

A look at LEP

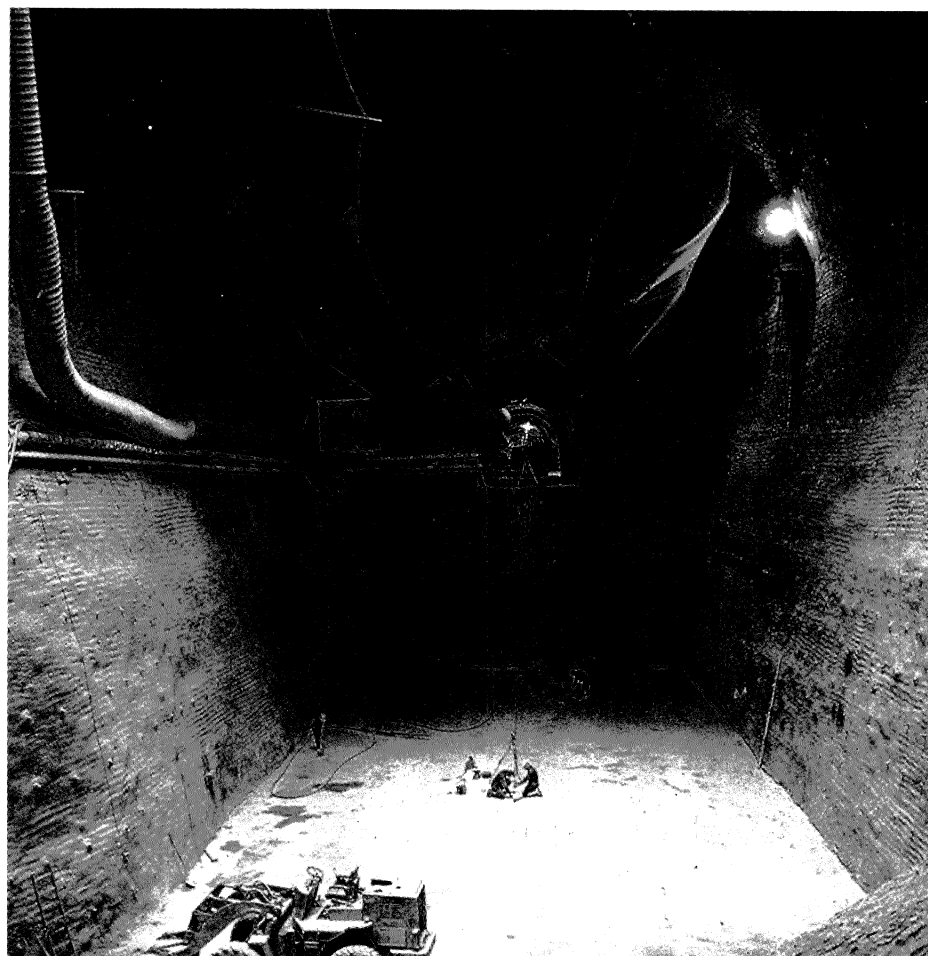
While work on the tunnel linking England and France under the English Channel has not yet begun, the 26.6 kilometre ring being built at CERN for the LEP electron-positron collider is one of Europe's major engineering projects.

Work began symbolically on 13 September 1983 when French President François Mitterrand and Swiss President Pierre Aubert gave the final touches to the LEP foundation stone. In a project of this size, problems and setbacks are only to be expected, but three years later the achievements are impressive and the project team is still confident that the gigantic machine can be finished on schedule towards the end of 1988.

With three big tunnelling machines now at work under the plain at the foot of the Jura mountains, over 10 kilometres of 3.8 metre diameter tunnel have been bored of the 23.3 required. In addition, 2.2 kilometres of tunnel have been blasted in a 3.3 kilometre stretch under the Jura, for which the tunnelling machines are not suited. Here special precautions are taken to avoid interfering with water courses which for centuries have served the towns and villages below.

February 5 saw one machine notch up a record of 58.7 metres of tunnel bored in one day, more than twice the average figure. As the machines move relentlessly forward, teams move in to line and concrete the completed tunnel sections.

Project Leader Emilio Picasso is always quick to point out that the status of the civil engineering work is even healthier than tunnelling progress alone would indicate. Before the machines could start work, huge shafts up to 150 metres deep had to be sunk



45 metres below ground, the LEP tunnel emerges into the vast underground cavern which will house the big L3 experiment.

(Photo CERN X 809.11.85)

and vast underground caverns excavated underneath. These are now 80 per cent complete, so that in total the underground operations are well past the half-way mark.

Over a million cubic metres of spoil will have to be removed, equivalent to digging a ditch several metres wide and several metres deep right round the urban sprawl of London!

But the tunnel is only the first step towards building a machine to accelerate and store beams of electrons and positrons (anti-electrons) initially at 50 GeV per beam, eventually higher.

For this, a myriad of sophisticated components has to be de-

signed and specified, ordered, manufactured and tested before installation work in the tunnel even begins.

Supplies for the magnet system to guide the particles are well in hand. The old tunnel from the Intersecting Storage Rings is stacked with kilometres of dipole magnets ready to be lowered into position. 102 of the 524 quadrupole magnets and 144 of the 510 sextupoles have arrived from European industry. Supplies for the radiofrequency cavities and the klystrons to power LEP's beams are also beginning to build up.

