ly in a W decay, giving a characteristic wide separation between the decay products. Likewise a lot of energy is released in the subsequent (semileptonic) decay of the top quark, which again makes for widely separated decay products.

The UA1 experiment looked at the collected sample of data from violent collisions producing a single lepton (electron or muon) and two or more hadron jets, selecting out those in which the emerging lepton and jets are well separated from each other.

Three good examples each are found of electron plus two jets and muon plus two jets. The total mass of the decay products corresponds to a W in each case, and the mass of the top quark decay products falls in a band between 30 and 50 GeV, peaked around 40 GeV. (There are also events with single electrons or muons plus three jets, but here the jet labelling problems make it difficult to come out with unique answers.)

Too early to claim that the top has been reached, but with more data from the autumn run at the Collider, the sixth quark may be soon added to the list of major physics discoveries at the Collider.

Leipzig Conference

Showcase for a memorable year of progress in particle physics, the 22nd International Conference on High Energy Physics was held in Leipzig, German Democratic Republic, from 19-25 July. After a busy three days of parallel sessions (four streams), well over a thousand participants gathered in Leipzig's Kongresshalle for the plenary talks. As at the Brighton Conference last year, these began with presentations from the big UA1 and UA2 experiments at CERN's SPS proton-antiproton Collider, still the focus of world attention despite having taken no new data since last year.

R. Böck of CERN, in the impressive style now so characteristic of UA1 presentations at major meetings, described the handful of events with widely separated jets of hadrons accompanied by single electrons or muons which could be the first indi-

Karl Marx University, Leipzig, scene of the parallel sessions of the recent International Conference on High Energy Physics.

Catching a tiger by the top! First plenary session at the Leipzig Physics Conference covered the first indications from the UA1 experiment at CERN of the sixth — 'top' — quark. The Conference plenary sessions were held in the Kongresshalle, immediately next to the city's magnificent zoo. At the Conference banquet, CERN Director General Herwig Schopper named a newly-born tiger cub — 'Top'. Looking on (right), is Prof. Seifert, the zoo's director.

(Photo: Hochschul Film- und Bildstelle, Leipzig)

cation for the long-awaited sixth quark — 'top'. Although the findings (see previous story) had been announced before, such a detailed presentation set the tone for what was to become a solid programme of physics at the Leipzig plenaries.

Immediately following Böck was J. Rohlf of Harvard who covered among other things UA1's unusual 'monojet' events (see May issue, page 139), which are difficult to explain by conventional physics ideas. These new results have already been pounced on by theoreticians with new ideas to sell (especially supersymmetry). As well as the monojets, UA1 now has an unusual three-jet event. Rohlf also mentioned the high hadronic activity seen accompanying UA1's Z^os, but not Ws. The Z appears to be 'noisier' than the W.

For UA2, J.-P. Repellin described some new UA2 results, including unexplained events (also see May issue, page 139). The UA2 oddball events are not quite the same as those in UA1. In the 'top' region, the signal-to-background ratio in the UA2 detector is appreciable and makes observation difficult.

Also with a vested interest in CERN Collider physics was P. Darriulat who abandoned his UA2 allegiance to present the concluding summary of experimental results at Leipzig. His talk paid a lot of attention to Collider results, especially in the W and Z sectors. After pointing out the difficulties inherent in UA1's candidate 'top' signal, he let it stand.

Earlier, in the parallel sessions, P. Bagnaia of CERN had showed UA2's results on hadron jet production, including the suggestion of a small signal out at 147 GeV transverse momentum in the spectrum of two jets. UA1 had nothing to say directly in the parallels, preferring to save everything for the plenaries.

