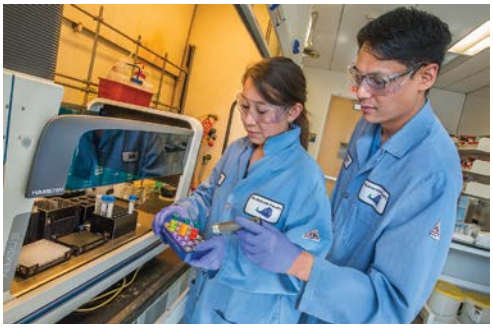

ABOUT THE IMAGES

Aerial view illustrates the enormous scale of Brookhaven National Laboratory's X-ray source, which replaced the original (smaller and less powerful) X-ray facility, part of BES's continuing stewardship of its shared research facilities. Electrons circulating at high speed in the circular magnetic storage ring are converted into intense X-rays for research use at dozens of individual beamlines.
(BROOKHAVEN NATIONAL LABORATORY)

Columbia University researchers using a beamline from the neutron source at Oak Ridge National Laboratory to analyze a suspension bridge cable and how it might fail under stress, in order to facilitate design of better cables.
(GENEVIEVE MARTIN / OAK RIDGE NATIONAL LABORATORY)

Scientists prepare nanoparticle samples for analysis at a Nanoscale Science Research Center in California.
(LAWRENCE BERKELEY NATIONAL LABORATORY)

SHARED RESEARCH FACILITIES

A Key Source of U.S. Scientific and Industrial Leadership

By the 1970s, it had become clear that X-ray and neutron beams could provide insights into the structure and properties of materials that were not obtainable in any other way. It was also clear that the cost and scale of the facilities required to produce such beams were beyond the reach of individual scientists or even major universities. So forty years ago, the Basic Energy Sciences (BES) office of DOE began to build dedicated facilities that could be used—shared—by many researchers. The result has been spectacular discoveries and insights into materials important for all forms of energy production and for national security, as well as insights into complex biological molecules and new drugs important for human health.

The Shared Research Facilities

Unique tools that enable university, industrial, and federal researchers to do cutting edge research while also facilitating collaboration among visiting scientists and the scientific staff of the facilities and the national laboratories where they are located.

- **X-ray**. Five immense facilities that accelerate electrons close to the speed of light and convert them into X-ray beams a billion times more intense than those in a dentist's office, which enable scientists to analyze the structure and electronic properties of matter.
- **Neutron**. A nuclear reactor that generates low-energy neutron beams useful for studying biological molecules and nanoscale materials; and an accelerator that smashes high-energy protons into a liquid metal target to create high-energy neutron beams, used to identify the location of atoms in a material, to study its magnetic properties, and to probe deep within materials or even inside an operating engine.
- **Nanoscale.** Five relatively recent facilities with contaminant-free rooms for sample fabrication and an array of analytical tools including advanced electron microscopes capable of "seeing" matter at atomic scales, which enable scientists to explore the unique properties and behaviors of matter that are the basis of emerging nanotechnologies.

The Impact

Remarkable advances in knowledge—including multiple Nobel Prizes—and the acceleration of new technologies. In addition, these facilities enable:

- Increased productivity for the nearly 16,000 scientists—mostly from universities and government laboratories, but also from industry—who use these facilities each year.
- Applied research by industrial users—who pay their own way for proprietary research—for such things as fine-tuning engine designs, metallic alloy compositions, or new drug candidates.
- Training the next generation of scientists, as 40 percent of the academic users are graduate or advanced undergraduate students on a professor's team who get an unparalleled exposure to cutting edge research.

The Takeaway

These shared research facilities, made possible by long-term BES support, remain a unique U.S. competitive advantage by facilitating cooperative science.

Adapted from chapter 12 of A Remarkable Return on Investment in Fundamental Research, U.S. DOE, June 2018.
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