEP acoustics test.

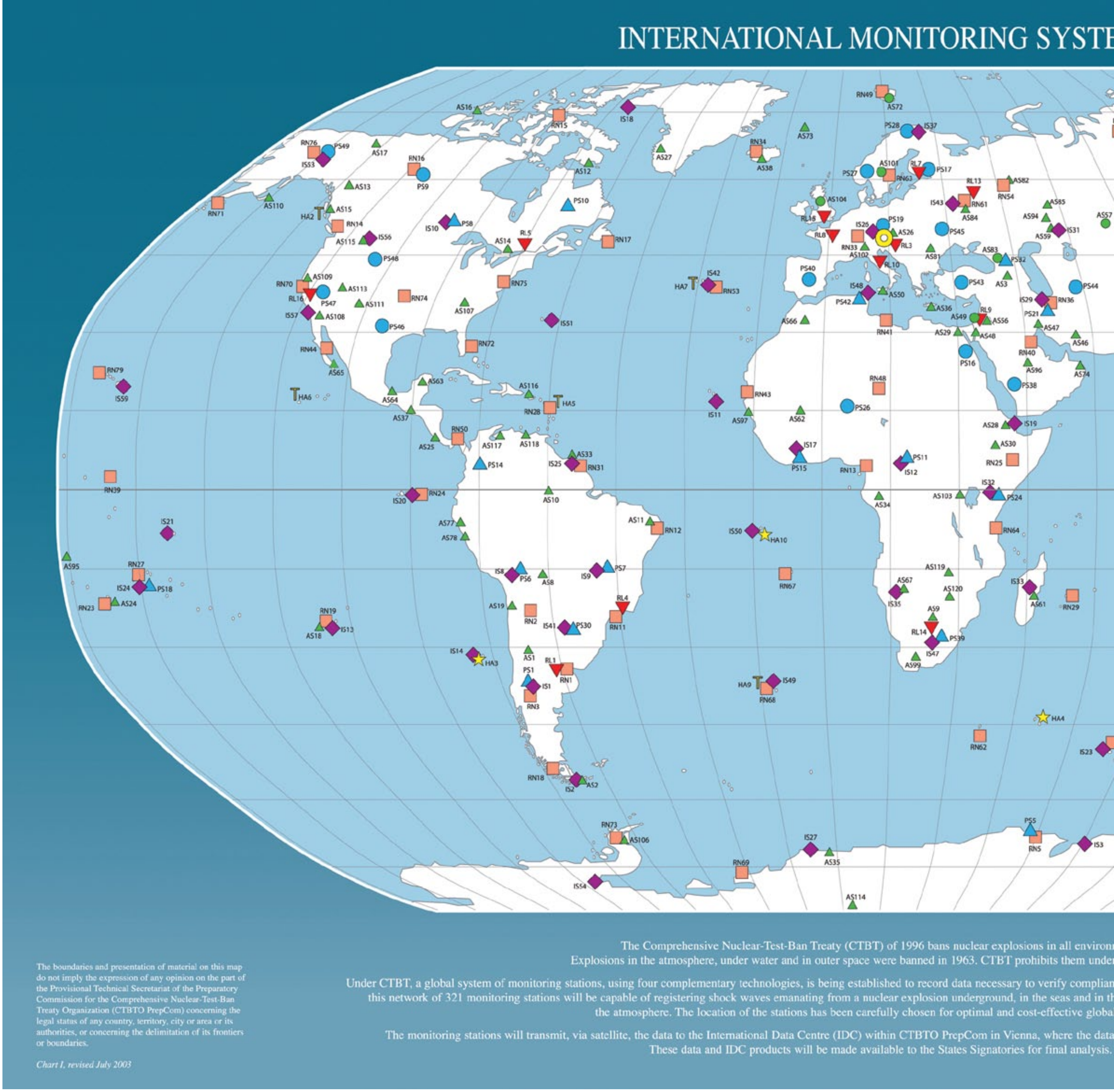
The term “Life Extension Program” (LEP) means a program to repair/replace components of nuclear weapons to ensure the ability to meet military requirements. By extending the “life,” or time that a weapon can safely and reliably remain in the stockpile without having to be replaced or removed, the United States is able to maintain a credible nuclear deterrent without producing new weapons or conducting new underground nuclear explosive tests.

