HIGH-ENERGY PHYSICS

Europe's most influential and costly collaboration

Geneva

CERN, the European Laboratory for Particle Physics whose new name does not match its old acronymn, seems always to be celebrating something. A few years ago, it was the successful production and identification of the particles called the Z^0 and the $W^{\pm}$ whose existence put the cap on the unified theory of electromagnetic and weak nuclear forces due severally to Salam and Weinberg.

This year, CERN will be celebrating the commissioning of its latest accelerator, called LEP (for large electron–positron storage ring).

With just a few months to go to completion, LEP seems already assured of success. The tunnel (with a circumference of 27 km) has long since been complete and the magnets which keep the two counter-circulating beams installed. One section of the storage ring has been tested for fidelity with real electrons. The hope now is that it will be possible to put electrons and positrons into circulation soon after midsummer and that the first physics will be done early in the autumn.

The most striking feature of the way that people talk about this prospect is their confidence. The underlying assumption is that every project to build a particle accelerator that CERN touches turns out successfully. Certainly this has been the laboratory's record since the late J.B. Adams, as director, built the machine called the Super-Proton Synchrotron (SPS) and began on the task of building LEP.

The immediate objective is to collide beams of electrons and positrons circulating in opposite directions in the same vacuum chamber and each carrying 55 GeV of energy. Apart from the gigantic scale of the construction, the technical difficulties are those of shaping the counter-circulating beams of electrons and positrons and controlling the position of the particles both in space and time. The particles travel in bunches and are meant to coincide in space and time at the eight points around the ring at which collisions are meant to take place.

With this energy, colliding pairs of electrons and positrons should yield copious numbers of the heavy bosons required by the electroweak theory, allowing the properties of these particles to be defined in detail. But there is also a scheme for making a more powerful machine of LEP by substituting superconducting cavity oscillators for those now meant to supply LEP with power. The result would be, perhaps by 1995, a machine capable of colliding 100 GeV electrons and positrons.

The scale of this project is quite breathtaking. The surface of the site shows no sign of the storage ring, which is in places 100 metres or so underground despite the way the ring has been tilted from the horizontal (to minimize excavation costs). Getting to a particular experimental hall requires a journey in a vehicle through the rural lanes of (mostly) France and Switzerland, where agriculture continues undisturbed.

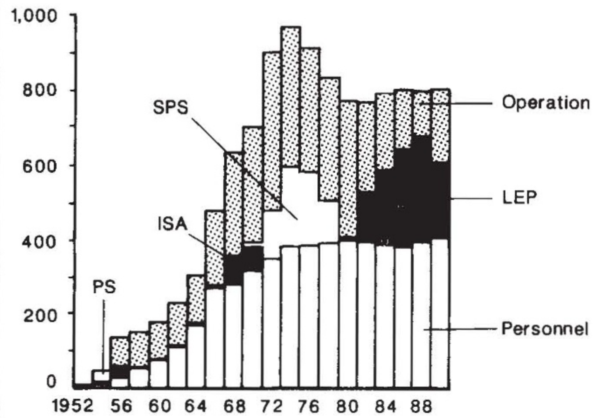
The hall that houses the planned experiment called Delphi is really an underground cavern 30 metres high which, last month, was buzzing with people threading power and data cables through the proper positions in the harnesses designed for them as if they were acrobats building a cocoon of cable for a mechanical monster lost underground (see this week's cover). Half-way up the detector being assembled are the ports that will deliver coincident bunches of electrons and positrons simultneously to the centre of the detector.

That is the heroic face of CERN, which is also, by being the most costly of all international collaboration in Europe, also one of the most controversial. More accurately, that has been how it has seemed from Britain in the past few years.

In 1984, it was decided that there should be a formal examination of continued British membership of the international high-energy physics community (carried out by a group under Sir John Kendrew), a further examination under the eye of the CERN council of the efficiency of its operations and, finally, a decision that British membership would continue, at least for the time being.

It is understandable that the workforce at Geneva (about 3,500 strong) should feel slighted by these signs of less than full approval. They are quick to point out that, as high-energy physics laboratories go, CERN is cheap, with a budget of just over 800 million Swiss francs a year out of which it must pay for the physical of cost of building LEP (roughly SFr1,200 million since construction began in 1981).

In reality (see figure), CERN has been required to live within a fixed budget since the beginning of this decade. In the process, it has become expert at cannibalizing its existing machines. Electrons and positrons for LEP, for example, will be given their high energy by first circulating them through the oldest machine in operation at the site (a proton synchrotron) and then through the SPS (giving them a total energy of 20 GeV) before they are fed into the larger LEP ring for final acceleration and storage.



CERN's total expenditure, 1952–91 at 1988 prices. For the past decade the budget has been constant.

A bizarre prospect for the more distant future is that, at some stage, the same cascade of accelerators may also be used for the purpose for which they were designed (accelerating protons or antiprotons) with which to fill a companion hadron storage ring in the same LEP tunnel. Since the two booster synchrotrons also have other functions on the site, the planning of what kinds of particles are delivered to which experimental rigs in what sequence threatens to become a planners' nightmare.

The Large Hadron Collider, the scheme for equipping the LEP tunnel with a second circular vacuum chamber for storing counter-circulating protons and antiprotons, is for the time being only a possibility. For one thing, the 14 full member states have not approved the scheme (which, with its superconducting

Science in Europe

THIS brief survey of collaborative research in Western Europe has been compiled by Steven Dickman (Munich Correspondent), Peter Coles (Paris Correspondent), Peter Newmark (Deputy Editor), whose contributions are attributed, and John Maddox (Editor).

The objective has been to illustrate by means of examples the manner in which collaborative research in Europe is undertaken rather than to provide a comprehensive survey of the institutions involved, and of their objectives. □