

LEP commissioning

LEP there be lepton Z!

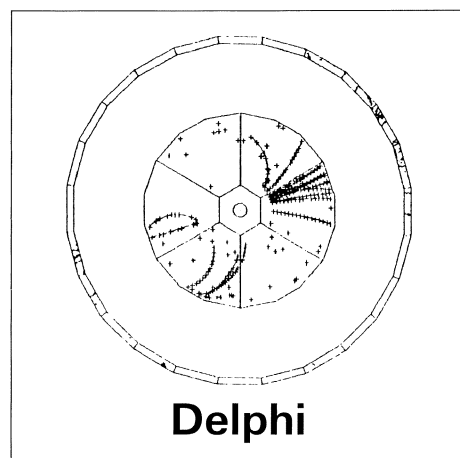
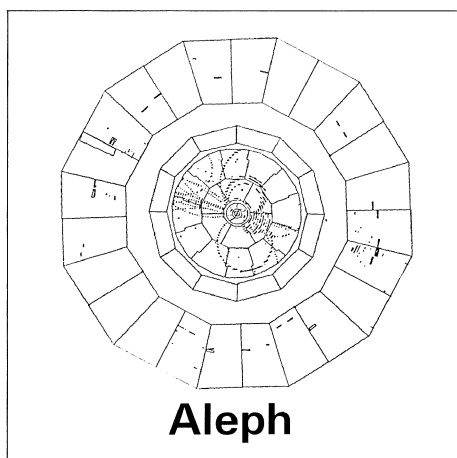
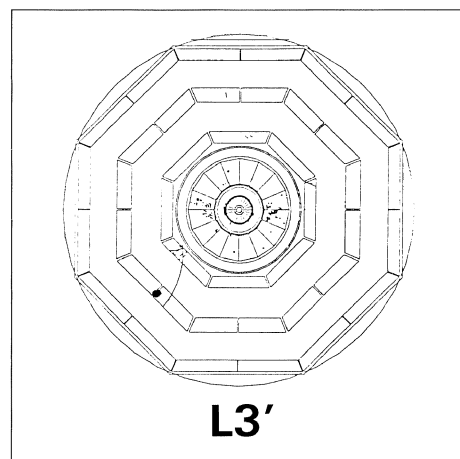
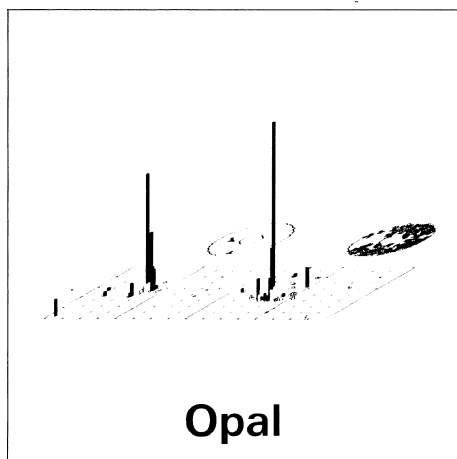
The particle physics scene this summer was dominated by the commissioning of CERN's new LEP electron-positron collider and the continuing effort by other experiments to contribute to the physics of the W and Z particles, the carriers of the weak nuclear force.

As this issue went to press, LEP was producing its first Z particles and other experiments were announcing important new W and Z results in this rapidly developing physics sector. More news in the October issue.

On 14 July, as all France celebrated the bicentenary of its revolution, CERN was the scene of a revolution of a very different kind. At 16.30 hrs, a 20 GeV positron beam went round the 27 kilometres (most of which is under French territory) of CERN's new LEP electron-positron storage ring. After more than a decade of careful planning and preparation, almost six years after groundbreaking, and two years after the start of equipment installation, the LEP team delivered on the day they had told people to mark five years ago.

