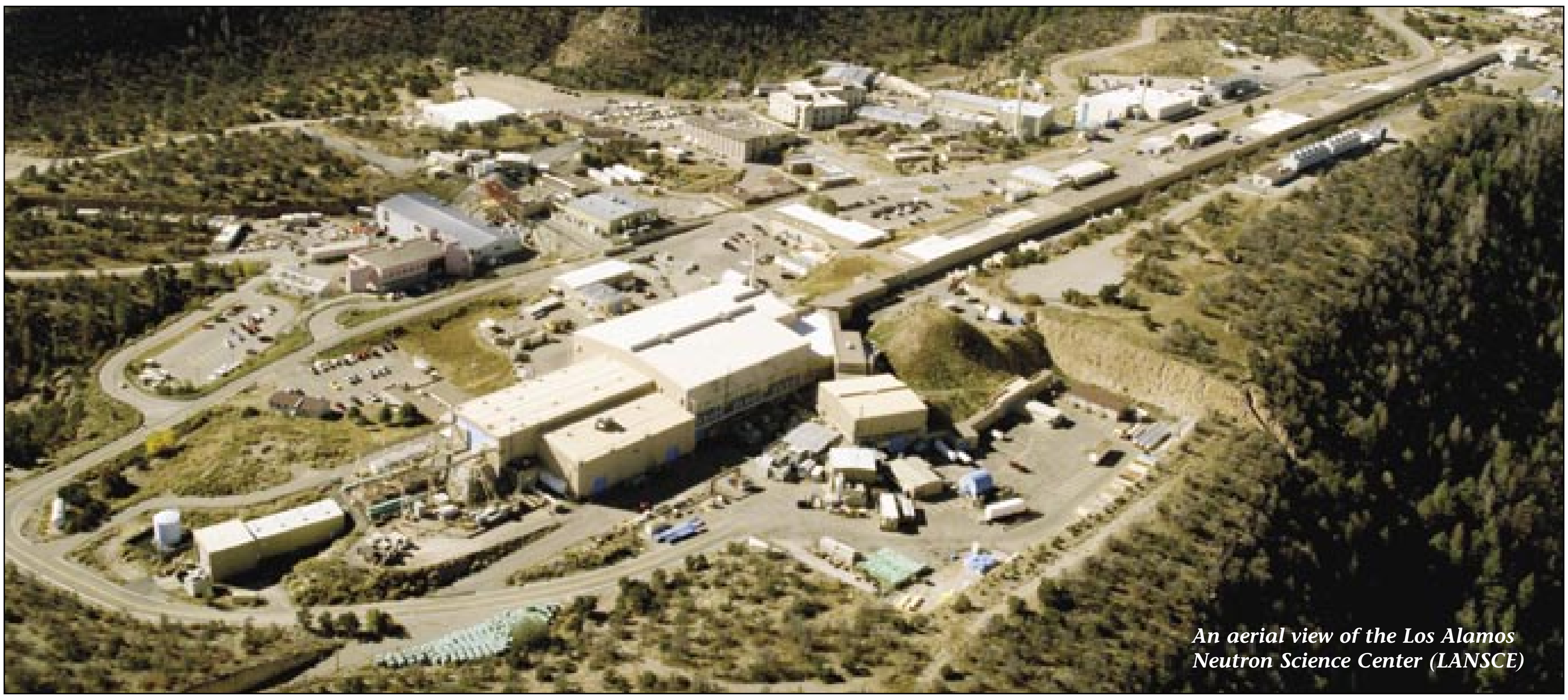

An aerial view of the Los Alamos Neutron Science Center (LANSCE)

Lujan Neutron Scattering Center celebrates record-breaking run cycle

"We hosted [more than] 700 researchers in 2005 between early February and late December when we ceased operations for scheduled maintenance," said Alan Hurd, the Manuel Lujan Jr. Neutron Scattering Center director. "Our previous record was about 540 researchers in 2003-2004, so we're really doing great. Even with some challenges last year, we were able to operate 24 hours a day for 174 days — which also is a record for us. That's almost a year and a half of normal workdays packed into just half a year. It's been a team effort, and the support's been wonderful."

The Lujan Center is a Department of Energy, Office of Basic Energy Sciences designated national user facility, serving top researchers from around the world who need powerful beams of neutrons to conduct experiments on a wide range of materials.

The center is highly complex and has 14 different instruments, which are operated and used simultaneously. These instruments allow researchers to peer into the structure of materials.

