

# SCIENCE AND TECHNOLOGY ON A MISSION

The Lawrence Livermore National Laboratory (LLNL) FY 2015 Annual Report chronicles our Laboratory's progress in developing and applying frontier science and technology to its national security mission.

From the standpoint of Livermore's goals and performance, FY 2015 was a very good year. We met our responsibilities in stockpile stewardship, achieved remarkable research and development milestones, and provided unique capabilities and results for the Department of Defense, the Department of Homeland Security, the Intelligence Community, and other partners, all while operating safely, effectively, and efficiently.

Of particular note were the opportunities our Laboratory had to celebrate its history. Events marked the 50th anniversary of the establishment of Z Program as a center for intelligence work on weapons of mass destruction, the 60th anniversary of Site 300's opening as an area for high explosives testing, and the 30th anniversary of the world's first x-ray laser, demonstrated at Nova, the precursor to the National Ignition Facility (NIF). Such celebrations, which help us rediscover our distinctive contributions to national security and scientific progress, honor successes that have established a firm foundation for LLNL's coming years.

We also celebrated people, the key to Livermore's enduring success. A great example was the inaugural bestowal of the John S. Foster, Jr. Medal on Johnny himself, at a star-studded event in Washington, D.C. Honoring Johnny's career—rising to Laboratory director and adviser to U.S. presidents—was certainly a reminder of what Livermore is all about; but it also taught us that having a storied past is not just a matter of nostalgia, but can form the basis for considering where we are and guide our future. To quote Johnny from his comments at the ceremony,

***"When considering the situation in which we find ourselves, we naturally will look to innovation as part of the solution!"***

— Johnny Foster

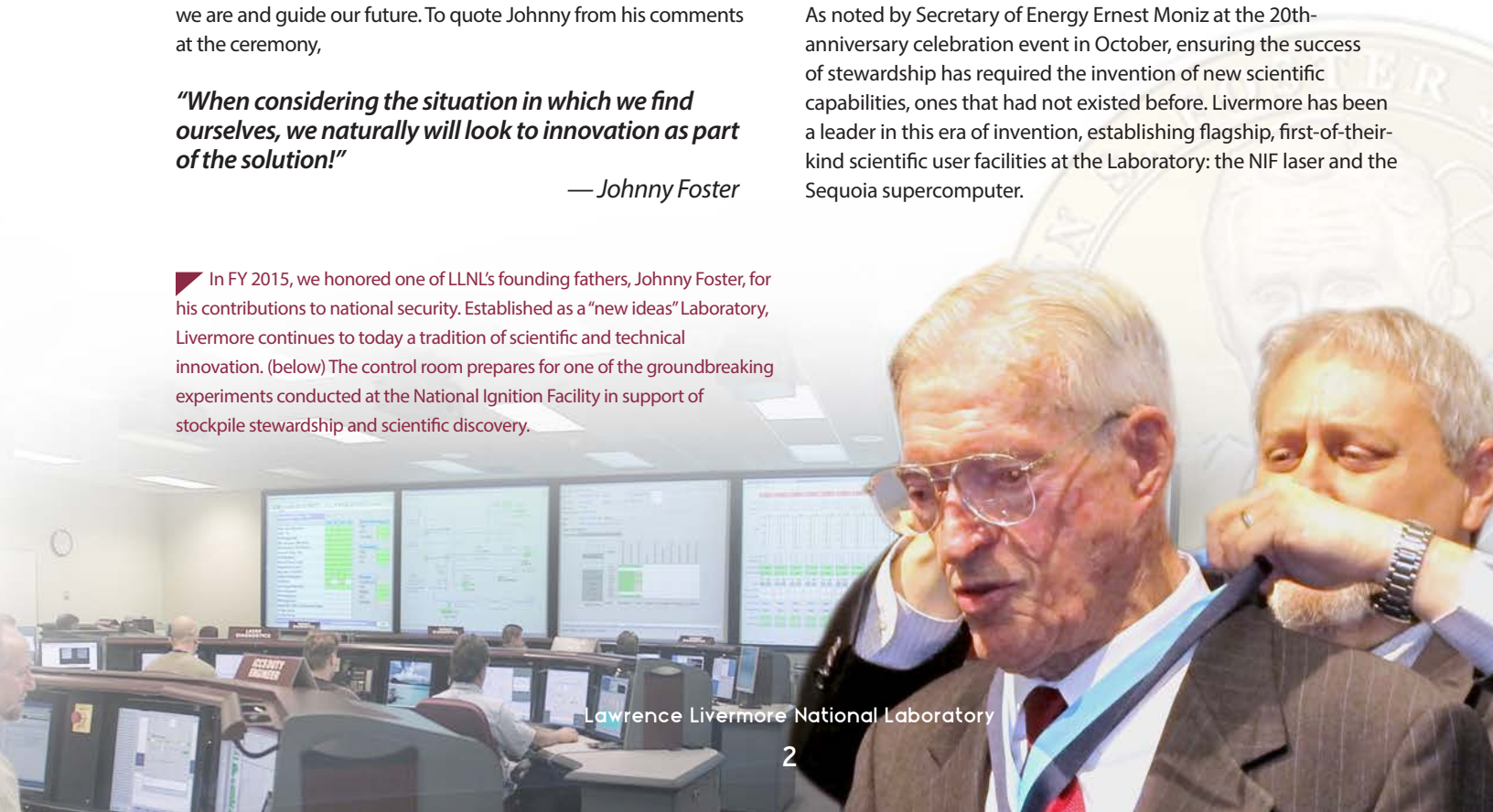
■ In FY 2015, we honored one of LLNL's founding fathers, Johnny Foster, for his contributions to national security. Established as a "new ideas" Laboratory, Livermore continues to today a tradition of scientific and technical innovation. (below) The control room prepares for one of the groundbreaking experiments conducted at the National Ignition Facility in support of stockpile stewardship and scientific discovery.

