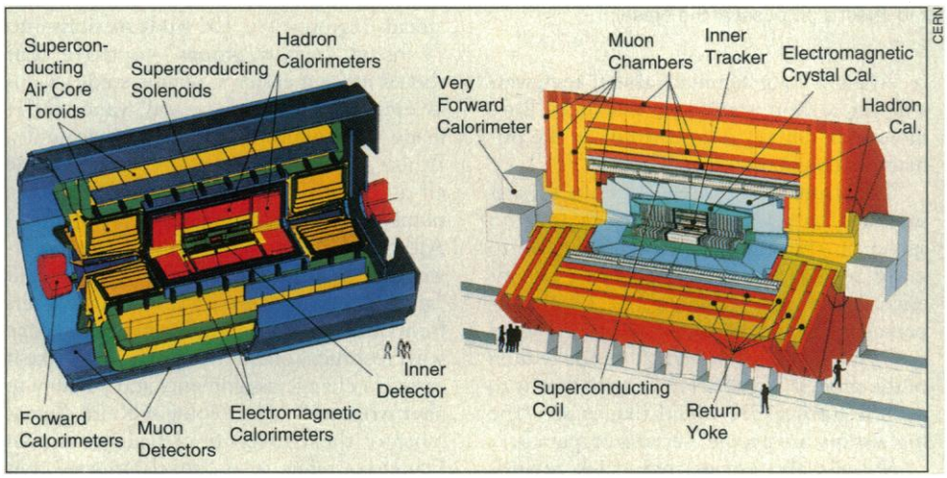
HIGH-ENERGY PHYSICS

The Window of Opportunity Is Closing Fast at CERN

Like a 747 roaring down a runway, then suddenly having to change direction, the U.S. high-energy physics community is having a hard time changing course after the demise of the Superconducting Super Collider (SSC). Where the community needs to be headed is clear: Geneva, home of the European Laboratory for Particle Physics (CERN) and its planned Large Hadron Collider (LHC). But physicists—stunned, resentful, and gloomy about their field's future—have been slow to respond. Now, time is running out as plans for the LHC firm up.

To focus the community on the dwindling prospects, the American Physical Society's Division of Particles and Fields (DPF) sponsored a meeting on 15-16 February at Fermilab. Convened by DPF chair Michael Zeller of Yale University, the meeting gave the 250 physicists who attended the opportunity to face their future head-on and discuss what opportunities might remain for U.S. experimenters and accelerator physicists on the LHC and its two large detectors, ATLAS and CMS. The upshot was the formation of an organization intended, says Zeller, "to explore the possibilities and mechanisms" for participation.

To "make sure we don't foreclose our future" by delaying, as George Trilling of the University of California, Berkeley, puts it, any collaborations will have to be set up well before a U.S. commitment to the LHC is certain. Department of Energy (DOE) Secretary Hazel O'Leary told *Science* last week that CERN has formally invited U.S. participation in a letter to the Administration. But educated guesses pin the amount CERN is seeking in return at around $500 million to $600 million over a decade. The prospects for that kind of support are far from certain: Congress has asked O'Leary to present a "vision" for the future of high-energy physics before it will consider funding any large new project, and the community is struggling to reach a consensus about its priorities (*Science*, 11 February, p. 749). A final decision on whether to accept CERN's invitation will take at least several months.



Where the action is. The LHC's two detectors, ATLAS *(left)* and CMS, incorporate some systems and technologies familiar to physicists who had worked on the SSC.

Meanwhile, the experimental teams for ATLAS and CMS are well under way, CERN management having given the detectors a provisional go-ahead last April. With technical proposals due by December, chances for newcomers to contribute to anything more than last-minute technical and engineering projects are evaporating. At stake is the chance to recover at least some of the physics opportunities offered by the SSC, as Ian Hinchliffe of the Lawrence Berkeley Laboratory told the physicists at Fermilab.

Speaking in a noticeable Irish brogue and pacing hyperactively back and forth, he quickly narrated the intellectual development of the field in the past quarter-century: how the Standard Model of particle physics provided a self-consistent picture that explains 99% of the data; how its principal missing pieces are the top quark and some mechanism for endowing particles with mass; how the simplest mechanism is the hypothetical Higgs particle, although other possibilities exist; how the SSC had been designed to resolve these issues in a definitive way.

