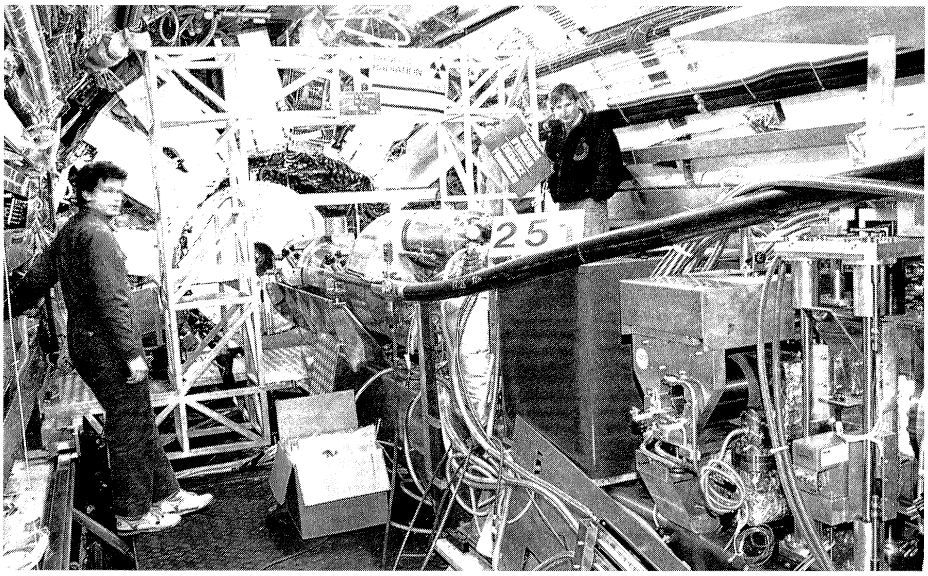
Around the Laboratories

One of the superconducting ('low-beta') magnets which squeeze LEP's electron and positron beams to boost the collision rate. These magnets have already performed well, compressing the beams tighter than originally foreseen.

(Photo CERN 74.2.91)



CERN
A big year for LEP

In April this year's data-taking period for CERN's big LEP electron-positron collider got underway, and is scheduled to continue until November.

The immediate objective of the four big experiments – Aleph, Delphi, L3 and Opal – will be to increase considerably their stock of carefully recorded Z decays, currently totalling about three-quarters of a million.

Interspersed with the data-taking sessions will be machine development periods to prepare the big machine for longer-term aims – higher collision rates, increased collision energies and polarized beams (March, page 1).

From LEP data collected so far, one major talking point is the implications of the precision results for so-called 'Grand Unified Theories' (GUTs). With the current Standard Model of particle physics in such good shape, GUTs go a step further, putting the two hitherto separate elements of the Standard Model – the electroweak picture (of electromagnetism and the weak nuclear force) and the field theory of quark interactions (quantum chromodynamics) – together into a single unified description of the three forces.

According to GUT ideas, the three distinct force couplings characteristic of the current Standard Model should gradually converge towards a single value – the GUT limit – at about 10^{14-16} GeV, an energy from which the three forces went their separate ways after the Big Bang.

LEP experiments give new precision values for the three couplings of the Standard Model, in particular the strength of the inter-quark force. Taken together, the information does not point to an easy unification.

If GUTS are to be in accord with today's data, some new physics has to lurk between the region currently explored by LEP and the GUT limit. One contender is supersymmetry (April, page 2), and imposing a convergence of the three different coupling strengths indicates that first signs of supersymmetry should be seen at about 1000 GeV. Or the new physics could come from some other source.

Whatever the new effects are, all this is extremely good news for planned or projected proton colliders like CERN's LHC for the LEP tunnel or the US Superconducting Supercollider (SSC) which aim to attain this energy region.

It also increases confidence in solving the 'dark matter' enigma of cosmology and astrophysics. For some time it has been clear that there is not nearly enough matter in the Universe to stop the Big Bang expansion continuing for ever, while analyses of galactic motion cannot be accounted for by visible matter alone.

Supersymmetry also provides a good candidate for this so-far invisible matter, with the lightest supersymmetric particles remaining as cosmological relics of the Big Bang. If these particles were electrically charged, they would have taken up residence in nuclei. However searches for anomalous abundances of heavy isotopes show nothing, so attention turns to electrically neutral super-particles.