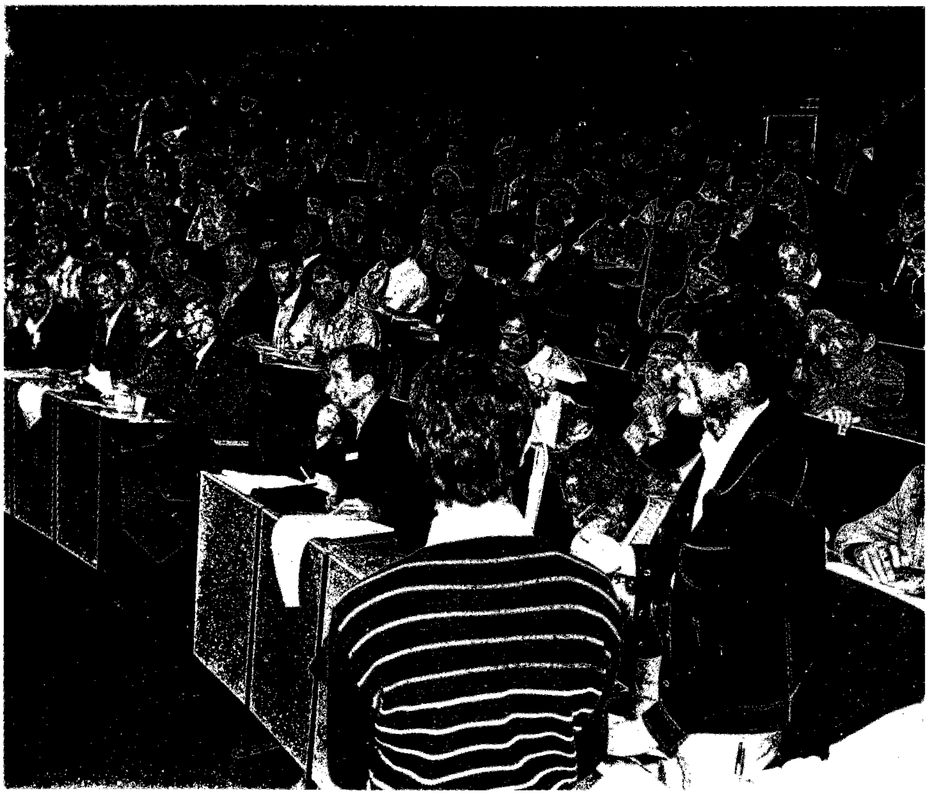
The CERN Collider experiments also got good coverage from M. Jacob of CERN in his summary of 'hard' hadron collisions and jet phenomena. These reactions probe deep inside the colliding particles and reveal interesting clues about what makes quarks and gluons tick. Jacob suggested that jet spectroscopy, as illustrated by several announcements at Leipzig, has now become an established physics tool for tracking down new particle states.

According to Jacob, the hadronic activity accompanying the production of W bosons at the Collider is well described by the conventional field theory of quarks and gluons. However he was less confident about the Z in view of the hadronic activity seen by UA1.

Physicists are eager to track down the differences between the behaviour of hadron jets coming from quarks and those from gluons. However this is not easy to sort out at the Collider, where any gluon jets come from non-primordial radiations. Production of heavier quarks in the collisions of particles built of light quarks could be an indicator of gluon involvement, and Jacob seized on some UA1 data on the production of charmed mesons as a possible signature of gluon jet effects. Elsewhere, he pointed out that experiments at the Split Field Magnet at the CERN Intersecting Storage Rings (ISR) have compared pion and kaon signals, the presence of kaons (strange quarks) suggesting again that gluons are involved (see May 1983 issue, page 131).

Several speakers mentioned the initial results from experiments at Fermilab and Brookhaven studying the decays of neutral kaons into two pions, which are a little bit worrying for standard theory, and could have deeper implications.

Another new result looking for an



P. Franzini poses a question on the new zeta state seen by the Crystal Ball experiment at the German DESY Laboratory in Hamburg. The zeta was the big surprise of the Leipzig Conference.

explanation is the observation by experiments using pion beams at the CERN SPS that the production of single photons by positive and negative pions is comparable, while a factor of two difference was expected.

New particles

The joker in the pack at Leipzig was the unexpected announcement by the Crystal Ball collaboration working at DORIS (the smaller electron-positron collider at the German DESY Laboratory in Hamburg) of a new state, the zeta, at 8.3 GeV. Initially presented in not one but two talks by H. Trost of DESY in the first day's parallel sessions, it is seen in radiative decays of the lightest upsilon particle.

Ground state upsilon decays into either a high multiplicity hadronic state or into two low multiplicity hadron jets (thus giving two distinct data samples) show extra activity at a photon energy near 1070 MeV, corresponding to the formation of the 8.3 GeV state, but the signal is almost invisible in the decays of the next (2S) upsilon.

With the windfall of a totally unexpected result, there were whispers of a possible 'Higgs' particle, but the consensus view was that this is excluded because of the absence of a signal in the decays of 2S upsilons.

Over at Cornell, the other Laboratory specializing in upsilon physics, the CUSB experiment at the CESR electron-positron collider has been looking for just such states, starting at lower masses, and has tantalizingly yet to produce results in the region of the Crystal Ball's zeta signal. News is eagerly awaited.

