REPORT FROM EUROPE

CERN: Regional Cooperation Amid Tightening Budgets

A year ago, when the European Organization for Nuclear Research (CERN) was granted use of about 100 acres of French territory adjoining the present laboratory site on the fringe of the Swiss canton of Geneva, it was a case of an international scientific effort's literally as well as figuratively transcending national borders. Symbolism aside, the additional space on the valuable flat between the Jura and the Alps permits construction of intersecting storage rings to be used in conjunction with CERN's big proton synchrotron and, in scientific terms, gives the facility a decidedly longer lease on life.

CERN means different things to different people. To European physicists it represents the possibility of doing advanced research in the field in which, many of them would argue, the most fundamental knowledge about the physical world is to be found. CERN is unquestionably a showpiece in regional scientific cooperation. The laboratory, to many Europeans, is also proof positive that, given the chance, European scientists can equal the Americans and Russians at their own game, a consideration not without force in persuading European governments to allocate funds.

Despite the generally acknowledged successes of CERN both as a laboratory of high-energy physics and an experiment in international scientific living, CERN shares the unsettled future of high-energy physics in the United States and, if muted reports are accurate, in the Soviet Union. The costs of the next generation of accelerators will be high enough to cause indigestion in any science budget, whether national or regional. And, even in the present research market, claims on funds by high-energy physics are being weighed against claims of other fields of research in which results may yield more concrete returns.

CERN's bargaining position, however, seems to be a strong one. CERN was a product of the special circumstances that prevailed in Europe after World War II. High-energy physics was a high-prestige field, but the need for powerful particle accelerators posed the problem of unacceptable costs. On the basis of country-by-country financing, European physicists faced the prospect of putting not enough eggs in too many baskets. In the years immediately following the war the trend toward European unity burgeoned, and common action in science had a strong appeal to government officials. As the French scientist L. Kowarski notes, in a useful account of CERN's beginnings, the United Nations Commission on Atomic Energy brought scientists into a working relationship with diplomats and government administrators in a way that proved fruitful for the movement that led to the formation of CERN.

Nuclear physics was an extraordinarily active and productive field of research in Europe in the 1930's. The great wartime effort in that area and the possibilities of exploiting fission as a source of usable energy increased the lure. But national projects in nuclear research were still fenced in by wartime secrecy. Internationalizing of nuclear research, therefore, was blocked. High-energy physics, however, was one subdivision of nuclear physics which did afford scope for "open" research.

By 1950 the idea of a regional European research effort had taken root under the aegis of UNESCO and with the encouragement of American physicists. Before the end of that year the idea of building a large particle accelerator had been put forward and funds to get the project under way had been pledged by Belgium, France, and Italy.

What happened next was an extraordinary voyage on uncharted seas. Before the formal structure and the financial arrangements for a permanant organization had been established, scientists and government officials, working in concert, made fundamental decisions on the scientific objectives to be pursued, picked a site for a laboratory, and began recruiting a staff.

Very early it was decided that CERN would opt for a machine of a size that would propel CERN into the front rank of particle physics research. A smaller machine was also to be built. It was to be the best of its type and was to be brought into operation earlier than the big machine.

A convention formally establishing the CERN organization was signed in the summer of 1953. Britain, which had maintained "observer" status during the formative period, was the first nation to ratify the convention, late that year. The last of the original 12 member states ratified early in 1955.* By that time plans for the lab and machines were well developed, and a site in Geneva had been selected and secured. The willingness of scientists and engineers to give their best efforts, and of governments to give money, to an organization which had as yet no legal existence gave CERN both a fast start and an élan which it might not otherwise have had.

CERN has stuck to originally established principles. The laboratory is devoted to fundamental research in subnuclear physics. No work is done to meet military requirements and none is done on applications—nuclear power reactors, for example. Results of experiments are published freely, and this policy extends ideas and inventions produced at CERN. What is regarded at CERN as the "building phase" covered the last half of the 1950's. The smaller CERN machine, a 600-Mev synchro-cyclotron which rivals the strongest American and Soviet machine of its type, was commissioned in 1957.

CERN's big machine, a 28-Bev proton synchrotron, is second in size only to a similar machine at Brookhaven (33-Bev). More than a decade ago, when CERN planners were considering what type of machine to build, they were aided in their task of thinking big about an accelerator by the availability of the strong focusing principle that had been invented in Greece and the United States early in the

* The 13 countries which are now CERN members and the percentages of the CERN budget which they provide—proportional to net national income—are as follows: Austria (1.90), Belgium (3.56), Denmark (2.05), Federal Republic of Germany (23.30), France (19.34), Greece (0.60), Italy (11.24), Netherlands (3.88), Norway (1.41), Spain (3.43), Sweden (4.02), Switzerland (2.11), and United Kingdom (22.16). Poland, Turkey, and Yugoslavia have observer status.