"Can LHC do the job?" Hinchliffe asked. Although the LHC will have a lower energy than the SSC, it will have a higher luminosity and thus will produce collisions at a faster rate. All told, said Hinchliffe, the LHC's capacities give it a good chance of finding the Higgs particle. But if the Higgs should prove a chimera and physicists need to look for some other mechanism for producing mass, said Frank Paige of Brookhaven National Laboratory, the picture is bleaker because the LHC won't be powerful enough to explore some of these alternatives easily. In that case, Paige said, "life at LHC will be painful."

In other respects, though, life at LHC has a familiar look to physicists who had been planning to work at the SSC. Like the SSC, the LHC will guide counter-revolving beams of protons using superconducting magnets. Physicists who had worked on the SSC's design could thus be a valuable resource for the CERN project. The same goes for former collaborators on the SSC's two detectors, GEM and SDC, because LHC's detectors include some similar subdetectors and technologies.

As at the SSC, the detectors take complementary approaches to observing and analyzing the debris of the collisions in search of the signature of some new heavy objects. ATLAS is striving for extremely high-resolution particle tracking close to the point of collision, as SDC did, meaning that the major groups that developed this technology for the SDC—at Lawrence Berkeley, for example—would be natural assets. ATLAS also uses GEM-like calorimetry to measure the energy deposited by the particle "jets" that would be produced by the decay of massive objects. That should attract ex-GEM physicists from Brookhaven National Laboratory, Columbia, and elsewhere, according to Larry Sulak of Boston University, a former GEM member. Unfortunately, most of ATLAS's major technical decisions have already been made, and many of the remaining tasks mentioned at the Fermilab meeting are engineering and technical projects.

The design of CMS is more in flux, with half a dozen major technical decisions still open and more room for large projects whose centers of gravity could lie in the United States. CMS has a fast, high-resolution calorimeter for hadrons (quark-containing particles) like that of the SDC, and a crystal electromagnetic calorimeter similar to a type once proposed for GEM. Those opportunities prompted a meeting of potential U.S. collaborators at the University of California, Los Angeles, in early February. But even at CMS, openings are vanishing quickly, for CMS plans to freeze participation for major groups later this month.

The newly formed collaborators' organization is partly meant to help physicists cope with the time pressure. Says Zeller, "At this time we need something more than the indi-

vidual experimental groups. You don't want to add another layer of bureaucracy—but issues come up, and who do you call?" The organization, for the moment called U.S.-LHC Collaborators Organization, will serve as a contact point among all the parties who would negotiate a U.S.-CERN agreement, including the physics community, CERN management, and federal agencies. It will be run by an executive committee consisting of six at-large members and two members each from U.S. groups wanting to collaborate on CMS, ATLAS, the LHC itself, and a separate, smaller B-physics experiment.

Some physicists at the Fermilab meeting found this focus on CERN and the LHC difficult to stomach. One declared that if CERN had thrown its support behind the SSC, the machine would have been built. He called it humiliating that U.S. physicists now have to supplicate CERN simply to become a "province" in the world of high-energy physics. But another physicist at the meeting called those the sentiments of the "two-standard-deviation people"—the ones who grouse out on the wings and don't represent the community as a whole.

Most saw that if they want any chance to pursue the physics goals that motivated the SSC, they have to put the LHC at the focus of their plans—and soon. "Much work will have to be done to make this happen," Joel Butler of Fermilab told the group. Failing that, "the U.S. high-energy physics community will face some very hard choices."