"We have the capability to actually see how materials are built at the atomic level, and what makes them behave the way they do. This is critical information, because with it we have the potential to build brand new materials to our specifications — 'designer materials,' if you will," Hurd said. "These are the kinds of new custom materials we'll need in the 21st century to explore space, become more energy independent, advance medicine, improve our national security and clean up the environment." Over half of the researchers are between the ages of 20 and 40. "It's a new generation of scientists looking to the future, and they see the future in materials research and development," Hurd explained. "The future looks quite exciting as we received 241 proposals for the

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Protons at the Los Alamos accelerator begin their journey here, in the domes at the top of three of the Cockcroft-Walton accelerators. By the time the particles leave this section, they have been accelerated to 7,440 miles per second (4 percent of the speed of light). From here, the beams pass through low-energy transport systems where they are steered, focused and bunched for injection into the second stage of the accelerator. *File photo*

Biologists discover the power of neutrons

For nearly two decades, condensed matter and nuclear physics researchers at the Laboratory and from around the globe have used the pulsed beams of neutrons available at the Manuel Lujan Jr. Neutron Scattering Center for explorations into the microscopic structure of matter. Today, a "typical" Lujan Center user is just as likely to be working in the biological sciences as in more traditional areas such as polymer physics or geoscience. In fact, in 2005 more than one-third of Lujan users conducted bioscience or nanoscience research.

Over the past several years, neutron scattering techniques pioneered at Los Alamos have been used to explore a variety of bioscience questions, including those related to newborn babies, electrocution victims and soldiers in the modern battlefield. The Los Alamos Neutron Science Center (LANSCE) neutron source has proven that neutrons, once considered too weak to compete with synchrotrons for unraveling biological structures, have a unique capacity to locate crucial hydrogen atoms in proteins and cell membranes.

In 2001, researchers from the Institute for Biophysical Dynamics at the University of Chicago, along with researchers from University of California, Santa Barbara; Risø National Laboratory in Denmark; Advanced Inhalation Research/Alkermes in Cambridge, Mass.; and Martin Luther King Jr./Drew Medical Center at University of California, Los Angeles, used the Lujan Center to discover that a small protein in lung surfactant is needed by newborn babies to prevent collapsed lung. Lujan Center experiments show that a protein called SP-B is crucial to keeping the surfactant in a sufficiently fluid, highly wetting state. Neutron reflectivity of these

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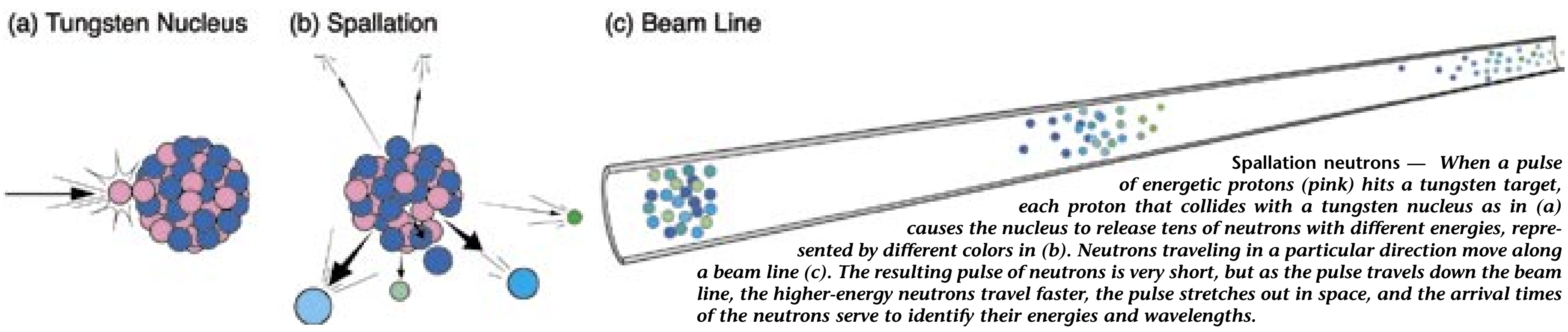

Spallation neutrons — *When a pulse of energetic protons (pink) hits a tungsten target, each proton that collides with a tungsten nucleus as in (a) causes the nucleus to release tens of neutrons with different energies, represented by different colors in (b). Neutrons traveling in a particular direction move along a beam line (c). The resulting pulse of neutrons is very short, but as the pulse travels down the beam line, the higher-energy neutrons travel faster, the pulse stretches out in space, and the arrival times of the neutrons serve to identify their energies and wavelengths.*

Neutrons, neutrons, everywhere

Present in all known atomic nuclei, except the most common isotope of hydrogen, neutrons are uncharged elementary particles with slightly more mass than protons. As the veritable Swiss of the atomic world, these neutral subatomic particles have neither a positive nor negative charge, and therefore interact weakly with any molecules they pass through. This makes them ideal particles with which to probe the atomic and molecular structure of materials.