1950's. A decision to build the proton synchrotron was made, and the CERN proton synchrotron in fact went into operation in 1959, beating the Brookhaven machine by about 6 months.

CERN's proton synchrotron came into use at a time when high-energy physicists were excited by discoveries that known elementary particles could be transformed into a variety of other particles—the number is well over 100 now. And CERN was splendidly equipped to participate in the rush to determine how the behavior of these particles accorded with old and new theories.

CERN's history, however, is not a saga of unrelieved luck and good management. When the proton synchrotron was first put into operation, CERN researchers, to overstate the case, didn't quite know what to do with it. The apparatus required to exploit the machine fully was not at hand, in part because of lack of experience in Europe with big accelerators and in part because of a squeeze in funds which slowed the provision of equipment needed to carry out sophisticated counter and bubble-chamber experiments. There was also a feeling amounting to distaste among many European physicists for the scale and complexity of the effort required to obtain and analyze results from the big machine.

Computer Delays

More recently CERN suffered what can be described as at least an inconvenience when the buildup of data-processing capacity at the laboratory fell behind the requirements imposed by planned experiments. A major cause of this was the delay in bringing into full use a big new CDC 6600 computer installed in early 1965. From CERN's standpoint, difficulties arose both from the limitations of the software delivered and from the need for engineering changes in the machine itself. The choice of the big computer was made in the knowledge that CERN would be getting equipment of advanced design with the risks that involves, but the loss of about a year in getting the big machine into full running order has been a severe disappointment.

There have been periods of stress over financing. The original understanding was that the cost of building the facility would be about 120 to 130 million Swiss francs ($30 million) but the final bill was about double that. It took time and persuasion to reconcile member governments to the costs of experimental apparatus for particle research, and also to condition them to the fact that operating costs would be high and that the CERN budget would not be reduced to minor proportions after the initial construction period. Tighter budget restrictions, in fact, were imposed in the years 1960 through 1962, with some of the results on research mentioned above, but in the end the budget did rise to meet reasonable requirements. The 1966 operating budget is about 149.7 million Swiss francs ($35 million).

Despite tribulations, which included a share of human misfortunes such as the death of the organization's director general, C. J. Bakker, a Dutch physicist who was killed in an air crash in 1960, CERN long since shed its scientific little-brother status. This is emphasized by CERN's part in what this year became something of a *cause célèbre* among high-energy physicists.

The fundamental questions involved the laws of symmetry. The working assumption is that the laws of physics would remain operative if positive and negative electric charges were reversed in the particles of which matter is composed. The symmetries undergird the concept of antiparticles, even antimatter galaxies.

If an experiment were to show symmetry violated in a way that could not be accounted for, this generation of physicists would be sent back to their blackboards in considerable disorder. High-energy physicists, accordingly, are intensely interested in the kind of particle behavior which the big machines allow them to observe.

At issue in the experiment in question was the behavior of one subnuclear particle, the eta meson, a short-lived neutral particle which, on occasion, can decay into three pions—one positive, one negative, and one neutral—in an event which can be tracked in a spark chamber or bubble chamber.

In a bubble-chamber experiment at Brookhaven, some 1441 photographs deemed to show genuine instances of the decay of the eta meson into three pions were obtained out of a total of 435,000 photographs, of which 80,000 were subjected to detailed analysis. The Brookhaven results showed that in 724 cases out of the 1441 significant cases the positive pion carried away more energy than the negative pion, and that in 627 events the negative pion carried away more energy. A violation of so-called "charge" symmetry in an electromagnetic interaction was indicated.

At CERN an experiment of similar intent but rather different design was carried out. From a smaller total number of photographs (350,000) some 45,000 events were closely analyzed and 10,600 were accepted as usable examples of eta meson decay. The result, briefly, was no evidence of charge violation. The CERN results have been given high marks at international meetings, and the laws of symmetry seem safe for the moment at least.

A Source of Pride

While the results of particle physics seldom get much notice in the press, the CERN performance was seized on as an example of European one-upmanship. The headlines in British papers ["European Precision Defeats US Theory" (the *Guardian*), "Europe Scores a Point in Physics" (the *Times*)] were not untypical, at least in papers having science writers with some inkling of the mysteries of high-energy physics.

