Los Alamos Neutron Science Center

The Los Alamos Neutron Science Center, or LANSCE, is an accelerator-based multidisciplinary facility that provides extraordinary research opportunities in basic and applied science for civilian and defense applications.

Central to the LANSCE facility is an 800-MeV proton linear accelerator (linac) that drives three major national user facilities:

- The Lujan Neutron Scattering Center (Lujan Center) for condensed-matter and nuclear-physics research using pulsed beams of moderated cold, thermal, and epithermal neutrons.
- The Weapons Neutron Research Facility (WNR), which uses an unmoderated neutron spallation spectrum for basic and applied nuclear-physics research, neutron radiography, neutron resonance spectroscopy, and irradiation testing of industrial components such as integrated circuits.
- The Proton Radiography (pRad) facility, which enables high-resolution, time-dependent studies of dynamic events for the study of high-explosive (HE) detonation and burn, hydrodynamics and shock physics, and dynamic materials properties.

In addition to significant achievements in stockpile stewardship and in basic and applied research, the LANSCE complex has been one of the most important Laboratory windows to the academic community and a source of many of the brightest young scientists at the Los Alamos National Laboratory. It is estimated that LANSCE and its predecessor, the Los Alamos Meson Physics Facility, have served as a gateway to nearly 10 percent of the workforce at the laboratory.

The Los Alamos Neutron Science Center, home to an 800-MeV proton linear accelerator.

NNSA Support

LANSCE-based research and capabilities are stronglytied to the requirements for maintaining and certifying the US nuclear deterrent. Facilities are engaged in nuclear, materials, and hydrodynamics research necessary for accurately assessing and modeling weapons performance. Researchers and users are also defining research to meet weapons certification and maintenance milestones. Specific areas of focus include

- measuring neutron-capture cross sections important to (1) interpreting radiochemical measurements of previous nuclear weapons tests and (2) modeling actinide inventories to infer device yield;
- measuring principal fission and fusion cross sections of nuclear fuels and cross sections of fission products to the required accuracy to accurately predict nuclear weapons yield;
- determining the hydrodynamic and shock behavior of weapons materials under the extreme physical conditions of relevance to weapons operation;
- measuring the properties, including the equation of state, of actinides and other weapons materials over a relevant range of pressures and temperatures;
- using the unique, high-resolution and temporal capabilities of pRad to study HE burn, hydrodynamics, and dynamic material properties;
- assessing the change in strength, texture, and compressibility of weapons-relevant materials with age;
- understanding the properties of energetic materials with a view to predicting the performance of weapons and the response of weapons systems in both normal and abnormal environments; and
- developing enhanced neutron tomography for the advanced surveillance of stockpile systems and components.

LDRD

The Laboratory-Directed Research and Development program supports innovative research and development work that extends LANL's science and technology capabilities. The LDRD program has two major components: (1) directed research, which provides funds to make larger strategic investments in research and development projects, and (2) exploratory research, which provides funds to conduct staff initiated research and development that is highly innovative in scope and often at the forefront of their disciplines.

LANSCE has many projects that owe much of their success to LDRD support, including:

- synthesis and characterization of super-hard materials;
- test of "Big Bang" nucleosynthesis model predictions by measurement of the n+p•d+• cross section;
- measurement of neutron cross sections for unstable nuclei of interest to s-process nucleosynthesis;
- exploration of nanoscale dynamics in soft matter;
- short-range order in materials;
- high-pressure crystal chemistry and acoustic elasticity of clathrates;
- stroboscopic studies of polymer dynamic response to stress;
- synthesis, characterization, and modeling of nanoporous hybrid materials;
- studies aimed at understanding lung-surfactant properties;
- development of high-performance cold-neutron spectroscopy;
- development of advanced-neutron-detection technology for nuclear science; and
- partial research and upgrade support for Lujan Center instruments Asterix, SPEAR, and LQD.

In addition to these LDRD projects within LANSCE, there is also substantial LANSCE involvement in projects within other LANL divisions, including neutronand accelerator-based science, advanced-neutrondetection technology for nuclear science, and nuclearisomer physics.