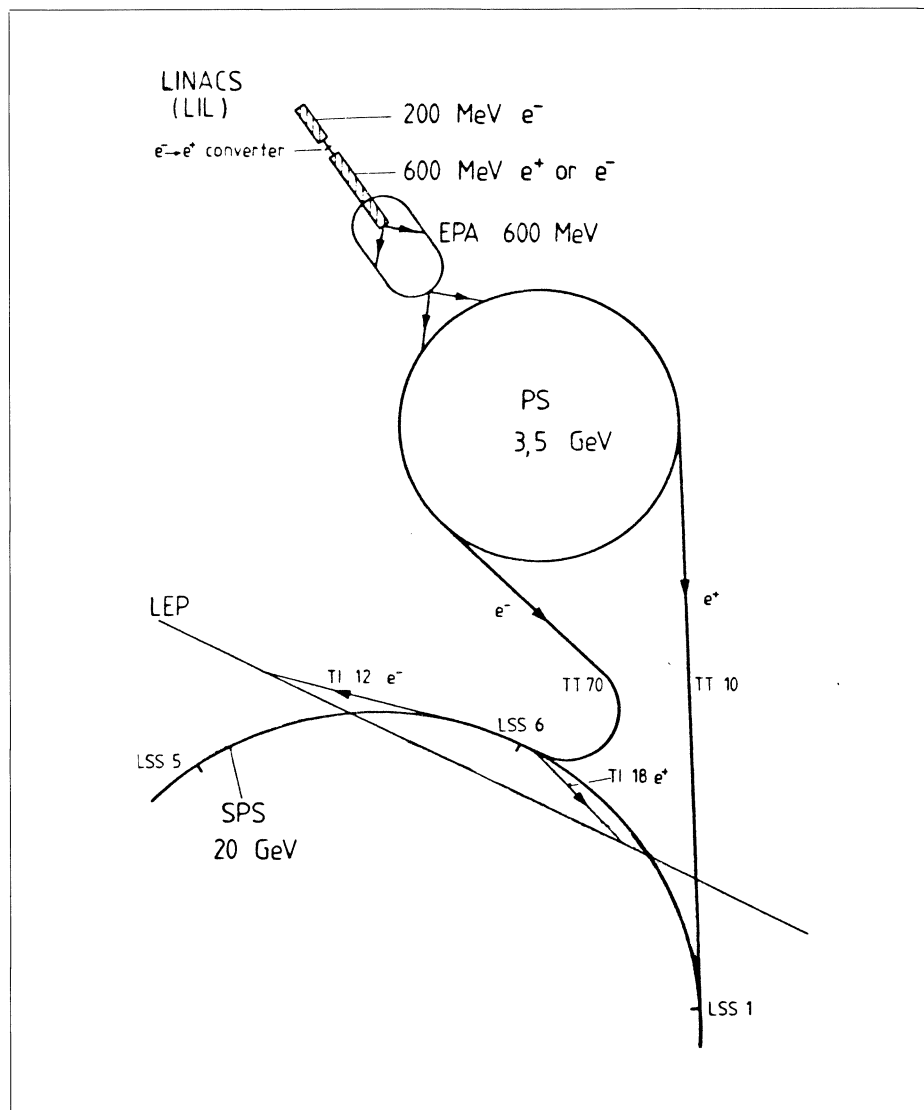
Following this first injection of positrons, priority was to commission the beam observation monitors. After the first measurements of the beam trajectory, the machine

Initial Zs in LEP, as seen by the four detectors.



Jubilation in the LEP control room.

Electrons and positrons for LEP are provided by CERN's complex of interconnected accelerators.



celerated from 20 to 47.5 GeV without loss.

Beam currents built up steadily, with positron beam reaching 700 and electrons 300 microamps over the next few days. On 11 August the low beta system came into action to squeeze the beam in the collision points, and there was enough confidence to go for a pilot physics run with 45.5 GeV colliding beams. By 14 August each of the four big experiments – L3, Aleph, Opal and Delphi – had seen their first Z particles. LEP was in business.

During this time, the faithful SPS, using subtle interleaving of acceleration cycles, continued to supply protons for a full programme of fixed target physics at the same time as providing LEP with its electrons and positrons.

Before arriving in LEP, the electrons and positrons have already come a long way, having transited CERN's unique complex of interconnected accelerators. The particles are manufactured by the LIL injector – positrons from an initial 200 MeV high current electron linac providing electron-positron pairs from photon conversion, with a second linac taking electrons and positrons to 600 MeV. They are then stored in the EPA accumulator before being passed to the PS synchrotron for acceleration to 3.5 GeV. Using the same beamlines as the proton-antiproton collider scheme, the particles are then fed into the SPS for acceleration to 20 GeV, ready for injection into LEP.