–Robert P. Crease

WOMEN IN SCIENCE

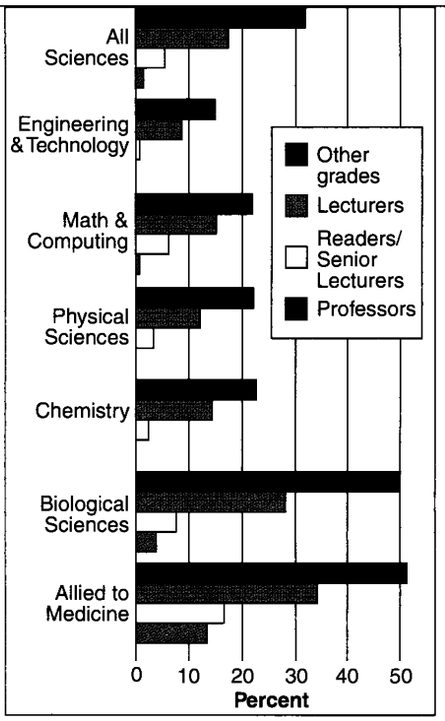
U.K. Panel Floats a Plan

LONDON—The British government may have got more than it bargained for when it assembled a committee of women scientists and engineers and asked them what could be done to improve the prospects of women in science and engineering. The Cabinet's Office of Science and Technology (OST) was keen to show its equal opportunity credentials when it commissioned the study a year ago. But some of the proposals that the committee came up with, in a report* issued last week, would be costly and would entail the kinds of social expenditures that the Conservative government has traditionally been reluctant to support.

The Committee on Women in Science, Engineering and Technology calls for tax relief on child-care costs and more publicly funded child-care services. It wants the Department of Employment to support and fund "returners' schemes" to help women make the transition back from full-time parenting to careers in research. And, to ensure that its recommendations are not just politely buried, the committee calls on OST to set up a unit to monitor progress in meeting the goals the committee laid out.

One of this unit's first tasks, says the committee's deputy chair, biologist and professional forrester Jean Balfour, former chair of the Countryside Commission for Scotland, should be to analyze the costs and benefits of child-care schemes. There is growing support for such schemes in Britain: Even the normally conservative Confederation of British Industry, which represents employers, has said that affordable child care is essential for long-term economic growth. But few women academics believe that this report will succeed where many other campaigns for public support for child care have failed. Eve Roman, an epidemiologist with the Imperial Cancer Research Fund's Cancer Epidemiology Unit in Oxford, who employs a nanny to look after her three children, says: "I am taxed twice, once on what I earn and then again on what I pay the nanny. I would welcome tax relief on child care but I would be astonished if the Government accepted this recommendation."

The urgent tone of the report is backed by some dismal statistics: Women account for just 1% of members of engineering institutions in Britain and 3% of Fellows of the Royal Society. A scant 22 out of nearly 500 professors of biological sciences are female. Only 15.5% of those in full-time academic posts in science, engineering, and technology are women. In industry, the only research-based occupation in which women outnumber men is that of laboratory technician. In view of these figures, the committee has set an ambitious goal: At least 25% of all public appointments and senior positions in science, engineering, and technology, in government departments and in industry, should be held by qualified women by 2000.



Academic ceilings. Percentage of university posts occupied by women.

This is unlikely to happen unless more young women opt for scientific careers, however. The committee therefore calls for better training for teachers, including guidance on maintaining girls' interest in all science subjects. And it urges the Department of Education to consider introducing a broader curriculum for students over 16—most only study three subjects—to encourage more young people to continue studying science.

William Waldegrave, Britain's science minister, said last week that the report made a "valuable contribution" to the debate and that he would consider its recommendations carefully. The Royal Society gave its "very warm support" to the report.

Balfour says some R&D-based companies have already begun to move in the direction her committee is advocating. One of them is the research arm of the drug company Glaxo, where most of the 3700 staff are scientists of graduate level and above. John Hume, director of human resources, says that 4 years ago Glaxo R&D introduced a range of facilities to help women with children return to work, including financial assistance for child care, maternity leave arrangements better than the state minimum—12 weeks' paid leave for those with 2 years service—and flexible working arrangements. The proportion of women who return to work after maternity leave is now 97%, up from 60% 4 years ago, staff turnover is down from 12% to 4%, and the number of women among senior staff has doubled to above 17%, Hume says.

British women scientists and engineers are also beginning to organize themselves. The Association for Women in Science and Engineering in the U.K. (AWISE) is being launched this month to provide an information exchange and a collective voice for women. Chemist Joan Mason of the Open University and Cambridge University, who is coordinating the group, says: "We want to provide a support network for women who are having trouble and falling off the career ladder. Women who want to have children and a career, as men do, need to support each other, as men do."

–Sharon Kingman

Sharon Kingman is a science writer based in London.

*The Rising Tide: A Report on Women in Science, Engineering and Technology, 1994.