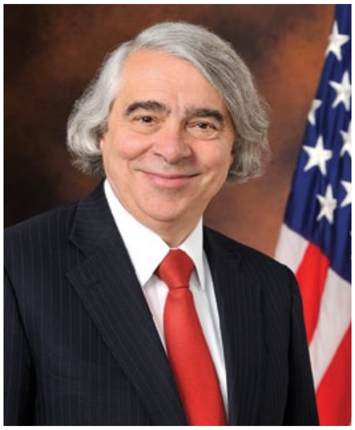
Underlying the LEP planning process, DOE/NNSA remains committed to supporting the President’s nuclear agenda as articulated in the 2010 Nuclear Posture Review. LEP activities will support the goal to reduce both the number of warhead types and the stockpile size by formulating options for interoperable (i.e., common or adaptable) warheads that could be flexibly deployed across different delivery platforms.

Additionally, a well-planned and well-executed stockpile life extension strategy will result in improved safety and security while also enabling the Department of Defense to be consistent with the Administration’s agenda to establish a smaller, yet still effective, deterrent.

NNSA must develop individual Life Extension Programs by using science-based research for each weapon type and develop specific solutions to extend the lifetime of each particular weapon because each is unique. Over time, the components of nuclear warheads deteriorate, even when kept in storage. LEPs will address known aging issues in weapon systems, and each LEP will study the options for increasing the safety, security, and reliability of weapons on a case-by-case basis.

Life extension efforts are intended to extend the lifetime of a weapon for an additional 20 to 30 years. The current planning scenario envisions that the useful lifetimes of the W76, B61, W78, W87 and the W88 will have been extended through major LEP and alteration efforts by 2031.





"The International Monitoring System for verifying compliance with the CTBT has developed and matured to the point that nuclear explosive testing by anyone, even at very low yields, will be detected."

Secretary Ernest Moniz,
U.S. Department of Energy,
September 2015

From 1945 to 1992, the United States conducted more than 1000 nuclear explosive tests. When President Clinton gave his support to the stockpile stewardship in August 1995 and signed the CTBT in 1996, he continued the moratorium on nuclear explosive testing, challenging the United States to continue its global leadership role in nuclear nonproliferation and diplomacy.

Improving U.S. and international nuclear explosion detection efforts is a key objective of the DOE/NNSA's mission to prevent nuclear weapons proliferation. The CTBT International Monitoring System (IMS) uses sensors that can detect a nuclear explosion. The NNSA and experts at its National Laboratories play a vital role in strengthening the monitoring and verification capability of the Preparatory Commission for the CTBT Organization (CTBTO PrepCom). NNSA experts work closely with the CTBTO PrepCom to operate, maintain and improve the capabilities of the worldwide IMS, supported by the International Data Centre in Vienna, Austria, and supported by an on-site inspection regime. When the IMS is complete, it will span 89 countries including the United States; today, the United States operates 36 IMS stations and a Radionuclide Laboratory.

"Since we have maintained a 20-year moratorium on explosive nuclear testing, our policies and practices are consistent with the central prohibition of the Treaty. But ratification of the CTBT would be a significant affirmation of the importance the United States attributes to the international nonproliferation regime. More importantly, by hastening the day the Treaty enters into force, U.S. ratification would concretely contribute to reducing the role of nuclear weapons in international security. With a global ban on nuclear explosive tests, states interested in pursuing nuclear weapons programs would have to either risk deploying weapons uncertain of their effectiveness, or face international condemnation for conducting nuclear tests. The CTBT would also subject suspected violators to the threat of intrusive on-site inspections – a further deterrent to those states tempted to carry out a nuclear test in the hope that it can be covered up."

Rose Gottemoeller,
Acting Under Secretary for
Arms Control and International Security,
U.S. Department of State,
September 2012