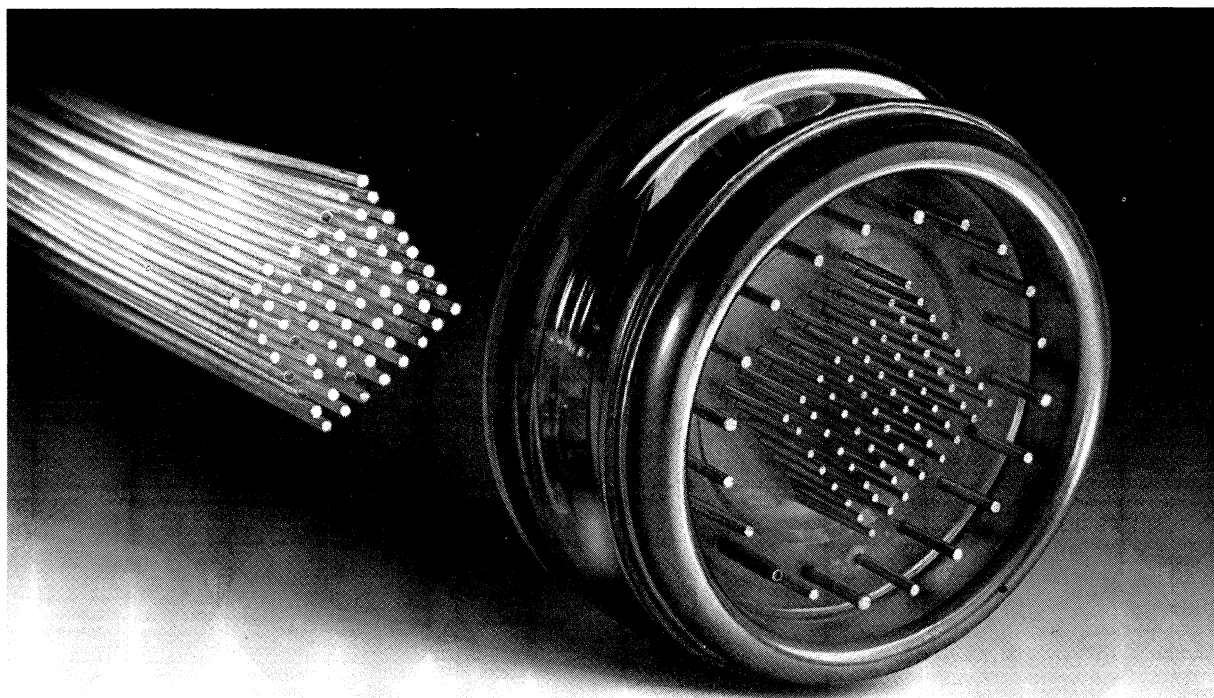
The commissioning featured regularly updated computer news bulletins. With accurate and up-to-date information readily available, enthusiastic LEP followers could monitor progress without having to pester colleagues who had their hands full.

physicists were making the first corrections. Several days later first particles were captured with the radiofrequency system.

Injection from the SPS had initially encountered some difficulties in the standing-wave radiofrequency cavities used for accelerating particles for LEP, but this was soon fixed and there was a steady beam of positrons. Both electrons and positrons were accelerated and extracted on the four lepton cycles,

and the transfer line feeding electrons to LEP was commissioned, although no particles were injected at first. Circulating electrons made their appearance in LEP on 25 July.

On 27 July positrons were accumulated and stored, the intensity of the stored LEP beam increasing over the following days from 20 to 250 microamps. On 3 August, attention turned to electrons once more, with particles being stored. Later that day, positrons were ac-



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Forerunner of LEP. Frascati's 60-cm radius AdA electron-positron collider achieved the first electron-positron collisions, at 250 MeV per beam, in 1963. AdA was subsequently moved to the French Orsay Laboratory.

Electron beam machines turn full circle

With the commissioning of CERN's 27-kilometre LEP electron-positron collider, the world's largest electron ring is now in operation. It is almost certain that no larger electron ring will ever be built, although larger machines (for example the proposed US SSC Superconducting Supercollider, with a circumference of 84 kilometres) to handle protons are on the drawing board.

To attain higher electron energies, physicists are now convinced that linear machines and new techniques are needed. The history of electron storage rings thus spans only about a quarter of a century.

In the late 1950s, machine physicists' attention was turning to the possibility of using storage rings to fire two particle beams against each other to obtain higher collision energies. (In firing a single beam against a fixed target, most of the beam energy is 'lost' in the target recoil.) For these ideas, the tide had turned against protons, and physicists were looking at the easier-to-stack electrons.

Three projects got underway. At Stanford, where the Mark III linear accelerator already supplied electrons, a Princeton (Gerry O'Neill, Bernie Gittelman) and Stanford (Pief Panofsky, Burt Richter) collaboration was looking to collide the 500 MeV electron beams held in two rings. At the Soviet Novosibirsk

At the Soviet Novosibirsk Laboratory in May, Director A.N. Skrinsky cuts the cake marking the 25th anniversary of the first electron-electron collision in the VEP-1 machine.

