back the operation of SLAC's linear accelerator from 9 months to 6 months, the lab would free up $35 million to $45 million each year—enough money to start the B factory in 1994 and complete it in 1998.

Shifting the budgetary SLAC

But Richter's seemingly thrifty plan appears to have backfired badly. On 13 April, a HEPAP subpanel accepted his idea to scale back SLAC's experimental program, but effectively decided to apply the roughly $20 million saved each year to programs at other facilities—in particular, the Tevatron upgrade and research support for the SSC staff. SLAC could still build a B factory, the panel's report stated—but in 1996, not in 1993. In addition, the panel recommended closing the SLC at the end of 1993 and shutting down SLAC's accelerators altogether if DOE's high-energy physics budget doesn't keep pace with inflation.

Panel members justify their decisions as striking a necessary balance in the overall U.S. high-energy physics program, given the budgetary constraints they were handed. Delaying the start of the B factory by 2 years was a "very difficult thing to do," says panel chairman Michael Witherell, a University of California at Santa Barbara physicist. "The most efficient thing is to do it right away while people are there and ready to go.... But we had a constant budget to get into, and in making hard decisions over balancing near-term, mid-term, and long-term goals [for the program], we found we couldn't do it."

Richter, however, argues that Witherell's panel "did not fully understand the complexities of running a national laboratory." Without a B factory, he says, SLAC will be "a different kind of laboratory"—one that supports work in synchrotron radiation and high-powered microwave energy systems, but little in the way of high-energy physics. And delaying the B factory until 1996 could create serious problems for the laboratory. "It's very difficult to cut a lab back and then come back up to gear 2 years later," says Michael Riordan, a special assistant to Richter. "The best engineers and technicians among those who get laid off will find jobs elsewhere." By one estimate, between 15% and 20% of SLAC's personnel could be laid off in a $20 million budget cut.

Surprisingly, not everyone is gloomy—especially not Jonathan Dorfan, the lead author of SLAC's B factory proposal and something of a resident spin doctor on the subject. "I think the report is very good news for us," he says. First, he claims, by emphasizing the importance of CP physics the Witherell panel has elevated that work to the same level now occupied by the physics experiments proposed for the SSC. And Dorfan argues that the panel's report is actually a clever way of recommending that SLAC should build a B factory in 1994. When the panel noted that additional funding of $40 million would allow construction to begin in 1994, he says, "I think they put in a little tease to argue for doing it on a realistic time scale."

But SLAC physicists who take the report at face value are much less sanguine. "I believe it was unintelligent to say we'll clip SLAC's budget by $20 million in 1994 and 1995 and then build a B factory in 1996," says one. "That isn't how it works. You can't be throwing away people and have an atmosphere of panic and worry preceding a major project like that." Swartz, for one, says he's seen no sign of a drop in morale. But in reacting to the possibility of seeing SLAC's high-energy physics program end in 1995, one of his colleagues implicitly suggests that morale already might have bottomed out. "Those are frightening words...but I think frankly the community is right to be upset with the level of particle physics output of SLAC," this physicist says. "I don't disagree with [the panel's] judgment even though it's a frightening one."

The interregnum...and beyond

If no B factory appears on the horizon soon, SLAC's experimentalists will be left with nothing more than the tail end of the SLC program and a handful of much smaller experiments. Some of these experiments are attracting interest: A team led by Charles Prescott, for instance, is preparing to take spin measurements that could help explain how the spin of protons and neutrons is distributed among their constituent quarks and gluons. Similarly, Swartz and Jaros are putting together a proposal for a molecular beam experiment that could definitively answer whether or not the elusive and controversial 17 keV neutrino really exists. No one, however, is pretending that these efforts are anything more than sideshows to the main attraction of a large accelerator facility.

Meanwhile, SLAC's competitors for the B factory are moving forward with their plans. Cornell's Berkelman says he soon hopes to upgrade his accelerator to near B factory luminosity—a step that may allow it to begin preliminary work on the physics of CP violation by 1996, he says. David Berley, an NSF program director for particle physics, says the upgrades necessary to create a Cornell B factory have "strong support" within NSF, and that a funding decision could be just 2 years away. Moreover, if Japan's Ministry of Education decides to fund a B factory proposal submitted by that nation's KEK laboratory, its decision could forestall either U.S. proposal.