Accomplishments

A number of significant accomplishments in science and technology were achieved in 2002, including the following:

- Researchers used the newly upgraded Pharos chopper spectrometer to perform in elastic-neutron scattering from a plutonium-aluminum alloy and extracted the first-ever phonon density of states. Accurate measurements of the electronic, phonon, and quasi-harmonic contributions to the thermodynamics of plutonium are fundamental in obtaining the equations of state needed for models of weapons performance.
- During the 2002 run cycle, 42 dynamic pRad experiments — a pRad shot record — were performed at LANSCE in support of weapons-physics research efforts. In addition, a new microscope radiography system that established an order of magnitude improvement in resolution and a novel detection scheme for radiography of thin systems were commissioned.
- Scientists and engineers from LANL and Hewlett Packard used WNR to measure neutron-induced failure rates in one of the most powerful supercomputers in the world, the ASCI Q machine.
- The commissioning of the Detector for Advanced Neutron Capture Experiments (DANCE) has allowed scientists to measure neutron-capture rates (cross sections) of importance to the interpretation of radiochemical measurements of previous nuclear weapons tests. DANCE enables, for the first time, studies of reactions on radioactive isotopes.
- A new, robust target-moderator system, the Mark 2, was designed and installed at Lujan Center. The new target has improved cooling compared to the Mark 1 moderator and upper target. A beryllium reflector replaced the lead reflector, cooling was simplified, and cadmium decoupling in the reflector was removed for more robust operation.
- The Basis for Interim Operation for actinide experiments was completed. This new authorization basis enabled completion of more than a dozen plutonium and uranium studies and restores an important capability to the DOE science complex.
- The intense beam from the LANSCE Proton Storage Ring (PSR) was used to measure the effects of pulsed beams on the liquid-mercury targets for the Spallation Neutron Source (SNS) project at Oak Ridge. As a result, scientists discovered that pitting in the container surfaces caused by the intense PSR beam pulse may be a lifetime- limiting problem for the SNS targets. Studying this problem at WNR before the SNS targets are installed has led to the development of mitigation techniques.
- The PSR e-p instability was tamed. A series of successful PSR development tests confirmed that the instability could be controlled at accumulated charge levels approaching 10 mC, well above the goal of 6.7 mC.

Lujan Neutron Scattering Center

The Lujan Neutron Scattering Center is a national user facility that serves more than 300 user visits per year in a peer-reviewed research program. Using beam from the linear accelerator at the Los Alamos Neutron Science Center, or LANSCE, the Lujan Center is a pulsed spallation neutron source equipped with time-offlight spectrometers for neutron scattering studies of matter. Neutron scattering is a powerful technique for probing the microscopic structure and dynamics of condensed matter and is used in materials science, engineering, condensed matter physics, chemistry, biology, and geology. Two of the beam lines at the Lujan Center are devoted to fundamental nuclear research. The product of the Lujan Center is fundamental research made possible by access to world-class instruments and staff.

The Lujan Center develops instruments and methods for addressing problems important to the basic research community and to stewardship of the nation's nuclear weapons stockpile. Examples include the study of elastic strain in metals and composites, the determination of bulk texture, structural studies at high pressure, characterization of the morphology of polymers and blends, and the examination of the structure of protective layers, coatings and adhesives.

Several divisions at the laboratory, especially the Materials Science and Technology, Chemistry, Physics and Theoretical Divisions work closely with Lujan Center staff to bring neutron scattering methods to bear on complex problems whose solutions often require the application of multiple techniques. The DOE's Office of Basic Energy Sciences sponsors operation of the neutron scattering user program. Among other DOE sponsors are Biological and Environment Research, Office of Industrial Technologies, and several of National Nuclear Security Administration campaigns and Readiness in Technical Base and Facilities program. More than half of Lujan Center users come from academia and are funded by a variety of sources, including the National Science Foundation and the National Institutes of Health.

A laboratory employee adjusts a magnet on Asterix.

Lujan Center beam time is allocated twice a year through peer-review of proposals, with roughly 20 percent allocated to national security experiments in materials physics for nuclear weapons research and chemical and biological science for Homeland Defense. Approximately one-third of Lujan users conduct research in nanoscience or bioscience.

The instrument suite at the Lujan Center consists of 13 instrumented neutron beamlines, two beamlines under construction, and two open beamlines for new instruments. Two beamlines are used primarily for nuclear physics research; the remaining 11, shown in the box below, are dedicated to materials science, including bioscience.

Diffraction — "Where atoms are"	**NPDF** **SMARTS** **HIPD** **HIPPO** **SCD** **PCS**
Spectroscopy — "How atoms move"	**Pharos** **FDS**
Reflectivity "Thin Films"	**SPEAR** **Asterix**
Small-Angle Scatterering — "Particles, Polymers"	**LQD**

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