However Cornell's cupboard is not completely bare. Both CESR experiments — CLEO and CUSB — have evidence for heavier upsilons (5S and 6S) to add to the upsilon collection, while CUSB has seen a B* meson in the decays of 5S upsilons. The mass difference between this level and the standard B (beauty) meson is about 50 MeV.

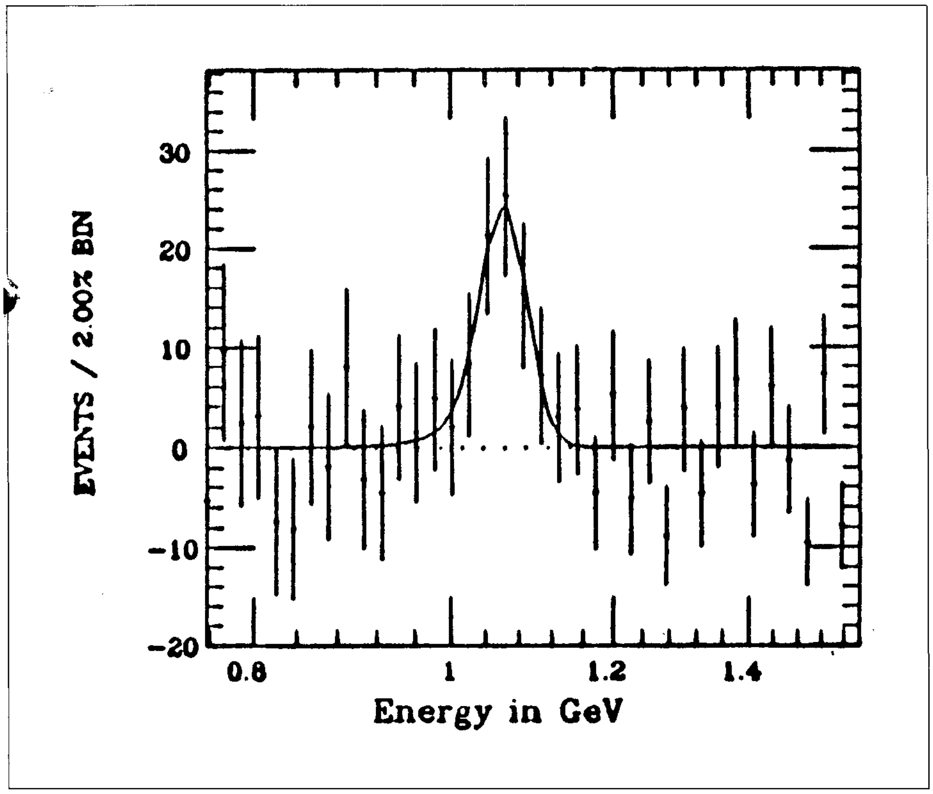
These and other new particle states were covered in the summary talk by A. Silverman of Cornell. An impressive list of experiments all over the world have now seen the F meson at 1970 MeV, following CLEO's reassessment of its mass last year. The ARGUS experiment at DESY suggests an F* 144 MeV heavier than the F.

Silverman also reported the initial findings by the gas jet target experiment at the CERN ISR. This unfortunately short-lived study involved firing a carefully tuned antiproton beam in one ISR ring past a jet of hydrogen gas. This has studied a number of charmonium states difficult to get at by more conventional means.

Covered in the summary talk by R. Klanner of Munich on the weak decays of heavy particles were mo[illegible] results on the lifetime of b-quark states. Initial suggestions last year from experiments at the Stanford PEP ring had indicated that this was unexpectedly long, in the 10^{-12} second region. This has now been supported by other experiments, both at DESY and at Stanford. However these values are all derived from statistical spreads and Klanner admitted that he would feel more confident about the result if the detectors actually picked up the decay paths of the unstable particles. Several other speakers also remarked on the relative longevity of b-quark.

A. Zaitsev of Serpukhov had the task of surveying the field of light quark spectroscopy, including candidate glueballs (states containing gluons as well as or in addition to quarks). The ksi (2.2 GeV) state re-

The zeta signal (after subtraction of background) seen by the Crystal Ball experiment in the decays of ground state upsilons into a photon and multiple hadrons. The 1.07 GeV photon peak corresponds to a particle mass of 8.3 GeV.



ported last year by Mark III at Stanford and yet to be seen elsewhere needs an interpretation, said Zaitsev. He also proposed the enhancements seen in some charge states of two rho mesons produced in photon-photon scattering as possible candidates for four-quark states.