If SLAC can still hurdle the formidable obstacles now before it, it may yet salvage its B factory and its future as a high-energy physics laboratory. If not, a significant chapter in the history of the U.S. high-energy physics program may have come to an end.

–David P. Hamilton

NUCLEAR WASTE

Another Panel Rejects Nevada Disaster Theory

Barren, remote, and of limited intellectual appeal, Yucca Mountain in far southern Nevada is fast becoming the world's most intensely studied piece of real estate. In a project expected to cost $4 billion over the next decade, the U.S. Department of Energy (DOE) is working to determine whether this heap of volcanic rock between Death Valley and the Nevada Test Site would be a suitable place to inter the most radioactive waste from the nation's nuclear power plants. But even before it is deemed fit to receive hot waste, the mountain has generated more than its share of heat. Last week a 17-member panel of experts assembled by the National Research Council (NRC) made the latest effort to quench it.

In a 240-page report, the 17-member panel unanimously dismissed a 1987 claim by a dissident DOE staffer that, within the next 10,000 years, an earthquake could suddenly drive ground water upward hundreds of meters, flooding the repository and releasing its store of deadly wastes. The concern had slowed the project by making it hard to obtain state permits for field work, prompting state politicians to demand that the site be abandoned, and causing scientists on and off the project to spend thousands of hours investigating its plausibility. As the third review body to find the flooding scenario scientifically groundless, the panel couldn't help asking why the controversy has been so persistent. It suggests in its report that an independent chief scientist—something the project has lacked—could have headed off the controversy. But other scientists familiar with the politics and personalities of the debate aren't so sure.

"I don't see that the scientific community could have acted too much differently," says William Dudley of the U.S. Geological Survey (USGS) in Denver, who headed up an earlier study of the Yucca Mountain flooding issue by federal scientists. No matter what researchers did, say Dudley and others, a protracted public debate was probably inevitable. From the beginning, they point out, two essential ingredients for potent controversy were present.

For one, Nevada was a political tinderbox set to go off at the mere appearance of difficulties with Yucca Mountain. Congress had already riled Nevadans by designating their state—the same one that endured 15 years of above-ground nuclear testing—the only potential repository site. The governor, most politicians, and upwards of three-quarters of the populace have been vehemently opposed.

DOE/YUCCA MOUNTAIN PROJECT

A geologic hot spot. Nevada's Yucca Mountain has been the focus of a 4-year controversy over whether mineral veins *(below)* were formed by rising ground waters or seeping rain.

DOE/YUCCA MOUNTAIN PROJECT

For another, a seemingly credible source within DOE's Yucca Mountain Project was willing to challenge his colleagues in public on an issue of safety. As a coordinator of some geological studies for the project in Las Vegas, engineering geologist Jerry S. Szymanski had traced veins of carbonate and silicate minerals that he thought showed signs of having been deposited by episodic upwellings of water through the mountain. The upsurges, Szymanski concluded, had been driven by shifting strain on the rocks induced by earthquakes. If an earthquake should trigger another upwelling, as Szymanski thought likely, the nuclear waste repository, 200 to 400 meters above the present water table, would be flooded. Szymanski wrote up these conclusions in a 322-page management report that he sent to the project director in December 1987.

The evidence against Szymanski's views began accumulating as quickly as DOE could mount an analysis of his report. More than 20 project scientists from DOE, the USGS, and national labs produced an internal analysis in July 1989 compiled by Dudley. "We found the evidence unconvincing or clearly wrong," says Dudley. "In many instances there was selective use of data and use of data out of context." Although Dudley and his colleagues never doubted that forces such as earthquakes could raise the water table, Szymanski "greatly exaggerated the magnitude of the effects of stress on water levels and the duration of those effects," says Dudley. The mineral veins that so alarmed Szymanski had been formed not by surges of ground water but by rainwater percolating gradually downward, according to the report (*Science*, 22 February 1991, p. 864).

That might have been the end of it. But at the same time as Szymanski submitted his report to DOE, he sent a copy to a contact in the Nevada state government, who passed it to the governor. The governor then released it, charging a cover-up by DOE, something even Szymanski denies. But given the public mistrust in Nevada of DOE, Szymanski was widely perceived as a dogged whistleblower fighting an intransigent bureaucracy.

