Spallation Neutron Source

Because they have no charge, neutrons penetrate more deeply into materials than do X rays, light, or electrons and thus reveal bulk structure and properties of materials. The results of experiments at a brighter neutron source will complement those from the other probes, plugging gaps in our knowledge about materials.

What is spallation? When a high-energy proton bombards a heavy atomic nucleus, some neutrons are "spalled," or knocked out, in a nuclear reaction process called spallation. Other neutrons are "boiled off" as the bombarded nucleus heats up. For every proton striking the nucleus, 20 to 30 neutrons are expelled.

Nobel Laureate Clifford Shull was among the Oak Ridge National Laboratory researchers who pioneered neutron scattering by using neutrons from the Laboratory's Graphite Reactor.

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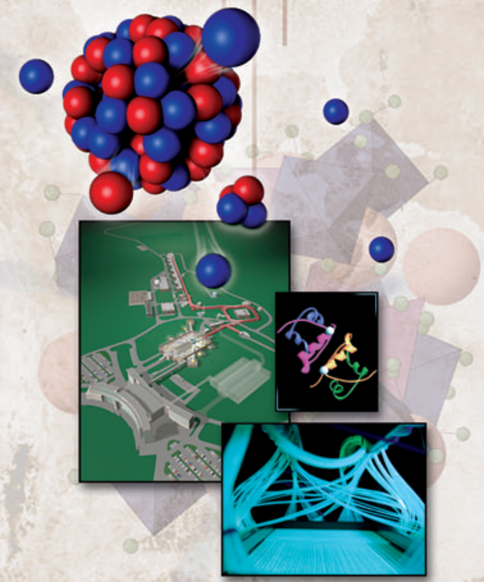
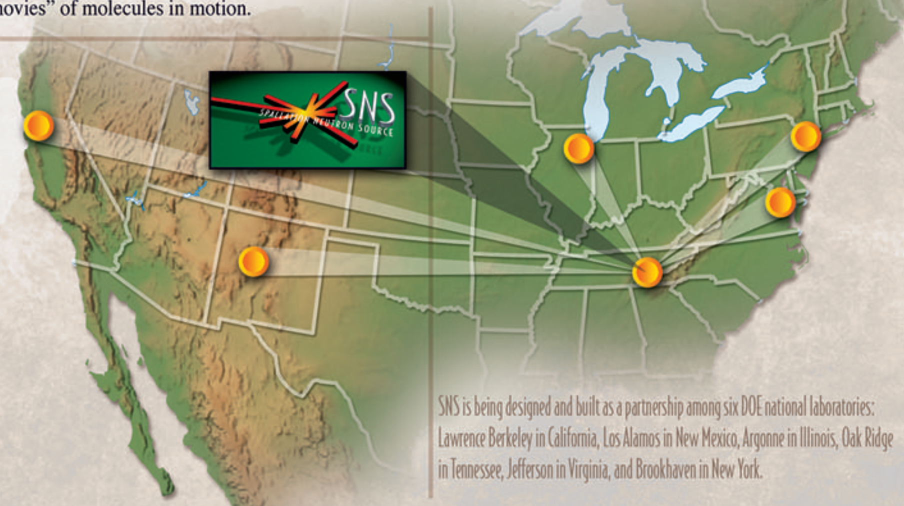
The next-generation neutron-scattering facility for the United States



The second half of the 20th century has brought us many new things that have improved our quality of life–things like audiotapes and videotapes, compact discs and computer disks, credit cards, cosmetics, environmentally friendly dry cleaning, shatter-proof windshields and automated car seats and windows, therapeutic drugs, and life-saving bulletproof vests. These materials have been improved by research with the building blocks of the cores of atoms—neutrons. If you bounce a beam of neutrons off atoms in a crystal and measure the directions and energies at which the neutrons "scatter," you can determine how the atoms in the crystal are arranged and how they interact. The properties of any material are largely determined by how its atoms are arranged and how they interact with each other. Such neutron-scattering experiments have produced information that has guided the design and manufacture of better materials and products that we use every day.

The U.S. Department of Energy (DOE) Office of Science is building the world's best accelerator-based, pulsed-neutron system, called the Spallation Neutron Source (SNS), in Oak Ridge, Tennessee. Six DOE national laboratories are involved in designing this powerful scientific tool. Like a flashing strobe light providing high-speed illumination of an object, the SNS will fire pulses sixty times a second at a target. Those pulses will contain up to ten times more neutrons than are produced at the most powerful pulsed neutron sources in the world. Just as we prefer a bright light to a dim one to read the fine print in a book, researchers will prefer this source of "brighter" neutrons. SNS will give more detailed snapshots of the structure of even the smallest samples of physical and biological materials, from plastics to proteins, making "movies" of molecules in motion.



