field" environment in Texas. Instead, he is monitoring radiation safety at the 48-year-old Argonne (Illinois) National Laboratory. "My job at the SSC was mainly to be sure that the same problems we were running into at Fermilab wouldn't occur in Texas," Baker says. "We really did get things off on the right foot. We're not going to leave [the SSC's neighbors] with a bunch of long-term environmental problems. But I'm disappointed that we couldn't continue with the work."

All technical activities at the lab must be halted by 1 January, including work on the linear accelerator, the first of three boosters for the main accelerator, and documentation of everything done before the cancellation. Some parts of the SSC will take care of themselves: The 23 kilometers of tunnel already dug, for example, will be allowed to fill up with ground water from the surrounding soil. But for many former SSC scientists, there's a hole in their professional lives that nothing can fill. Indeed, soldiering on is challenge enough.

For Argonne's Sam Baker, whose wife still works in the SSC's administrative offices and whose teenage son is an hour away at the Texas Academy of Mathematics and Science, reuniting his family is a first step. "Slowly," he says, "we're getting our lives back together."

–Wade Roush

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SPACE SCIENCE

Small Satellites Offer Global Appeal

JERUSALEM—In the aftermath of the collapse of the Soviet Union, east European scientists like Karoly Szego seemed to have little hope of taking part in space research missions. Their governments had little money to support such ventures, and they lacked the access to space that comes with membership in the exclusive Western space clubs. But prospects for Szego—and for scientists from other countries that don't have the resources to support much space science—are looking up. The reason: The worldwide trend toward smaller, cheaper satellites is lowering the cost of participating in space programs.

Szego, a Hungarian physicist, is part of a team of scientists and engineers from seven nations building 10 instruments for the 1998 launch of the 300-kilogram Central European Satellite Advanced Research (CESAR). The mission, to study Earth's magnetosphere, ionosphere, and thermosphere, is scheduled to be launched on an Italian rocket at a cost of around $50 million. CESAR is the biggest of a slew of upcoming small satellites that are allowing more players into a game that has been, until now, the province of large countries (see table). The trend, which is also giving traditional space powers a chance to do more science for less money, was the talk of the the International Astronautical Federation Congress, held here earlier this month.

This enthusiasm for small, inexpensive satellites is an abrupt change from the bigger-is-better philosophy that prevailed for much of the 37-year history of space exploration. Within a year of the first space probe—the 80-kg Sputnik 1—the Soviet Union had orbited a 1-ton satellite. The U.S. space program was no different, featuring such scientific behemoths as the 3-ton Galileo mission to Jupiter and the 12-ton Hubble Space Telescope. But with the collapse of the Soviet Union and a shrinking National Aeronautics and Space Administration (NASA) budget, science programs around the world are suddenly thinking small.

In Russia, where budget cuts and inflation have made the old style of space research unaffordable, small satellites are the only option available to many space researchers. "Microsats may help us solve our financial problems," says Michael Ovchinnikov from the Keldysh Institute of Applied Mathematics in Russia. "And instead of 5 to 10 years to develop a spacecraft, it should be not more than 1 or 2 years."

PLANNED SMALL SATELLITE MISSIONS

Mission	Country	Mass (kg)	Launch	Purpose
FASat-A	Chile	50	1995	Engineering tests
Interball	Czech Rep.*	59	1995	Aurora research
SAC-B	Argentina*	175	1995	Upper atmospheric research
Badr-B	Pakistan	60	1995	Earth observation
USSP	Russia	60	1996	Scientific and communications
Satex-1	Mexico	50	1996	Engineering tests
Techsat	Israel	50	1996	Earth observation
Hutsat	Finland	50	1998	Engineering tests
CESAR	Italy* and East Europe	300	1998	Upper atmospheric research

* Includes substantial international participation SOURCES: NATIONAL SPACE AGENCIES, IAFC

And even in the West, space agencies are promoting a smaller, faster, and cheaper approach. NASA, for example, is sifting through a raft of proposals for its Discovery program—satellites costing in the range of $100 million to $150 million—for planetary exploration, with two missions already in the works (*Science*, 27 May, p. 1244). France's space agency CNES is also contemplating a small-satellite future, eyeing a series of $50-million spacecraft that would focus on oceanography, astronomy, and geomagnetism.

Even relatively inexpensive missions are out of reach for some countries, however. For them, pooling resources to work on a single small spacecraft makes sense, says Szego. CESAR, for example, provides eastern European scientists an alternative to the crippled successor to the Soviet space program, as well as an opportunity to showcase their technical skills and bolster their bid for membership in the European Space Agency (ESA). And participation in the project has important industrial spin-offs as well. "Developing the industrial works is really an important driver in this," says Szego.

Some Latin American countries are also taking this collaborative approach. Argentina and Brazil, for example, are working with NASA on SAC-B, which will provide a variety of upper-atmospheric data. Argentina is supplying the spacecraft and instruments, and Brazil will help prepare them for launch. The satellite will be taken aloft on a Pegasus rocket supplied by NASA. Brazil also plans to launch a small remote sensing satellite to monitor the country's vast forests and fields, and Chile is building a 50-kg spacecraft called FASat-Alfa that will carry a simple suite of scientific instruments. Mexico also intends to launch two 50-kg satellites with cameras to observe the Earth. The launch vehicles for these missions have not yet been chosen.

For all the hoopla over small satellites, scientists and government officials acknowledge that large spacecraft are still essential for many missions. "First-class science can be done with small satellites, but not everything," says Arnoldo Valenzuela, a physicist at the Max Planck Institute for Extraterrestrial Physics in Munich who spoke at the Jerusalem conference. Some Earth observation missions require simultaneous readings by several sensors aboard a single satellite, while mirrors needed for many astronomy missions demand large platforms. "Big missions are still necessary," he says, "and we don't want politicians using small satellites as an excuse to reduce [overall space] budgets." But for Szego and his colleagues, small is the only way to go.

–Andrew Lawler