And Szymanski, according to geologists who have sparred with him, has played that role for all it was worth. "We're dealing with a person of great fervor, equal to the religious fervor of people who have drawn great followings," says Dudley. A researcher who has accompanied Szymanski around Yucca Mountain goes further: "We've all met at some time someone who's a true believer, a guy who believes so strongly in himself, so strongly that he's right, that he doesn't see the evidence against him."

Szymanski's visible supporters, who number fewer then six, jump to his defense when such charges are leveled. Says seismologist Charles Archambeau of the University of Colorado: "People get irritated by Szymanski's style, but what matters is the science. The substance is there, but most criticisms of the substance have been superficial. My own conclusion is that it's a dangerous place."

The Nevada state government agreed, and began throwing legal obstacles in the path of further studies of Yucca Mountain. In response, DOE convened an external review, completed just last fall, that fared no better than the internal one in ending the controversy. By an agreement between project manager Carl Gertz and Szymanski, a five-person panel was formed, with two of the members—including Archambeau—named by Szymanski and three chosen by DOE. Perhaps predictably, the panel split so sharply along those lines that it ended up issuing majority and minority reports. The split did nothing for DOE's credibility. According to a study by Ed Helminski and Maureen Conley of *The Radioactive Exchange*, an independent newsletter published in Washington, D.C., "The [external] panel's inability to reach a consensus opinion reinforces the perceptions [among Nevadans] that loyalties color the outcome of the scientific process."

Trickle down. Now, in the latest effort to put the issue to rest, comes the report of the NRC's Panel on Coupled Hydrologic/Tectonic/Hydrothermal Systems at Yucca Mountain. Two years in the making, the report recounts the panel's consideration of published and unpublished data and observations made during upwards of 100 person days in the field, at times with Szymanski as a guide. On the central question of whether minerals on the mountain were deposited by water driven upward from deep below, the panel is adamant: "...There is no evidence to support the assertion that the water table has risen periodically hundreds of meters from deep within the crust [during the past 100,000 years]. In fact, the evidence strongly supports a surface-process origin from rainwater for [the deposits]."

Among the most telling evidence was a comparison of the deposits left in the geologic record at Travertine Point, near Death Valley, by a certifiable hot spring—the kind of flow Szymanski envisions at Yucca Mountain—and the Yucca Mountain deposits. The panel found nothing but contrasts. The real thing has mounds of carbonate deposits laid down by gushing spring waters; Yucca Mountain has none. Spring water rising through a fracture lays down parallel bands of mineral on either side of the conduit, while Yucca Mountain's veins are filled with cross-cutting layers. Spring deposits are pure, while Yucca Mountain veins are clouded with sand, clay, and volcanic ash. The panel also concluded that Szymanski's earthquake trigger could not raise the water table more than some tens of meters, not the hundreds of meters claimed.

In the panelists' view, that's more than

enough field evidence to refute Szymanski's arguments, but even more turned up in recent weeks, after the report went to press. Continuing excavation on the mountain gave researchers a deeper look at some of the mineral veins Szymanski interprets as conduits for mineral-laden fluids rising from great depth. The trenches reveal the veins petering out at depth, just as they would if they had been filled by rainwater seeping from above, says panel member Mary Lou Zoback of the USGS in Menlo Park. "There's no longer any possibility of debate," she says.

Szymanski is unmoved by such conclusions. "I have used the data. I think the academy panel has used their beliefs," he told *Science* the day after the release of the NRC report. "They looked like a bunch of fools. Nonsense like that you don't expect from the National Academy of Sciences....There are things in the Earth that the National Academy report didn't dream of."

Disappointed with the "irresponsible science" done in the project, Szymanski said he would resign on 20 April. As his legacy, he leaves the latest 600-page version of his hypothesis, a follow-on to a 1000-page 1989 report. Undaunted, project manager Gertz has said that the project will now forge ahead.

–Richard A. Kerr

AID TO RUSSIAN SCIENCE

A European Plan Gathers Support

When Russian physicists appear at international conferences, their non-Russian colleagues used to say, they have a way of stealing the show with their keen theoretical insights. But since the recent breakup of the Soviet Union, ex-Soviet physicists have been making a different kind of stir: by showing up to plead for help. As economic chaos sends average salaries plummeting to a pathetic $15 per month and cuts off funds for equipment and overhead, Russian science, according to its beleaguered practitioners, faces extinction. Which is why the French government last week endorsed a comprehensive plan—hatched in the European particle physics community—to aid Russian science.