Neutrinos

Very much still in the spotlight is the non-zero value for the electron neutrino mass from the ITEP (Moscow) experiment on the beta decay of tritium. Since the initial announcement at the Brighton Conference last year, the spectrometer has been recalibrated and more work has been done. According to V. Ljubimov of Moscow, Leipzig neutrino rapporteur and working on the ITEP experiment, the electron neutrino's mass should 'realistically' lie in the region between 20 and 45 eV. Other neutrino limits are also coming in, with the Mark II detector (now removed from the PEP ring at Stanford) giving an upper limit for the tau neutrino mass at 143 MeV.

Elsewhere in the neutrino sector, the Annecy / Grenoble team working at the French Bugey reactor cannot yet totally rule out neutrino oscillations. Part of the allowed area lies in a region not yet covered by other experiments. Whether this oscillation window stays open when results from other experiments come in remains to be seen. Ljubimov pointed out the range of neutrino matters still to be settled and advocated tackling a comprehensive programme of work to throw more light on this continually interesting corner of particle physics.

It is now two years since the discovery by the European Muon Collaboration at CERN that the quark structure of nucleons appears also to depend on the surrounding nuclear environment — the so-called 'EMC Effect'. This was quickly supported by historical data from electron beam scattering experiments at Stanford.

Quark structure of nucleons

The nucleon structure parallel sessions at Leipzig heard more results and a lot of healthy discussion. Plenary speaker I. Savin of Dubna was able to report that similar behaviour has been seen by the other big muon scattering experiment at CERN (Bologna / CERN / Dubna / Munich / Saclay) and by a new survey of electron scattering on heavy targets at Stanford. Other experiments, particularly those involving neutrino beams, do not see an explicit effect.

A number of experiments have now probed the relative contributions of longitudinally and transversely polarized photons in these reactions, and this also seems to be dependent on the target nucleus. Savin suggested that this effect might be responsible for some of the discrepancies between different experiments, and that the various sets of structure function data could happily coexist, even if some of the neutrino fraternity were not of the same viewpoint.

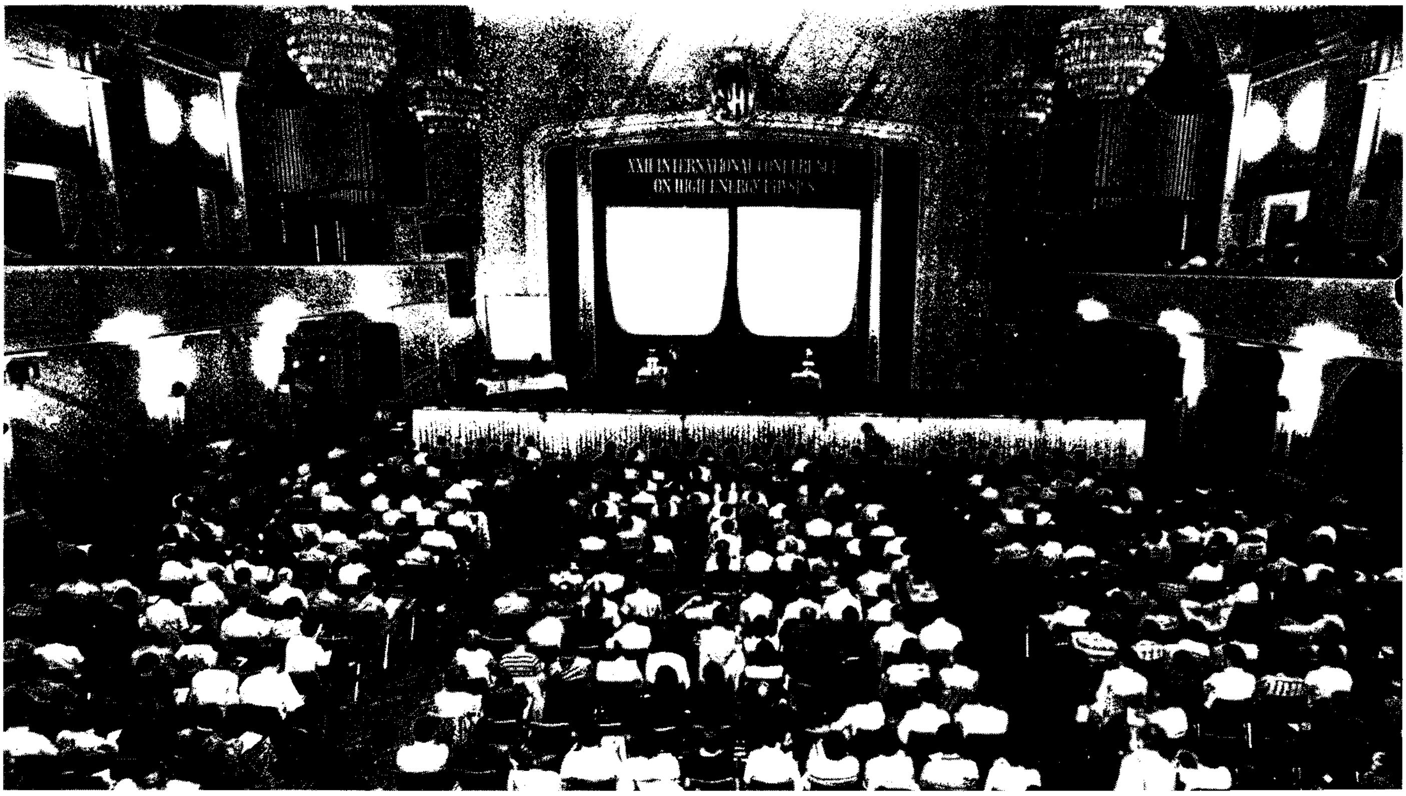
In his final summary talk, Darriulat emphasized that these effects, as well as being a subject for speculation in their own right, have important implications for the extraction of quark structure information from fixed target experiments.