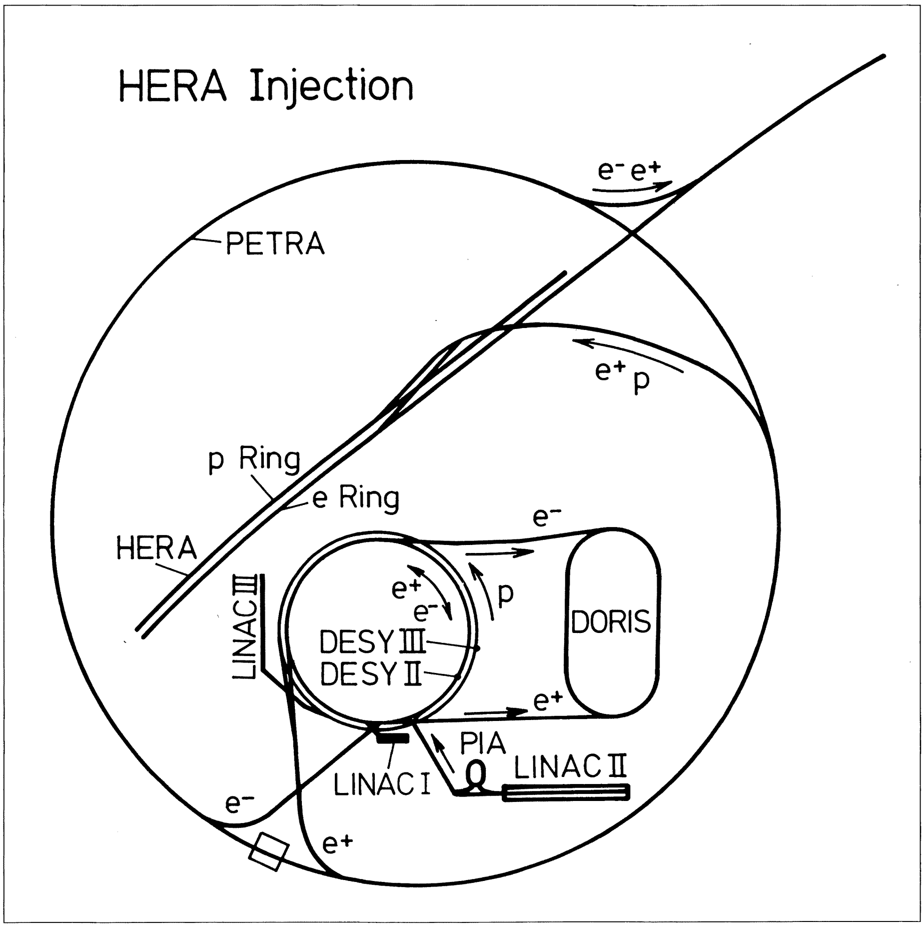
No sign of such particles has been seen so far at LEP, implying they must be heavier than about 10-20 GeV. Plausible estimates of cosmological abundances show that these neutral super-relics could supply enough gravitational pull to hold the Universe together.

Some 500 years ago, Copernicus startled the world by showing that it is not the centre of the Universe. Having learnt to live with that, we may now have to reconcile ourselves to the realization that we are not even made of the same stuff as most of the rest of the Universe.

*** see also page 26**

In the meantime the LEP experiments have their work cut out to sharpen the picture at currently available or accessible energies and provide a more confident basis for extrapolations to simulate the evolution of physics after the Big Bang.

The 'DESY chain' of injectors preparing electron and proton beams for the HERA electron-proton collider soon to begin operations at the DESY Laboratory in Hamburg.



DESY 40 GeV protons in PETRA*

In February protons were accelerated for the first time in the PETRA ring at Hamburg's DESY Laboratory to the 40 GeV needed for injection into the new HERA electron-proton collider.

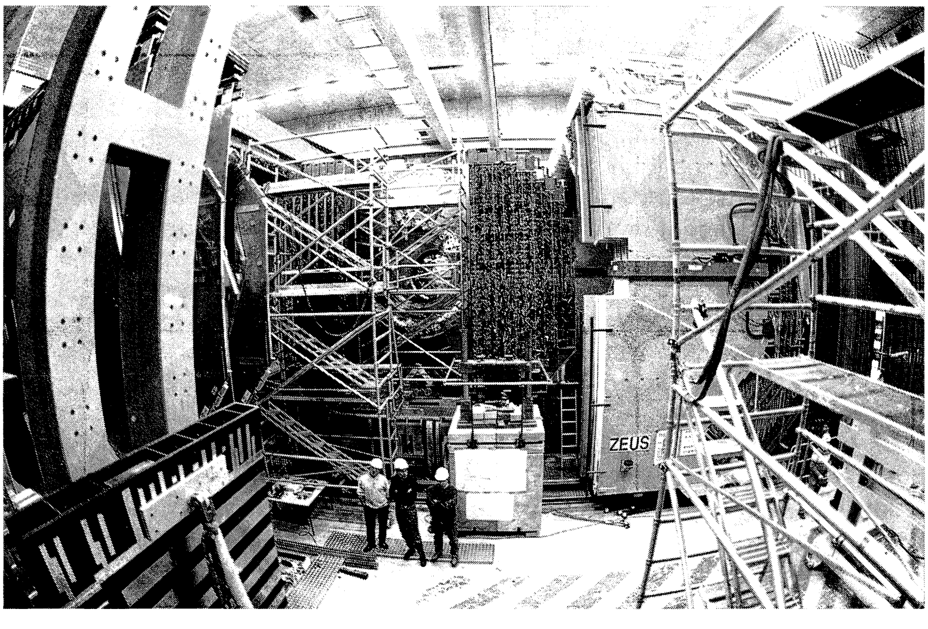
The next step is to increase the intensity and quality of these PETRA proton beams prior to injection into HERA's 6.4 kilometre ring of superconducting magnets.

The PETRA ring, built as an electron-positron collider, came into operation in 1978. The physics programme terminated in 1986 to prepare the ring for its new career as HERA's injector of both electrons and protons.

The complete 'DESY chain' of electron machines was tested in 1989, with electrons being taken to 14 GeV in PETRA and above 27 GeV in the HERA electron ring.

Zeus

Installation work is in full swing for the two big detectors – H1 (April, page 10) and Zeus for the HERA electron-proton collider soon to be



Now taking shape in the South Hall of the HERA electron-proton collider at DESY, Hamburg, is the Zeus detector.

(Photo Nick Wall)