The Past

SEPT 23, 1992

United States Performs Last Nuclear Explosive Test

SEPT 24, 1992

Hatfield-Exon-Mitchell Amendment Approved

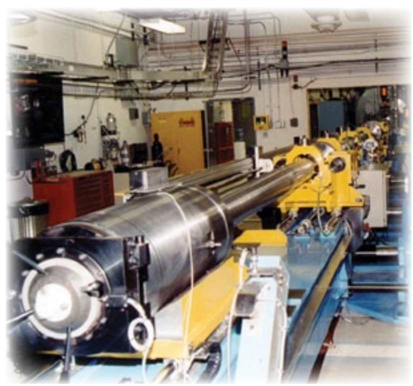
OCT 2, 1992

President George H.W. Bush Signs Nuclear Test Moratorium

2000

NNSA is Established

2003



JASPER Two-Stage High Energy Shock Gun

2005

First 100 Teraflop Computer Installed

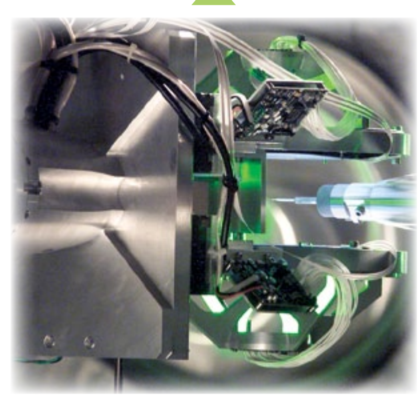
2006

Completed Qualification Activities for W76 LEP

2008

DARHT Second Beam Line

2009



Breaking the Megajoule Barrier

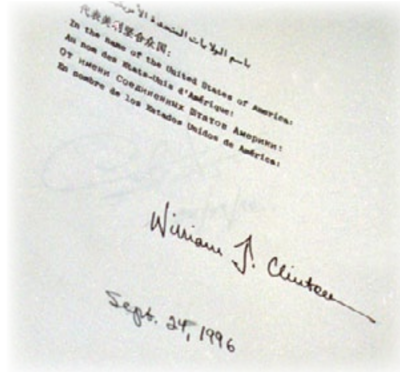
1995

Announced True Zero Yield Comprehensive Test Ban

1996

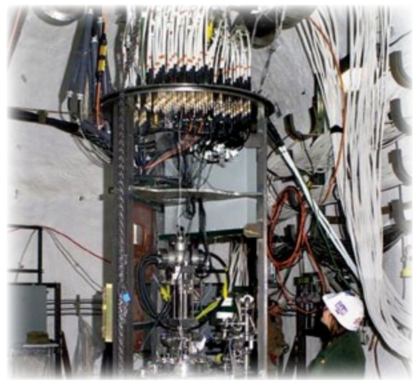
First Teraflop Computer

SEPT 24, 1996



United States Signs the CTBT

1997

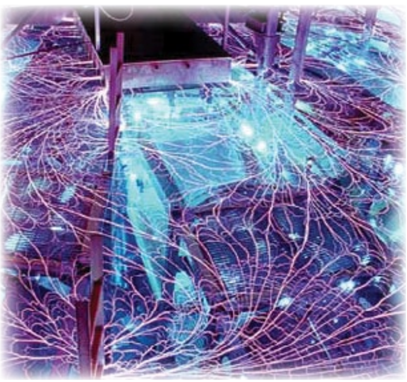


First Subcritical Experiment Conducted

1999

NIF Target Chamber Dedication

1999



Pushing the Z Machine to New Limits

2012

25,000 Teraflops Reached

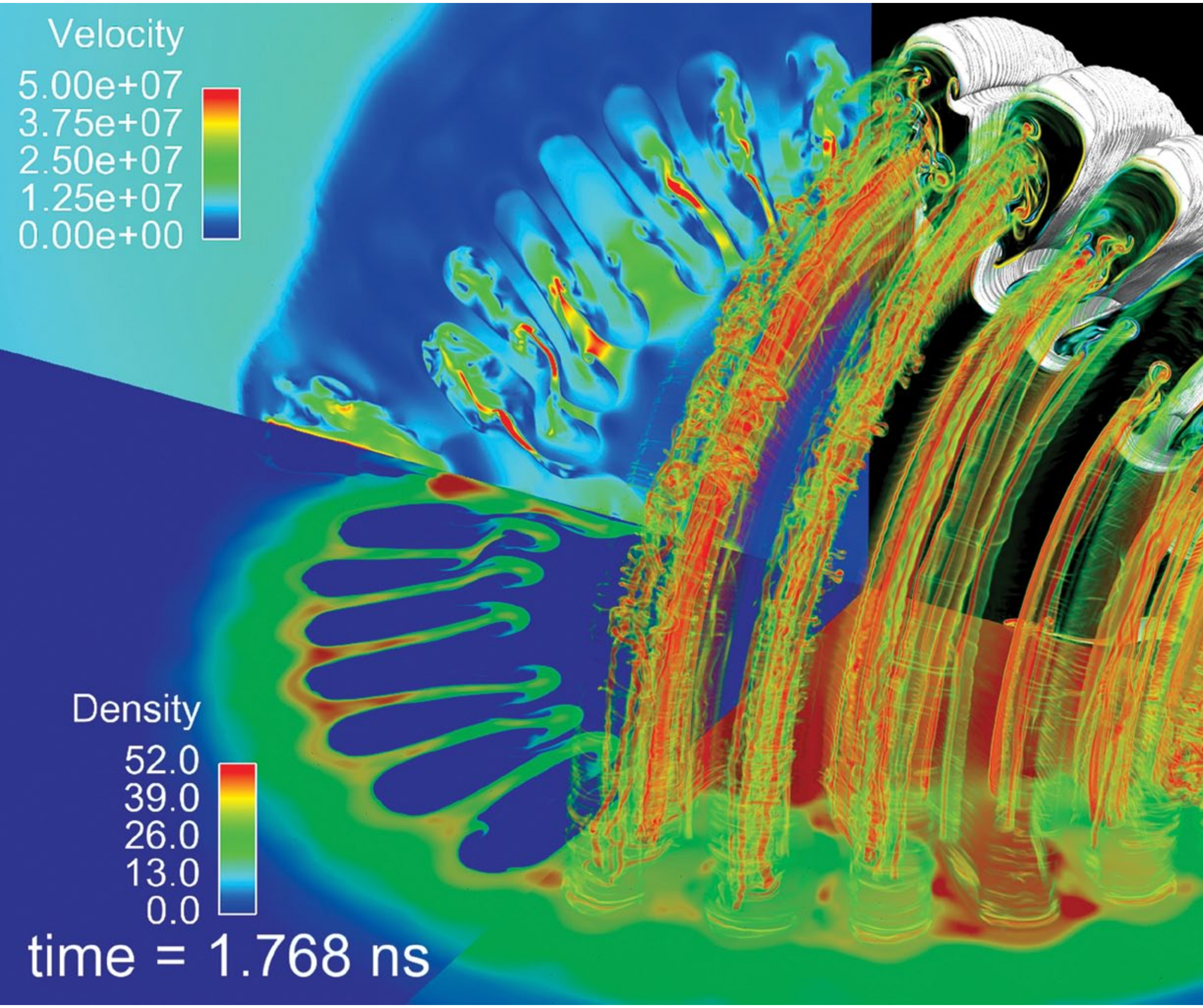
2014

Next Generation Manufacturing

PRESENT

Next Generation Supercomputer, Trinity

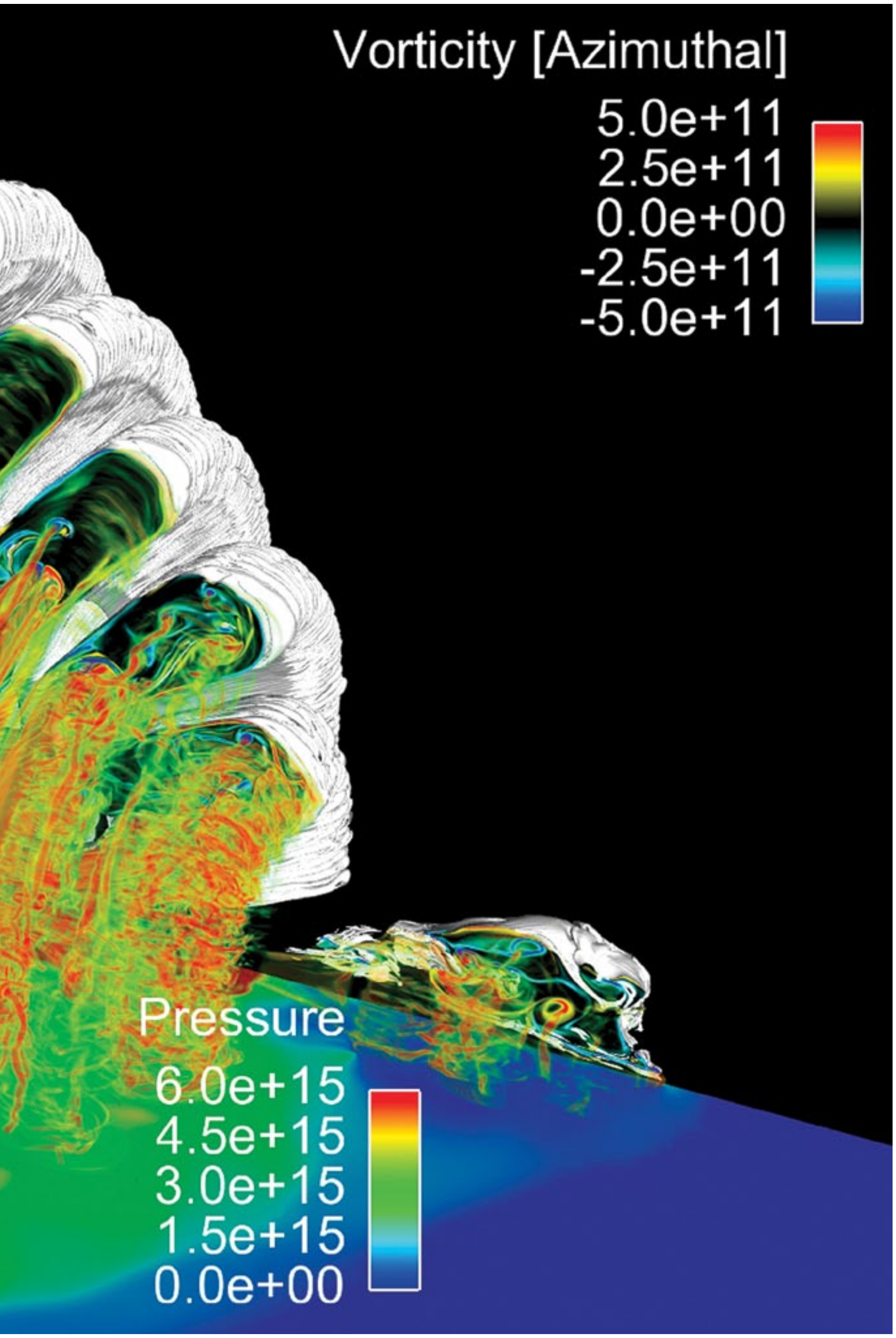
The Future



Visualization of the one billion cell 3D RAGE simulation of turbulence growth in an Inertial Confinement Fusion (ICF) implosion.

