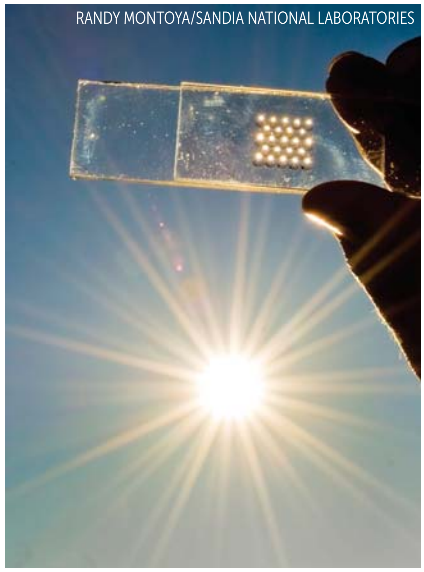
Scientists at US national labs thrive on discretionary funding

The opportunity to follow their curiosity keeps researchers connected to the greater scientific community.

"You can start a program out of thin air—the lab will back you for a while if your idea is compelling," says Los Alamos National Laboratory scientist Albert Migliori. "But you'd better have a compelling elevator speech."

The availability of internal funding at the Department of Energy's national labs encourages researchers to have "bold imaginations and push the boundaries of scientific progress," says Kelly Sullivan, manager of institutional science and technology investment at Pacific Northwest National Laboratory (PNNL). "Discretionary funding is a really valuable tool for helping each lab execute its strategy, and in helping DOE define the future of science."

Discretionary funding—known as Laboratory Directed Research and Development (LDRD)—is especially important for the weapons labs, where much of the work is classified. (See PHYSICS TODAY, October 2009, page 23.) LDRD serves as a recruitment tool and provides a path for researchers to publish in the open literature. Says William Priedhorsky, who oversees LDRD at Los Alamos, "It's about maintaining scientific vitality."



RANDY MONTOYA/SANDIA NATIONAL LABORATORIES

THESE TINY PHOTOVOLTAIC CELLS grew out of a project funded by the Laboratory Directed Research and Development program at Sandia National Laboratories. Each crystalline silicon or gallium arsenide photovoltaic cell is up to 20 microns thick and 250 microns across. The cells can be attached to clothing, tents, satellite surfaces, or other substrates to provide power on demand.

Higher caps in sight?

From the national labs' start more than 60 years ago, government agencies have recognized the value of discretionary research funding to the labs and to their national missions. Historically, LDRD funding has been about 6% of each laboratory's budget. For fiscal year 2000, the amount dipped to 4%; it then jumped back the next year to 6%. A decade ago it was raised to 8%, but overhead—or burden—was imposed, "which made it a wash," Priedhorsky says. Then, in FY 2014, it was lowered back to 6%—still with overhead. "That was a real cut," he says.

Congress has a particular interest in the LDRD pool because it is created by taking a percentage from other lab budgets "to use with some leeway," says Lucille Gentry, the Albuquerque-based federal program manager for LDRD. The fluctuations in LDRD may stem from lawmakers' discomfort with that leeway. But, stresses Gentry, "LDRD is not a sandbox. It's futuristic R&D, and it's subject to a huge amount of oversight" by the lab directors and DOE.

Two recent developments suggest that LDRD may grow a bit. Last November President Obama signed the National Defense Authorization Act (NDAA) for FY 2016, which stipulates that for the weapons labs—Los Alamos, Lawrence Livermore National Laboratory, and Sandia National Laboratories—LDRD should be "not less than 5 percent and not more than 7 percent." Over the years, says Priedhorsky, "LDRD has found both passionate detractors and advocates in Congress. Never before has Congress specified a minimum. This speaks to someone recognizing that LDRD provides great value."

Around the same time, in a congressionally mandated external review of the DOE laboratories, the Commission to Review the Effectiveness of the National Energy Laboratories (CRENEL) said it "strongly endorses the LDRD programs, both now and into the future, and supports restoring the cap on LDRD to 6 percent unburdened, or its equivalent."

At press time, DOE was still working out how to reconcile the 5–7% cap for weapons labs in the new legislation with the preexisting 2014 6% cap for all DOE labs and with the CRENEL recommendation for 6% without overhead. Priedhorsky notes that LDRD comes out ahead with both the CRENEL recommendation and the NDAA and says "there is a vague hope" that higher caps will go into effect for FY 2017.

Discretionary categories

Although LDRD research topics are broad and bottom-up, they are required to be relevant to the host lab's core missions. Typically, a lab will request proposals of various scopes. At Livermore, for example, projects range from individual efforts to those involving large multidisciplinary teams; annual funding falls into three categories: up to $300 000, up to $1.5 million, and up to $3 million. Proposals have to tie in to stewardship of the nuclear stockpile, biosecurity, high-performance computing, or another of the lab's missions. The other labs have similar funding categories; each lab also saves a few percent of its LDRD funding to respond to new ideas as they arise.