The reluctant proton

Proton instability, once the flagship of grand unified theories, seems becalmed. Rapporteur M. Koshiba of Tokyo recalled the 'optimism' of 1982 after the initial results from the

A plenary session in the Leipzig Kongresshalle.

(Photos AdW/Fröbus)



underground experiment at the Kolar Gold Fields in India, followed by the 'depression' of 1983 with the negative results coming in from the big new Irvine / Michigan / Brookhaven search.

However Koshiba was optimistic about the new Kamioka experiment in Japan, pointing out the potential of the large phototubes used. He ventured that the effects now being seen in the Japanese experiment could be the edge of a genuine proton decay signal.

With the simplest theory unifying electroweak and strong interactions now ruled out by the absence of the predicted proton instability, theory has no well-defined path to follow.

In his summary talk on the phenomenology of grand unified theories, D. Nanopoulos of CERN listed the growing number of unexplained effects which nevertheless hint at a larger theory — CERN Collider results, new particles, the possibility of neutrino oscillations, the lifetime of the beauty quark, etc., as well as the large number of free parameters floating around. The two main approaches to this larger theory are supersymmetry (abolition of conventional fermion/boson classifications) and composite models (with an extra level of structure deep inside quarks). Nanopoulos preaches a supersymmetric way of life.

A 'new' feature of field theory is the Kaluza-Klein method for making larger dimensional theories more compact, thus enabling the power of a larger dimensional theory to be exploited before constructing a smaller, physical theory. The 65-year-old Kaluza-Klein approach is ironically the biggest thing to hit theoretical physics since supersymmetry (early 1970s), declared Abdus Salam in his excellent mini-summary talk earlier on in the parallel sessions.

Despite the absence of proton decay, particle physics theory is sound enough for many bold souls to venture out and attack problems on the origin and nature of the Universe. A. Linde of Moscow gave the first rapporteur talk at such an international meeting on the growing links between particle physics and cosmology. In a memorable presentation, he described how phase transitions (inflation) at the outset of the Universe's career can avoid unsightly problems such as massive magnetic monopoles.

These new developments in the technology of universe creation are challenging. Linde, who sells the 'chaotic' picture of primordial inflation, underlined Ehrenfest's ideas earlier this century on the compression of bigger theories down to our confinement in four dimensions to generate workable mechanisms of gravitation and electromagnetism.

Elsewhere in theory, much attention was paid to quantum chromodynamics, the standard picture of quark/gluon interactions. Rapporteur B. Ioffe of Moscow claimed that QCD is no longer a candidate but a real theory, despite calculational difficulties and missing connections with other established physics ideas. It is clear that much more work needs to be done before 'fragmentation' — the link between the interaction at the quark level and the observed production of free hadrons — is completely understood.

