

meeting key social, environmental, scientific or industrial needs”—that is, it must meet the test of relevance that has been advocated by some aggressive members of Congress, led by Senator Barbara Mikulski, the Maryland Democrat who heads the Senate appropriations subcommittee that funds NSF, NASA and the Environmental Protection Agency. Some staffers on Capitol Hill see the Gibbons-Panetta exercise as an attempt

to wrest control of science policy away from Mikulski and her adherents in Congress.

The criteria also recognize that the research organization or university applying for a grant must pass certain tests. Most notably, it should possess a demonstrated capability to conduct the project and to establish effective scientific and technical links with industrial, academic and international organizations, as well as to propose a

budget with sufficient funds to complete the project on schedule without coming back to Congress for more money. Holding to such criteria could be difficult in some cases, especially for complex megaprojects that take years to complete. But to the agencies and to many scientists and engineers the criteria will appear a clear sign that the White House means business this time.

—IRWIN GOODWIN

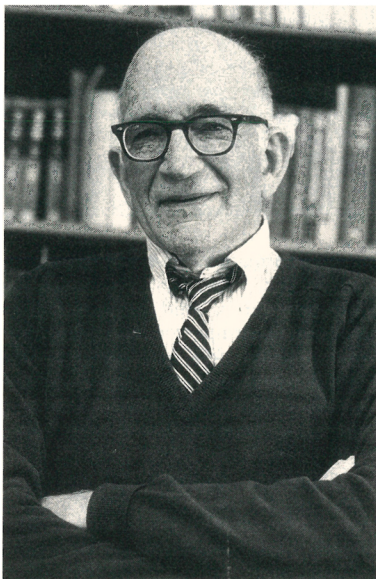
HEPAP CALLS FOR JOINING CERN'S LHC AND FOR \$150 MILLION PROGRAM 'BUMP'

The dream of a Superconducting Super Collider ended as a nightmare last October when Congress canceled all funds to complete the accelerator. At a time when great emphasis is being placed on deficit reduction in political circles, it was hard to argue that the SSC, which by some estimates would have cost at least \$11 billion, deserved the highest priority among science programs. Without the SSC, high-energy physicists confronted a life crisis: Since the early 1980s they've been stuck with the same picture of fundamental particles and forces, the so-called standard model. In April a team at Fermilab's Collider Detector Facility announced evidence of success in the hunt for the top quark, believed to be the last member of a family of six such particles (PHYSICS TODAY, June, page 17).

But other mysteries about the particles remain: There is still no explanation of why the top quark weighs orders of magnitude more than its siblings, why a meaningful pattern for the masses of the quarks defies understanding—a conundrum that may be resolved if the elusive Higgs boson is discovered—and why there appears to be more matter than antimatter in the universe—a condition that ultimately enables galaxies, planets, plants and humans to exist. Less esoteric questions also persist: What damage will the loss of the SSC do to the careers of displaced physicists and engineers in the field? Will particle physics continue to attract some of the best and brightest young American students?

Only days after Congress jettisoned the SSC, Energy Secretary Hazel R. O'Leary formally asked Stanley Wojcicki, the Stanford physicist who heads the department's High Energy Physics Advisory Panel, to appoint a subpanel to "turn its attention immediately to the task of defining a long-

term program to pursue the most important high-energy physics goals." To head the subpanel, O'Leary suggested and Wojcicki agreed to appoint Sidney Drell, deputy director of SLAC and a leading member of President Clinton's transition team that re-



Drell: Some 'modest' proposals.

viewed DOE programs. The rest of the panel included two highly respected accelerator designers, an astrophysicist, the newly appointed research director at CERN, a Japanese physicist, a condensed matter physicist who was troubled about the cost and immensity of the SSC and six high-energy physicists in their 30s (see box, page 52).

Since January, when the Drell panel first met at SLAC with O'Leary and Martha Krebs, director of DOE's Office of Energy Research, it has received more than 400 letters and e-mail messages from scientists and

conducted often crowded town meetings at Southern Methodist University, the University of Chicago, Fermilab, Lawrence Berkeley Laboratory, Harvard, UCLA and the University of Pennsylvania. The panel also was briefed by dozens of prominent high-energy physicists, including Christopher Llewellyn-Smith, director general of CERN; Volker Soergel, former director general of Germany's DESY; Wolfgang Panofsky of SLAC; T. D. Lee of Columbia University; Jerome Friedman of MIT and Roy Schwitters, who had headed the SSC Laboratory. When Drell submitted the panel's report to HEPAP on 23 May, he observed that "for my own sake, the letters and discussions had an important effect on my thinking."

The panel's first recommendation sets the stage for what follows: "As befitting a great nation with a rich and successful history of leadership in science and technology, the United States should continue to be among the leaders in the worldwide pursuit of the answers to fundamental questions of particle physics." The panel seems satisfied that the current collection of US high-energy accelerator labs is world class, and given adequate support to upgrade and operate the machines and their detectors and to respond to the many new ideas for experiments, the US program "will remain a world leader for a decade or more." But it appears to be unsure of the field's position in the world beyond a decade. The US high-energy physics community, consisting of about 2500 physicists and 1100 graduate students and postdocs, is resilient enough to recover from the SSC debacle, the report indicates, to take a leading part in international projects abroad as well as to create opportunities at laboratories and universities at home with a strong program of research in advanced accel-

erators and detectors. The termination of the SSC, argues the Drell panel, leaves only one main international option to advance the high-energy physics frontiers—participation in Europe's Large Hadron Collider.