Committees at the labs evaluate proposals for science and engineering merit and for alignment with the host lab's mission. The internal peer-review process is "rigorous" and is modeled on "federal best practices," Priedhorsky says.

In FY 2015 the 16 DOE labs that can skim their budgets for LDRD used it to fund a total of 1741 projects to the tune of $542 million, according to an annual report by DOE for Congress. Of those, 817 projects, for nearly $352 million, were at the three weapons labs. The weapons labs nearly reached their caps, and they funded only 10–15% of proposals.

The labs with a strong applied focus came next in spending; PNNL, for example, invested nearly 4.5% of its budget in a total of 203 projects. Fermilab and the Thomas Jefferson National Accelerator Facility, which have more tightly focused R&D programs, each put less than 1% of their budgets into LDRD. The value of discretionary funding at those labs was recognized more recently; DOE gave them the green light in 2014 to set aside LDRD and they are still experimenting with it.

Curiosity driven, mission relevant

In his four decades at Los Alamos, Migliori has been involved in several LDRD projects. In one, he developed ultrasound techniques to study high-temperature superconductors. Later he applied ultrasound to plutonium thermodynamics. And in research that started as LDRD but has moved into the weapons program, he studied the electronic structure and aging of plutonium-242, which is less fissile than the plutonium-239 used in nuclear weapons and reactors.

For one LDRD project, Los Alamos's Chris Fryer and colleagues took computer algorithms they were working on for the National Ignition Facility (NIF) at Livermore and applied them to simulate photon emissions from supernovae. "It's the same physics," he says, "radiation flowing through materials." But because material moves faster in supernovae, he found bugs in the codes that were not evident in the NIF work. "By pushing codes to new extremes, we found things we could make better for the lab mission codes. It brought us full circle."

Some components and processes that are now integrated into NIF grew out of LDRD research. One project focused on grinding and polishing fused silica, measuring microfractures, and then coming up with strategies for eliminating them. Another worked to minimize nanometer-scale impurities in glass. As a result, the optics can tolerate higher-intensity laser exposures, leading to less damage and an extended lifetime, says Tayyab Suratwala, who runs an optics group at Livermore. "Without those advances, NIF would be running at roughly half the energy it is today." He adds that LDRD funding was crucial: "The other source would be project dollars, which don't have the bandwidth to devote to fundamental science."

At Sandia, Edward Jimenez adapted graphics processing units (GPUs), which


LLNL

FÉLICIE ALBERT (center) and Bradley Pollock (right) prepare to do experiments with a betatron. The tabletop synchrotron produces femtosecond x-ray pulses and "is a good tool to probe dense plasmas," Albert says. It took her several tries to win discretionary funding for the project at Lawrence Livermore National Laboratory.

PNNL

IN THIS MOCK CONTROL ROOM at Pacific Northwest National Laboratory, researchers study how to better manage the power grid.

handle images in game consoles and other devices, to computed tomography. He explains that computed tomography is applied to things as small as thimbles and as large as trucks. That wide range meant that no single user was likely to back the development of a new general reconstruction algorithm. "No one, neither internally nor externally, wanted to buy in," he says. That's why he applied for LDRD. His algorithm for GPUs has greatly reduced time and energy consumption of tomography computations.

Keepers

When Jimenez first joined Sandia about five years ago, the opportunity to compete for LDRD funds was "a huge attraction," he says. "It was a big draw to not only pursue work related to national security problems, but to see my science put to use in quality assurance."

At the weapons labs, more than half the postdocs spend time on LDRD. Félicie Albert, for example, joined Livermore eight years ago as a postdoc to work on a gamma-ray source for nuclear spectroscopy experiments. After a couple of years, she became a full-time staff member. Postdocs "get to know the lab, and we get to know them," says Rokaya Al-Ayat, who oversees Livermore's LDRD program. "At the end of three years, we know if someone is a keeper."

Even at senior levels, LDRD is effective for recruitment and retention. Fermilab, says lab director Nigel Lockyer, used LDRD to entice and provide startup funding for a leading researcher, Brad Benson, in the area of cosmic microwave background polarization. And Dan Sinars, who is responsible for inertial confinement fusion and radiation science at Sandia's Z machine, recalls when LDRD made it possible for him to do unclassified work in pulsed power and to publish it openly. "It gave me the freedom to pursue my ideas, which helped retain me as a staff member at Sandia." Sinars was part of the team that developed the magnetic direct-drive inertial confinement fusion target for the Z machine (see PHYSICS TODAY, June 2014, page 24).

Priedhorsky says that in any given year, about 1400 Los Alamos employees out of a total of 9400 spend at least one hour on LDRD. Livermore reports similar statistics. "A lot of people do a little LDRD," says Priedhorsky. He estimates that about 50 charge at least half their time to LDRD for four years running. "It's not a way to make a living," he says.

The high numbers of baby boomers at both Los Alamos and Livermore mean that about one-third of the workforce is expected to retire in the next five years, notes Priedhorsky. "LDRD will be essential to continue to attract the best scientists."

Toni Feder