To free neutrons from their tight nuclear confinement and create a stream, or beam, of neutron-bearing pulses, the Los Alamos Neutron Science Center (LANSCE) proton storage ring receives a stream of high-intensity proton pulses from the one-kilometer LANSCE accelerator, compresses the pulses to be shorter, then sends them toward a tungsten target. As the proton pulses collide with the target, they break neutrons away from the nuclei of the target atoms. These neutrons are called spallation neutrons, which fly away from the target at the rate of about 20 neutrons for each original proton. The more intense the proton beam, the more neutrons released. These neutrons fly through slabs of water or hydrogen to slow them down, then down a "beam line" toward one of the several Lujan instruments, where they are used in neutron scattering and nuclear physics experiments.

The instrument suite at the Lujan Neutron Scattering Center consists of 16 instrumented neutron beam lines. Of this number, two beam lines are used primarily for nuclear physics research, leaving the remaining 14 for use by the international materials research community for such work as the study of elastic strain in metals and composites, structural studies of materials at high pressure, the characterization of the morphology of polymers and blends, understanding proteins, and the examination of the structure of protective layers, coatings and adhesives.

The Lujan Center is a source of innovation and a site of collaboration within the Laboratory. Scientists from the Materials Science and Technology (MST), Chemistry (C), Physics (P) and Theoretical (T) 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.

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 Center users conduct research in nanoscience or bioscience.

The third and longest stage of the accelerator is the side-coupled-cavity linac, where protons are accelerated to their final energy of 800,000,000 electron volts, moving about 157,000 miles per second (84 percent of the speed of light).

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first part of our next run cycle beginning May 1. This is 20 percent more than for any comparable period."

The Lujan Center, located at Technical Area 53, is one of four facilities and five experimental areas that comprise the Los Alamos Neutron Science Center (LANSCE) at the Laboratory. At the heart of LANSCE is an 800-million-electron volt proton accelerator, the most intense in the United States. The beam from this accelerator, in the form of pulses of protons, can supply beam to the Lujan Center, the Weapons Neutron Research Facility, the Isotope Production Facility and the Proton Radiography Facility, all simultaneously. Since its construction 33 years ago, LANSCE has been a leading facility for research in materials science and engineering, condensed-matter physics, chemistry, biology and geology.

In addition to the Department of Energy's Office of Basic Energy Sciences, LANSCE is sponsored by the National Nuclear Security Administration, the Office of Biological and Environment Research, the Office of Nuclear Energy and the Office of Industrial Technologies.

Biologist …

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lung surfactants showed why certain molecules prevent collapse, which was important news for both physicians treating premature newborns and populations that may come to be exposed to respirable bio-threat agents.

Another team of researchers used the neutron scattering capability at LANSCE to better understand why electrocution victims often die several hours after their exposure to high voltage and current due to cell membrane damage and leakage. The investigators are trying to develop a better understanding of a polymer called "poloxamer" and the mechanisms involved in its ability to seal cell membranes that have been compromised by trauma and diseases like electrical shocks, radiation injuries, thermal burns, frostbite and sickle cell disease, and poloxamer's inexplicable ability to gracefully exit the cell when the membrane integrity has been restored.

Another area of biological science in which neutrons have been applied is in the area of defenses against bio-toxins, where neutrons have been used to study the molecular attack strategy of peptides against various cell types (bacteria, viruses, red blood cells). The result has been knowledge about how to design a new wave of antibiotics that are more robust and with greater, longer-term efficacy against bioterrorism. A crucial step in these studies was to determine the structure of complex proteins, and the instruments at the Lujan Center were critical in deciphering the full molecular structure.

In light of the Lujan Center's growing role in biophysics research, LANCSE will devote this year's annual Neutron Scattering School to studies of soft condensed matter and structural biology. Co-sponsored by the Laboratory, DOE's Office of Basic Energy Sciences, the National Science Foundation and New Mexico State University, the school will provide an overview and training in using neutron scattering for soft condensed matter studies and structural biology. The school, which is being held at the Lujan Center May 18 through May 26, will include basic neutron scattering experimental methods, data reduction and analysis techniques, and the opportunity for hands-on experiments. It is intended for graduate students and postdoctoral researchers working in the physical, chemical and biological sciences.

More information about the school is available at *http://lansce.lanl.gov/neutronschool/index2.html* online.