"This 20th anniversary is an important milestone. The Science-Based Stockpile Stewardship program was and remains successful thanks to the vision and determination of its proponents and the significant investment in the necessary tools, facilities, and people. The men and women employed by the national nuclear labs and production plants have achieved this goal with decades of hard work, ingenuity, and unmatched science and engineering."

Lt. Gen. (Retired) Frank G. Klotz,
Under Secretary for Nuclear Security and Administrator,
National Nuclear Security Administration (NNSA),
August 2015



To date, the DOE Stockpile Stewardship Program has been remarkably successful in sustaining confidence in the U.S. nuclear deterrent. Twenty years ago, the moratorium required the adoption of a completely new paradigm, and as a result of the National Laboratories – science and technology powerhouses – the United States has been able to maintain a nuclear weapons stockpile without creating new classes of weapons or conducting nuclear explosive tests.

Since technology is only as good as the people and processes that operate them, NNSA and all of its lab partners across the DOE complex are committed to work together in advancing the human capital skills and continuing the scientific and engineering capabilities essential to protecting the United States and its allies.

Maintaining a safe, secure, and effective nuclear weapons stockpile in the absence of nuclear explosive testing remains a fundamental responsibility. While the Cold War has ended, the governments of Russia and China continue to present political and strategic challenges, including their nuclear weapons modernization programs. Nuclear proliferation and nuclear terrorism loom large. Continuing with appropriate support, the SSP will ensure the President's confidence in U.S. nuclear weapons, and the viability of the underlying science and technology. At the heart of the SSP are the trusted people and organizations that deliver the nuclear deterrent for the security of our nation.

"In the end this is not an issue of technology but an issue of courage and will and persistence, and if we have the courage and will and persistence, we will not fail."

Victor H. Reis,
Assistant Secretary of Energy for Defense Programs,
U.S. Department of Energy,
October 1997

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