In addition, we honored the 90th birthday of Berni Alder, Presidential Medal of Science laureate and inventor of computational molecular dynamics, and celebrated the 60-year career of Dan Patterson, who has mentored a generation of nuclear weapons designers.

Livermore's talented staff is inspired by these individuals, shares their dedication to national service, and carries on the Laboratory's tradition of scientific, technological, and engineering (ST&E) excellence. In the past year alone, 10 Livermore scientists were named fellows of the American Physical Society, and 17 scientific journals featured covers highlighting work by LLNL authors. To help sustain our outstanding workforce, we launched an Early- and Mid-Career Recognition Program to identify promising scientists and engineers and provide them with funding to boost their careers. Our activities to attract future staff members, and enhance the diversity of our workforce, are highlighted in this report.

Our core mission at LLNL is to ensure that the nuclear arsenal remains safe, secure, and effective. The year 2015 also marked the 20th anniversary of the Stockpile Stewardship program, which has successfully enabled us to perform this mission without nuclear testing, and to reduce the numbers and types of weapons we rely on for deterrence. LLNL is central to realizing the vision for the nation's future nuclear deterrent, with responsibility for the next two warhead life extension programs (LEPs). The first, the W80-4 LEP, will present the new challenge of adapting an existing warhead for use on a new delivery vehicle, the next-generation cruise missile. The LEP also presents the exciting opportunity to use additively manufactured components to better assure performance and reduce production costs.

As noted by Secretary of Energy Ernest Moniz at the 20th-anniversary celebration event in October, ensuring the success of stewardship has required the invention of new scientific capabilities, ones that had not existed before. Livermore has been a leader in this era of invention, establishing flagship, first-of-their-kind scientific user facilities at the Laboratory: the NIF laser and the Sequoia supercomputer.



High performance computing (HPC) has been essential for stockpile stewardship both as the replacement for full-scale integrated testing and as a means for advancing our understanding of physics under the extreme conditions relevant to nuclear explosions. Advancements in HPC will continue under the Department of Energy's exascale (1,000 quadrillion operations per second) computing program and the President's National Strategic Computing Initiative. As described in our annual report, the next step toward exascale, the Sierra supercomputer, will be delivered to LLNL in the next two years.

NIF surpassed expectations to fire a record-breaking 356 experiments last year, including shots that safely used minute amounts of plutonium to generate data directly relevant to understanding nuclear weapon performance. We are on track to perform 400 experiments this year and will begin using complex new diagnostic capabilities to directly observe the burning hot spot in fusion experiments.

The Laboratory played a critical role in international threat reduction in FY 2015. A Livermore scientist was one of the U.S. government's technical experts at the negotiations of the Joint Comprehensive Plan of Action with Iran over its nuclear program. He utilized his Laboratory team for reach-back technical support and provided extensive, timely, real-time analysis to Secretary of State John Kerry, Secretary Moniz, and the rest of negotiating team during intense discussions. In addition, our scientists and engineers played a leading role in fielding an underground high-explosive test that improved the nation's ability to detect and identify low-yield nuclear tests.

Our researchers also apply our exceptional ST&E to broader issues of national importance, such as energy and environmental security, and to advance fundamental science. For example, readers of this report will also learn about new implants to treat neural disorders, novel, heretofore unrealizable materials created through additive manufacturing, a promising approach to carbon capture based on microcapsules, and a telescope that will map the sky in unprecedented detail every few nights.

Laboratory staff provided extensive technical expertise to the team that negotiated the Joint Comprehensive Plan of Action with Iran (with LLNL engineer Roger Miller at the lower right). (right) Engineer Vanessa Tolosa holds up an implantable flexible electrode array. Laboratory-developed neural interfaces—together with efforts in computational biology and biological agent detection—improve human health and strengthen defenses against bioterrorism and outbreaks of pandemic diseases.

The programmatic and scientific accomplishments highlighted in this report, and the many more that have made FY 2015 such a success, would not have been possible without an ongoing focus on safe, secure, sustainable, and effective operations, and the exceptional support provided by our operations staff. Thanks to their dedication, and the unwavering attention of our entire workforce, we achieved or exceeded every operational goal we set for ourselves. We have also seen the start of new facility construction, and set the standard for the entire NNSA complex for innovative approaches to infrastructure management.

The Laboratory's combination of a highly skilled workforce and state-of-the-art facilities serves national security in many complementary ways. It is a vital part of U.S. readiness to any dramatic shift in the nuclear security environment that might require changes to our force structure. We provide the technology and expertise to enable high-confidence implementation of arms control, nonproliferation, and other threat reduction measures. Laboratory programs aim to counter the spread and potential use of weapons of mass destruction across the full spectrum of threats. In addition, LLNL's strong ST&E base is a national asset in ensuring that the U.S. has a competitive advantage in advanced technologies with potential security implications. Finally, we help our leaders to understand new challenges and opportunities in a manner that is technically informed and sound.

In each of these roles, FY 2015 was a standout year for the Lawrence Livermore National Laboratory.