Work on the other ancillary equipment — cooling and ventila-

While work for the LEP machines forges ahead, the four big experiments keep step with the demanding schedule to be ready to intercept the first electron-positron collisions towards the end of 1988. Here is a prototype module of the Ring Imaging Cherenkov counter (RICH) for the DELPHI experiment. The DELPHI RICH, the largest example of this relatively new detector technique, will surround the central tracking chamber and will identify charged hadrons.

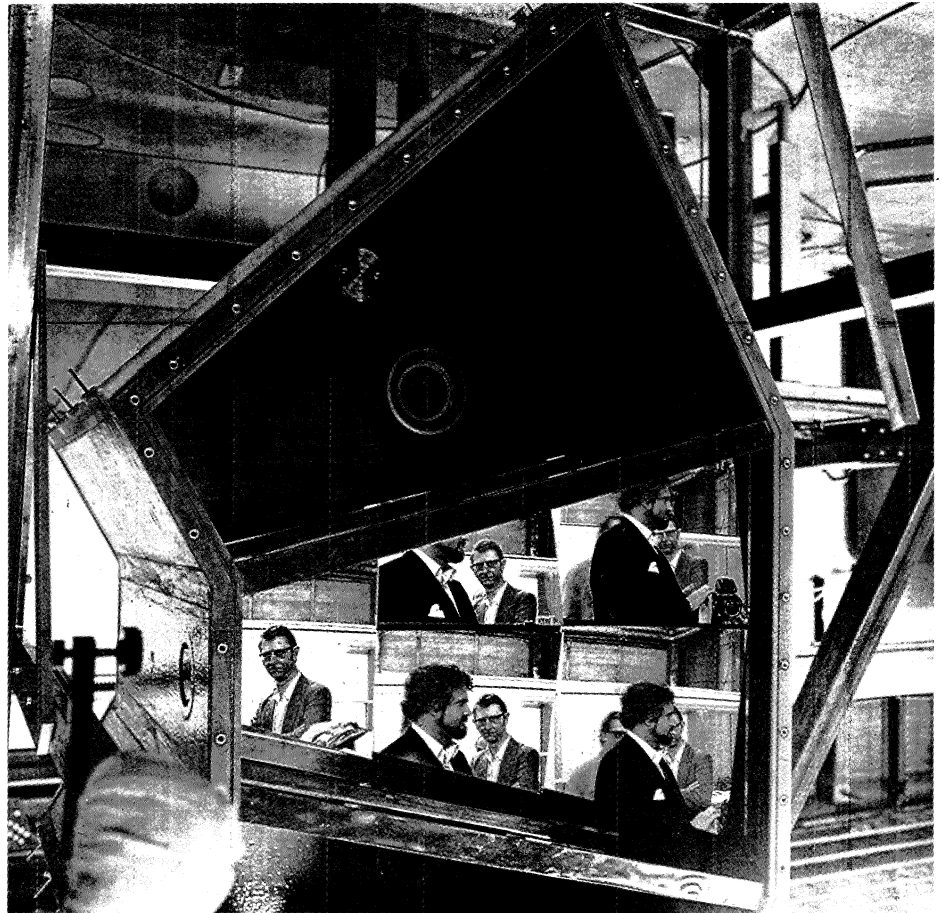
(Photo CERN X 757.5.85)

tion, transport, cabling, power transmission, vacuum, control systems,... — is moving steadily ahead ready to lock into the intricate planning of the project.

While the tunnel progresses and the machine components begin to arrive, preparations unfold to supply particles for LEP. Near the valiant 27 year-old 'Proton' Synchrotron (PS) which gives all CERN's particle beams their initial kick of high energy, a 100 metre linear accelerator — the LEP Injector Linac — is being built. Just before Christmas one sector of this machine accelerated electrons to 4 MeV and accelerator physicists anxiously studied the behaviour of the beam.

In these tests, a number of important functions (vacuum, power supplies, beam position) were monitored and controlled by elements of the new computer control system. This gave confidence for the task of integrating the remaining controls and process elements.

In June, the linac is scheduled to inject the first electrons into the new Electron-Positron Accumulator (EPA), which will store the particles prior to injection into the PS. Injection into the PS is planned for the end of the year, providing a Christmas present for the stalwart team



who are also looking forward this year to handling oxygen ions.

At CERN and the hundred or so research institutes across the world collaborating in the four big experiments to use LEP, an intri-

cately dovetailed effort ensures that the four huge detectors will be ready to intercept LEP's first collisions of electrons and positrons, opening a new era of particle physics.

Neutrino masses

Postulated in the early days of quantum mechanics by Wolfgang Pauli to make energy-momentum conservation in nuclear beta decay come out right, the neutrino has never strayed far from physicists' attention. The Moriond Workshop on Massive Neutrinos in Particle

Physics and Astrophysics held recently in the French Alps showed that more than half a century after Pauli's prediction, the neutrino stubbornly refuses to yield up all its secrets.

Peter Rosen (Los Alamos) began the Workshop with the charge that

since 'no simple principle demands that the neutrino is massless, it's up to the people in this room to determine the mass', and the participants eagerly took up the challenge.

The possible role of neutrinos in cosmology was discussed by a