SNS is being designed and built as a partnership among six DOE national laboratories: Lawrence Berkeley in California, Los Alamos in New Mexico, Argonne in Illinois, Oak Ridge in Tennessee, Jefferson in Virginia, and Brookhaven in New York.

Oak Ridge National Laboratory
SNS

"A brighter source of neutrons could bring a brighter future"

So what new things might we expect from neutron science in the next millennium when the United States has a new SNS by 2006? Here's the stuff of dreams that might be realized faster with the help of neutron scattering at a new SNS:

- Drug-delivery systems that release a medicine precisely when and where it is needed in the body to relieve pain.
- Cities with cleaner air where trucks, buses, and cars are all powered by small, nonpolluting, cool-running fuel cells.
- Lubricants specially tailored for tomorrow's more efficient, emission-free car engines.
- Advanced medicine that tests and provides remedies for demineralizing diseases such as osteoporosis.
- Superconducting wires and stronger magnets that will bring lower power costs and more fuel-efficient vehicles.
- Plastics manufactured cost effectively with environmentally friendly processes that don't harm the ozone layer.

Magnetism & Superconductivity

High-speed trains of the future that will be levitated by superconducting magnets will be even faster than the TGV in France (shown here).

Complex Fluids

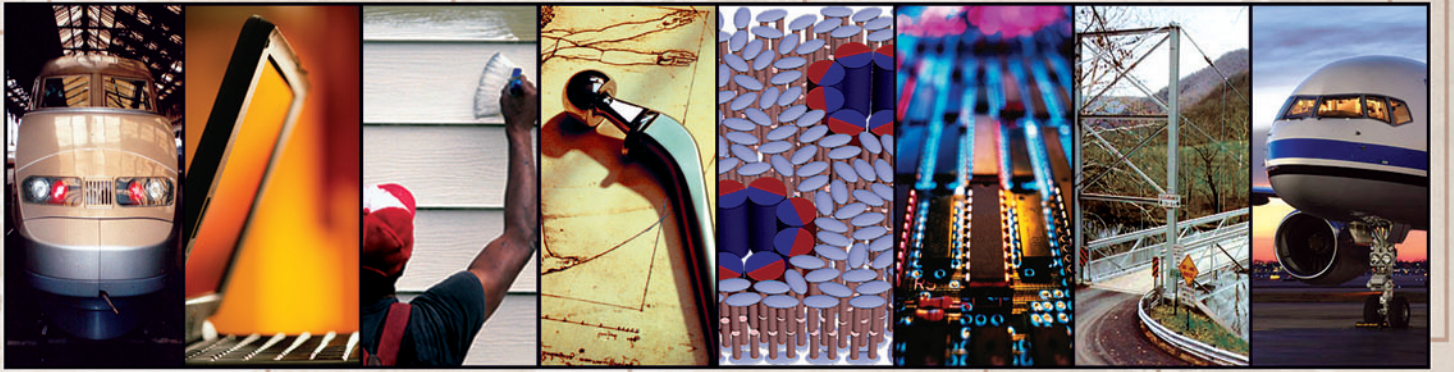
Protective coatings, such as paint, are complex fluids whose change in molecular structure during shear thinning (e.g., brushing paint on a wall) can be studied with neutrons.

Biomaterials

A neutron-scattering study carried out at the Intense Pulsed Neutron Source, Argonne National Laboratory, produced data for a model that shows peptides (cylinders) inserting themselves in holes they form in a cell membrane.

Polymers

Much of the Boeing 757 airplane is made of lightweight plastic. Neutron studies could lead to safer, faster, more energy-efficient aircraft.



Crystalline Materials

Thin films that can be probed by the SNS will be used for nonvolatile memory, extending the life of laptop computer batteries.

Disordered Materials

Intense neutron beams will offer clues on preparing better surfaces of wear- and corrosion-resistant alloys for use as hip implants.

Semiconductors

Smaller, faster electronic chips that may result from neutron studies will bring low-cost power devices and the convenience of smart cards and ubiquitous computing.

Engineering

The Corbin Bridge in Pennsylvania was the first to have an aluminum deck replacement (in 1996). Aluminum welds for such decks are being characterized by neutron scattering.