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Let there be light!

IMAGE COURTESY OF BROOKHAVEN NATIONAL LABORATORY

BRIGHT DAYS LIE AHEAD FOR BROOKHAVEN AND OTHER US LIGHT SOURCES, BUT STAFFING SHORTAGES MAY MEAN TROUBLE FOR MATERIALS SCIENTISTS.

Dark days lie ahead for American science. The price tag for the occupation of Iraq is now nearing US$150 billion dollars, and the economy is sluggish. The deficit is growing and newly enacted tax cuts are choking government revenue. Agencies supporting the physical sciences will be lucky to win even a small budget increase to keep up with inflation in 2004.

But into even the darkest days a little light must fall, and for materials scientists that light may well come in the form of X-rays from the nation's synchrotrons. Despite a decade-long budget freeze at the Department of Energy's Office of Science, which oversees the majority of US synchrotrons, light sources continue to receive healthy budgets, and plans for newer and more powerful facilities appear to be on track. The Advanced Photon Source, the nation's premier light-source facility in the Argonne National Laboratory in Illinois, continues to build new experimental beam lines every year, with an eye towards 80 such lines by 2008. At the National Synchrotron Light Source at Brookhaven National Laboratory, in New York State, programme managers are laying the groundwork for a US$400 million upgrade to make the source 10,000 times brighter by 2012. And this month the Stanford Linear Accelerator Center is scheduled to complete a US$58 million upgrade to its Stanford Positron Electron Asymmetric Ring (SPEAR) facility, which will be five times brighter than before.

Stanford is also home to a far more ambitious conversion project. Scientists and laboratory administrators are planning to convert the lab's 15 GeV linear electron accelerator, which discovered the charm quark in 1974, into a powerful X-ray laser. Magnets positioned along the beam line will wiggle bundles of electrons as they shoot through the accelerator, creating tightly focused pulses of 1–15 Å X-rays that will be powerful enough to probe nanometre-sized structures. The pulses, which will be only a few femtoseconds long, should also give scientists an unprecedented picture of motion at the nanoscale, allowing researchers to study everything from magnetic and thermal phase transitions in condensed matter, to the interactions of large organic molecules. It may even allow materials scientists to follow the dynamics of complex biological processes such as photosynthesis. If approved, the $US300 million facility will begin construction in 2006 and be fully operational by 2009.

What allows light-source scientists to make ambitious plans at a time when most researchers are struggling to make ends meet? The answer is the wide applicability of these facilities to physical, environmental and biological sciences. The life sciences, which have done better in recent years due to the success of the biotech industry, have been especially instrumental in ensuring funding for light sources. In some cases, life sciences agencies have contributed directly to facility upgrades. For example, the National Institutes of Health came up with half of the money needed to increase SPEAR's power. But more frequently, the money supports the building of new experimental beam lines for specific applications such as protein crystallography.

According to organizers of light-source users, this leaves materials scientists in a quandary. Although the synchrotrons themselves are in the public domain and free for all to use, beam lines are individually financed by agencies, universities or corporations, in exchange for a majority share of time for their own experiments. This means that beam lines devoted towards materials science are plagued by the same funding problems that dog the rest of physics and chemistry, and are often understaffed and unable to run at full capacity. The problem has been exasperated by the telecom downturn, which has caused companies like Lucent to withdraw support for fundamental research. One proposed solution is to give the Department of Energy a larger role in managing beam lines at government facilities. But given the current fiscal climate, it is unclear how the department would get the money needed to increase staffing.

Despite these problems, US light sources will continue to be a valuable tool for materials scientists. They are free to use for any researcher in the world whose proposal passes an internal peer-review, and their powerful X-rays are a tool that few scientists could afford even in the best of times. As these facilities continue to be upgraded, they should provide a few bright spots for researchers that might otherwise be facing some dark times.