

LANSCÉ and the Nuclear Weapons Program

Philip D. Goldstone

In 1996, sponsorship of the Los Alamos Neutron Science Center (LANSCÉ), previously known as the Los Alamos Meson Physics Facility (LAMPF), was transferred to Defense Programs, and it was clear that neutrons provided a unique tool for understanding materials. It was also clear that improving physical models of materials and understanding materials issues related to aging or remanufacturing were going to be important for stockpile stewardship. However, although that vision could be broadly painted and some thrusts were well identified (for example, structural studies of plutonium), elements of that vision were not fully realized at the time.

The decade since 1996 has been remarkable for the nuclear weapons program and for LANSCÉ. Stockpile stewardship itself has moved to incorporate a more-coherent, sound methodological basis (the quantification of margins and uncertainties, QMU), and the technical details and priorities of the program have matured as a result of the successes and, especially, the challenges the program has identified and overcome. Some new tools have emerged. Proton radiography (pRad), in particular, which was not even in the minds of the “forefathers” of stockpile stewardship, has become a crucial element of the research program within a remarkably short time after key breakthroughs were first demonstrated at LANSCÉ. Further, understanding what is needed to reduce uncertainties in assessment resulted in a renewed appreciation at both Lawrence Livermore and Los Alamos National Laboratories of the importance of measuring certain neutron nuclear-reaction cross sections that only LANSCÉ can provide.

And although there is now a need to refurbish additional elements of the accelerator that powers the research capabilities at LANSCÉ’s several experimental areas, considerable investment was made over this decade to operate, maintain, and improve elements of the LANSCÉ infrastructure and scientific equipment, supported, as appropriate, by the National Nuclear Security Administration (NNSA) and the Office of Science sponsors and institutional funds. LANSCÉ is now a far more powerful and important facility in terms of the breadth of its scientific reach and its impact on stockpile stewardship than it was in 1996, when its sponsorship was transferred. LANSCÉ is also the Laboratory’s key world-class experimental user facility and science “magnet.” In 2001, LANSCÉ was designated a national user facility.

Strategic Role of LANSCÉ

Direct Mission Support through Science-Based Prediction and Assessment.

LANSCÉ contributes both directly and indirectly to the nuclear weapons program. The principal direct impacts are through pRad, nuclear data measurements, and structural information from neutron scattering on key materials. These measurements, most of which require the particular capabilities at LANSCÉ, are helping to reduce uncertainties in science-based predictive capability for weapon safety, reliability, and performance.

They are directly impacting weapon assessment and certification decisions and are essential for many identified program milestones. All NNSA laboratories rely on

LANSCE's capabilities.¹ The articles in this section will speak to a few examples of a broad set of contributions in three main areas:

pRad. Proton radiography at LANSCE is providing important data on detonation and burn properties of insensitive high explosives at controlled temperatures, shock-driven material damage and spall, ejecta transport, small implosion experiments, and dynamic loading of neutron generator components. Lawrence Livermore and Sandia National Laboratories and the Atomic Weapons Establishment in the United Kingdom have collaborated with us on, or led, many of these experiments. The results have been important for developing and validating physical models. Looking forward, we have identified work to be done with pRad using the 800-million-electron-volt beam at LANSCE that we estimate will take over a decade to complete at the rate of 20 to 30 experiments per year. Further, we continue to design and perform experiments that are immediately responsive to (and help resolve) unanticipated technical questions within the stewardship program. Experiments we have done have also demonstrated pRad's long-term value as a capability for stockpile stewardship. In the future, a 20-giga-electron-volt pRad capability for hydrotesting could potentially be based on the present LANSCE facility.

Nuclear data. Using the GEANIE detector at the Weapons Neutron Research Facility (WNR) and the DANCE detector at the Lujan Neutron Scattering Center (Lujan Center), LANSCE is providing key nuclear-cross-section data on actinides and radiochemical tracers, enabling important refinements in models and

better use of the historical nuclear-test database. The WNR recently enabled irradiation testing relevant to Sandia National Laboratories certification of the W76 arming, fuzing, and firing system. The neutron spectra available from LANSCE (including very high energies at the WNR) and the Laboratory's ability to handle short-lived isotopes, along with unique capabilities of a range of instruments, make LANSCE the only source for a variety of nuclear-cross-section data of interest.

Materials. Unique instruments and sample environments at the Lujan Center, which is operated with Office of Science sponsorship as a user facility, are contributing to high-pressure data on plutonium, to understanding the constitutive properties of other weapon materials, to evaluation of the effects of fabrication processes on the characteristics of plutonium and uranium components and on neutron tubes, and to corrosion studies. Research at the Lujan Center is also determining underlying structural changes that occur in aging of uranium-niobium alloys, high explosives, and other materials.

Indirect Value to the Nuclear Weapons Mission through an Institutional Role. LANSCE also contributes to our national security missions indirectly by sustaining the Laboratory's scientific capabilities, which are essential to our ability as a national laboratory to address tomorrow's challenges. LANSCE's broad scientific reach in key areas that are important to national-security missions—materials science and engineering, nuclear science and nuclear energy, and structural biology—have made it integral to the scientific vital-

ity of the Laboratory. Synergy with the Center for Integrated Nanotechnologies and the National High Magnetic Field Laboratory not only provides distinguishing opportunities for scientists at LANSCE but makes the facility a central element of the Laboratory's materials strategy. LANSCE, as was LAMPF before it, is well established as a significant recruiting portal for mission activities across the Laboratory. Literally hundreds of Laboratory staff now engaged in other parts of the Laboratory in support of our missions initially came to Los Alamos through work at this facility. Research using LANSCE adds to contact with the best outside scientists in condensed matter and nuclear science; contact with the cutting edge of science is important to our continued technical excellence in these fields of importance to our weapons mission. Medical isotope production is a national service, and industry has made LANSCE a standard for single-event-upset testing of semiconductor devices.

To ensure that LANSCE remains a "magnet" for excellent scientists, we intend to maintain the facility's scientific vitality and productivity with an emphasis on condensed matter and biology, in addition to weapons program priorities. Feedback from the scientific community has indicated that, properly managed, LANSCE will maintain an important role as a complement to the Spallation Neutron Source for neutron scattering. At the same time, LANSCE offers unique nuclear-science capabilities at WNR, and with an operational Materials Test Station, it could become a unique U.S. capability for materials testing for advanced nuclear power. LANSCE continues to make important contributions to stockpile stewardship and to the scientific underpinnings that will enable the Laboratory to respond to national-security challenges in the future. ■

¹ In 2005, weapons program users from Los Alamos, Lawrence Livermore, and Sandia National Laboratories, as well as the Atomic Weapons Establishment, conducted 27 dynamic experiments at the pRad facility; 66 experiments using 20 percent of the beam time allocated to the user program at the Lujan Center (a 100 percent increase from 2004); and 51 experiments at the WNR and DANCE.