J. Kripfganz of Leipzig covered recent work in lattice gauge theories, pointing out some milestones which indicate that the right path is being followed. Even gravity is being submitted to lattice treatment these days, and Kripfganz recalled Riemann's 1854 remark that the underlying space of physics must have some discrete structure.

As always, the Conference summary speakers did a good job, but it was impossible to intercept in plenary talks everything that was covered in four streams of active parallel sessions. Detailed accounts of the experiments working at electron-positron colliders, two-photon physics (photon-photon collisions), magnetic monopoles, soft hadron phenomena, experimental techniques, particle searches, all these and more were profitably attended in the parallels.

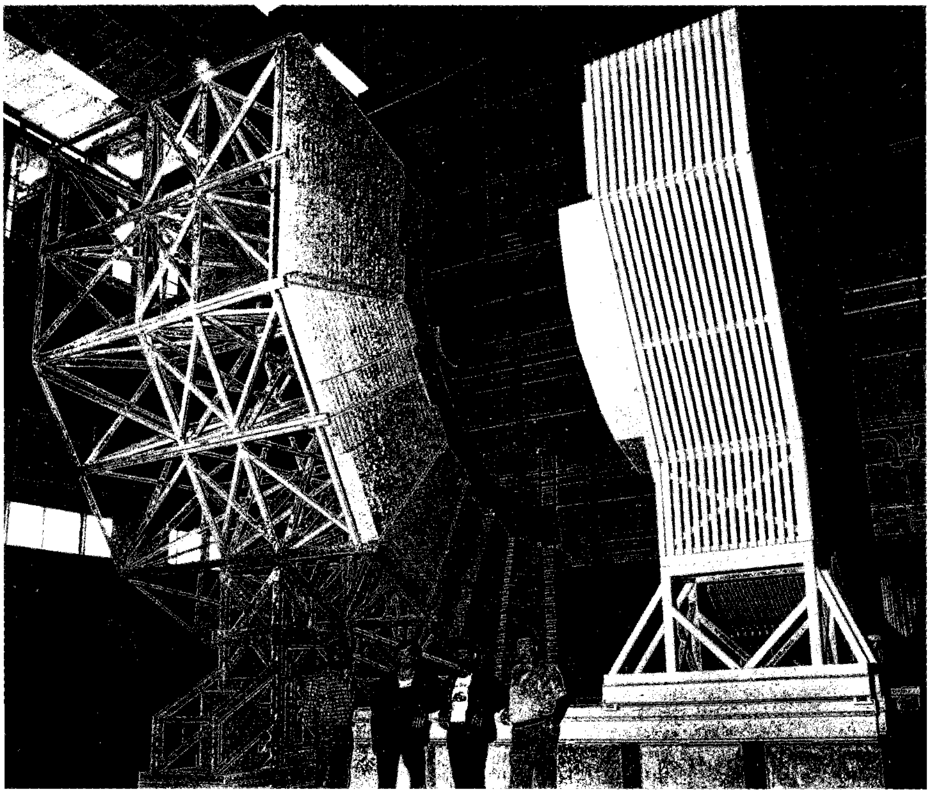
Under the general auspices of the International Union of Pure and Applied Physics (IUPAP), the Leipzig Conference was organized by the Institute of High Energy Physics of the Academy of Sciences of the German Democratic Republic, the Physics Departments of Leipzig s Karl Marx University and Berlin's Humboldt University, and the GDR Physical Society. Full marks to the organizers for catering for the intellectual and material needs of well over a thousand visitors from all over the world.

Report by Gordon Fraser

ALEPH

Our previous issue carried the first of a series of articles (DELPHI, page 227) on the four major experiments for CERN's 9 kilometre diameter LEP electron-positron ring, now under construction and scheduled to produce its first colliding beams in 1988.

This month we continue with the ALEPH (Apparatus for LEP pHysics) detector. The typical electron-positron annihilations produced in LEP will be very complex, producing many particles, distributed in turn into showers ('jets') which may turn up anywhere in the spherical volume surrounding the beam crossing point. The ALEPH detector is designed to collect as much informa-



Full-scale mock-up of part of the ALEPH detector, showing (right), a portion of one end-cap, and a segment of the hadron calorimeter with (inside) the fine-grain electromagnetic calorimeter.

(Photo CERN 103.6.84)