Swayed by appeals from such prominent European physicists as CERN director Carlo Rubbia and DESY director Volker Sorgel, French President Francois Mitterrand pledged his government's assistance in putting together a fund of 100 million ECU's ($120 million), which would fund Russian scientists in all disciplines. In his official statement, Mitterrand went on to solicit contributions from the rest of the European Community, the United States, Canada, and Japan. The fund would be administered by an international foundation—modeled on the U.S. National Science Foundation—which would distribute the money to research groups.


STANFORD

The comprehensive initiative contrasts with the piecemeal rescue efforts being launched in the United States by individual foundations and businesses (*Science*, 27 March, p. 1632). It also differs from U.S. programs to convert the weapons industry to peaceful purposes in that its target is fundamental science. "Our plan will be complementary to weapons reconversion," says CERN physicist Robert Klapisch.

The goal, say advocates, is to preserve an entire research community. With salaries for physics professors now dipping below the subsistence level, there is little choice for Russian researchers but to leave or quit science, says Russian physicist Michael Veloshin, who recently moved to the University of Minnesota. The consequence of continued dispersal, say other physicists, would be the loss of a unique research culture. "The Russians have their own footprint, trademark, signature," says Stanford University physicist Sidney Drell. If they all move to the West, he says, "they will become absorbed and homogenized into the Western style of physics."

The European high-energy community is keenly aware of the potential loss because prominent Russian scientists have long been working in close contact with the major labs—CERN in Geneva and DESY in Hamburg. And so when Russian particle physicists sprang into action to rescue their field after the failed coup last August, they were able to enlist powerful European allies, including Sorgel and Rubbia. The Russian and European physicists presented their plan by letter to several European leaders in late 1991, and Mitterrand was the first to bite.

"The Russians have their own footprint, trademark, signature."

—Sidney Drell

One selling point of the plan is its parsimony. When prominent Russian physicists gathered last month at La Thuile, in Italy, to discuss the aid plan with Sorgel, CERN's Klapisch, and Superconducting Super Collider lab director Roy Schwitters, other scientists expressed surprise at how little the Russians were requesting: about $100 million, to be distributed as $20,000 grants to about 5000 research groups. The current goal exceeds that figure, but not by much.

To make the most of that money, though, Russian physicists say their country's scientific community also needs other kinds of aid. "Charity is important only in the short term, but strategically it is not a solution," said Russian physicist Alexander Skrinsky. One challenge is shedding the Soviet-style inefficiency and stifling bureaucracy that still plagues Russian science. "The main problem is the rigid hierarchy," says Russian physicist Lev Okun. To overcome it, he and Skrinsky both advocate integrating Russian science with the West. That would force the ex-Soviets into healthy, Western-style competition.

A happy few. Okun explains a related challenge for the aid program: "giving the money to those really working." Adds Veloshin, "There is a lot of dead wood"—so much, in fact, that the Russians say saving just 5% of current research programs would preserve a valuable fraction of Russian science. Getting the money to the right 5% will mean the program will have to "bypass the traditional bureaucratic channels," says Klapisch, relying on the foundation's own peer-review board. And for the future, he says, the Russians will need lessons on Western-style peer review.

For the moment, the plan faces its biggest hurdles nearer to home, in the effort to enlist donors. The French are waiting for expressions of support from other countries before they promise any specific amount. So far, the signs are encouraging. At the La Thuile meeting, Okun announced that the Finns have already agreed to put up $1 million and set up a computer link between Russian research institutes and their counterparts in Western Europe. The Italians are also getting enthusiastic about the rescue effort. Italian television and newspapers covered the discussions at La Thuile, drumming up national interest by calling the plan the "Rubbia initiative" and featuring pictures of the Italian Nobel laureate, who is a much bigger celebrity in his home country than is the average Nobel physicist in the United States.

European physicists such as Klapisch and Sorgel hope their message will quickly turn that enthusiasm into ECUs, and win other countries as converts as well. It's a matter of self-interest, says Klapisch: "A foundation where the best of Russia and the West can work together will be very fruitful."

–Faye Flam