At CERN itself there was understandable satisfaction with the coup, particularly since CERN in recent years had sometimes been chided for coming in second with important results. One moral drawn from the incident by Europeans is that it is important to have more than one laboratory capable of performing a particularly important experiment. Among the experimentalists themselves there was little unseemly glee. High-energy physicists are an extremely mobile and cosmopolitan lot not noted for institutional chauvinism. In the early days a Ford Foundation grant made it possible for CERN to invite distinguished American physicists to work at the new laboratory. The Ford grants have recently run out, but CERN has continued to invite able foreigners into residence, allocating about 1 percent of the operating budget to financing the visits. CERN physicists have recently been exploring the possibilities of collaboration between CERN and the Soviet facility at Serpukhov, where a 70-Bev proton accelerator is under construction (*Science*, 5 August 1966). There is a brisk international traffic in young physicists, involving major laboratories, particularly CERN and American and British labs.

CERN now employs well over 2500 people, but only about a third of these are professional scientists and engineers. The rest are divided about equally into two groups, administrative workers on the one hand and technicians and support workers on the other. There are more than 200 professionals on the permanent staff, but a relatively small number of these are scientists engaged in research. About 330 scientists are on the books as "visitors." They are paid by CERN but work at the laboratory for a stipulated period. Many of them are postdoctoral-level researchers who work on CERN teams.

As a pioneering international laboratory, CERN faced special problems in establishing a permanent staff structure. CERN could not make appointments in the way that a national civil service could, but the prospect of a career had to be offered if capable administrators, engineers, and technicians were to be attracted and kept. A new employee is given a 3-year contract. Generally, after two 3-year contracts, if a person's service has been satisfactory and his services are required he may be offered a permanent appointment.

The policy has been to limit the number of permanent appointments of scientists. There is a firm intention not to make CERN a refuge and haven for expatriate physicists, but, more important, the laboratory is intended essentially as a facility to be used by working physicists based in the member countries.

CERN has made it a point not to distribute jobs and contracts on a pro rata basis according to the size of national contributions. The aim is to hire the best man for the job and award the contract to the lowest bidder who can satisfy requirements. Circumstances naturally affect the balances. CERN is in a French-speaking area, so many of the employees in lower grades are French-speaking. France produces a lot of engineers. Many CERN engineers are French. Britain probably leads Europe in training people in data-processing work, and in the CERN computer center—which now has the biggest capacity of any computer center in Europe—the British are much in evidence. This is not to say that the national origin is ignored. If two candidates for a post are equally well qualified, the nod may well go to the one from the country which might be underrepresented. Sometimes nothing more than tact is involved, as in seeing that a CERN delegation to an international meeting includes a range of nationalities. Salary and allowance policies worked out in the early years seem to have made CERN an attractive place to work.

The success of the laboratory in organizing itself for productive research, however, would obviously have been irrelevant if things had not gone well at the interface between the laboratory and the member governments. The vital group here is the policy-making council, which had its origins in the provisional committee set up in 1952. Under the CERN convention each member state is entitled to two representatives on the council. In practice, these posts have been filled by one scientist of high reputation and a senior official of whatever government department administers the national grant to CERN. The result has been that CERN has maintained well-mended fences with both scientists and governments. All members have equal votes, whatever the size of their contribution, and CERN's history has been something of a testimonial to skill and good will in maintaining a consensus.

CERN, however, has not found a magic formula which banishes all difficulties. Links between CERN and the universities in the member states are still far from perfect. Big Science can hold expensive frustrations for small countries. As costs rise, the major European countries face increasingly difficult decisions in allocating funds among national and regional projects in high-energy physics and other research. These present and future problems will be the subject of another article in this space.—JOHN WALSH

Test Detection: Decoupling Theory Verified, but Does It Matter?

Although extension of the 1963 test-ban treaty to underground detonations continues to be an objective of U.S. arms control policy, the Russians are showing little interest at the moment in negotiating such an agreement. One recalls, however, that the successful negotiations which led to the 1963 treaty had been preceded by years of discouragingly slow progress. Thus, there is always the possibility that U.S. research on test detection problems will take on a real immediacy and political significance. "Project Sterling," a recent experiment which tends to verify the theory that an underground nuclear explosion can be "decoupled" or muffled to avoid detection, is a case in point.

Should prospects improve for a ban on underground tests, the results of Sterling will be cited by those who oppose such a ban. Already Representative Craig Hosmer, a California Republican and member of the Joint Committee on Atomic Energy, is saying, "now that undetectable cheating has been proved even more possible than before believed, there is more reason than ever to stay away from this kind of national security trap." The U.S. insists that a comprehensive test ban treaty must provide for a limited number of inspections for the verification of suspicious events. But Hosmer argues that if, through decoupling, the Soviet Union can prevent detection of their tests, the right to make inspections would constitute no real safeguard.

Government arms control experts strongly dispute the contention that agreeing to a comprehensive test ban treaty need entail high risk. In their view, Sterling merely supports a theory already widely accepted. The decoupling theory, first advanced in 1959 by a group of scientists at the Rand Corporation, holds that the seismic signals