"Besides providing US physicists with access to new scientific territory, participation in the LHC would benefit the US in other ways beyond the lifespan of the accelerator itself," the report claims. Construction and operation of Fermilab's Tevatron, along with research and design work on the SSC, have given US physicists and engineers just the right experience and knowledge that could contribute greatly to the LHC, the report says. "This priceless human resource . . . will be invaluable in keeping the US at the forefront of proton accelerator technologies for the long-term future." Of overarching importance, "helping to build the LHC and developing strategies and mechanisms needed for global cooperation on large science projects would further strengthen our credibility as a capable host for such projects in all fields of science," the panel writes. The Drell group considers the statement significant for furthering joint international science projects. After Congress stopped the SSC, it became almost commonplace to hear politicians and scientists in other countries expressing their wariness about committing themselves to US scientific collaborations. Two international megaprojects still on the drawing boards are the \$27 billion space station and the \$8 billion International Thermonuclear Experimental Reactor. As for the accelerator after the LHC, whatever that is, "We would like to be the home base for the next phase in the high-energy physics story—a reliable, trusted partner in a worldwide collaboration," Drell told HEPAP members.

There is no assurance that even the \$3 billion LHC, a proton-proton collider with 7 times the energy and up to 100 times the luminosity of the Tevatron, will answer all the questions in particle physics after it comes on line around 2003. To ensure the long-term future of the field, the Drell panel proposes "a number of diverse approaches to accelerator and detector research and development should be encouraged. . . . Preliminary examination indicates that it may become practical to build a proton collider with beams of up to ten times the energies of the LHC, using technology that could be developed in the next decade." Unabashed by critics who have accused high-energy physicists of hubris and chutzpah for pro-

HEPAP Subpanel on Vision for the Future of High-Energy Physics

Sidney D. Drell, SLAC (chairman)
Jonathan A. Bagger, Johns Hopkins University
Patricia R. Burchat, University of California, Santa Cruz
David L. Burke, SLAC
Joel N. Butler, Fermilab
Helen T. Edwards, Fermilab
Kevin Einsweiler, Lawrence Berkeley Laboratory
Lorenzo Foa, CERN
Val L. Fitch, Princeton University
John Huth, Harvard University
Daniel Kleppner, Massachusetts Institute of Technology
Akihiro Maki, Japan Society for the Promotion of Science
William J. Marciano, Brookhaven National Laboratory
Jack L. Ritchie, University of Texas at Austin
Bernard Sadoulet, University of California, Berkeley
Maury Tigner, Cornell University
Roberto D. Peccei, University of California, Los Angeles (ex-officio)
Stanley G. Wojcicki, Princeton University (ex-officio)
Michael E. Zeller, Yale University (ex-officio)

posing a project as vast and expensive as the SSC, the panel recommends that research should be pursued on another upgrade for the Tevatron main injector and on a next generation electron-positron linear collider to follow SLAC. The panel does not venture a guess as to how much these might cost.

But when it has done some accounting, the panel submits the price tags. Accordingly, the report recommends that the US contribute \$400 million over six years, beginning in 1998, to help build the LHC, a smaller and less costly version of the SSC. The sum would result in what Drell calls a "lean" US involvement in the LHC. "It's not what some proponents would have wished for," he told HEPAP members, "but we're trying to be practical." If the extra money cannot be found, the government should consider closing down one or more of DOE's accelerator facilities so that money can be freed to join up with 19 European nations on the LHC. The report suggests as a sop to Congress that a large fraction of the funds for the LHC is likely to be spent in the US on building special magnets and equipment for the collider's inter-

action halls and for large particle detectors.

The panel also requests that a "modest" \$50 million be added to DOE's annual base budget of \$650 million for high-energy physics in 1996, 1997 and 1998 to tide the program over the period when construction of the Tevatron main injector and SLAC's B Factory will strain funding. With program cuts of \$135 million over the past three years, after inflation is taken into account, "we have a program in trouble," Drell told HEPAP. The \$150 million "Drell bump," as it has been called, is less than 1.5% of the estimated cost of the SSC, Drell observed, "and would get us through the present crisis so that we could build for the future. . . . If the budget is flat, it means more pain." Drell said the panel refused to "wimp out" and decided that DOE would need to cancel some programs or close down a facility if the bump was not achieved. "It wasn't an easy recommendation," he said, "but it was well thought out. High-energy physics is not an entitlement program and we don't deserve an entitlement program."

The report also expressed concern about the high cost of DOE's "excessively bureaucratic application of environmental, safety and health regulations that is neither risk-based nor adequately evaluated for its contribution to safety." According to Drell, Fermilab's cost of complying with the regulations now amounts to 11% of the lab's budget and at SLAC the total is 11% of the annual budget. "This is a lot of money going out the door and not into the program," Drell told HEPAP. In effect, 7% of the high-energy physics program is equivalent to the recommended \$50 million annual bump, Drell noted.

White House officials and members of Congress had waited for the Drell report before taking positions on the future of the field. Two hours after reporting to HEPAP, Drell appeared before the House science subcommittee. Both the subcommittee chairman, Rick Boucher, a Virginia Democrat, and the SSC's chief executioner, Sherwood Boehlert, a Republican from upstate New York, expressed their support for the report's main themes—joining the LHC and the additional \$150 million for high-energy physics. Boehlert said the Drell panel "has drawn an appealing picture of the future of high-energy physics—a future that foresees an active American presence in the field, international cooperation and continued scientific progress."

—IRWIN GOODWIN ■