

The Gallex (gallium-based) solar neutrino experiment in the Gran Sasso underground Laboratory in Italy has seen evidence for neutrinos from the proton-proton fusion reaction deep inside the sun. A detailed report will be published in our next edition.

again, with particles taken to 26.5 GeV and initial evidence for electron-proton collisions being seen.

Earlier this year, the big Zeus and H1 detectors were moved into position to intercept the first HERA collisions, and initial results from this new physics frontier are eagerly awaited.

HERA collisions

During the night of 31 May – 1 June, the HERA machine at the DESY Laboratory in Hamburg provided its first collisions between peak energy (820 GeV) protons and 26.7 GeV electrons. A 35 microamp proton pulse and a 140 microamp electron pulse were stored and collided in both experimental areas. Initial luminosity was measured at 1.5×10^{27} per sq cm per s and both the H1 and Zeus detectors were able to record and measure collisions. The HERA experimental programme has begun.

CERN LHC magnets

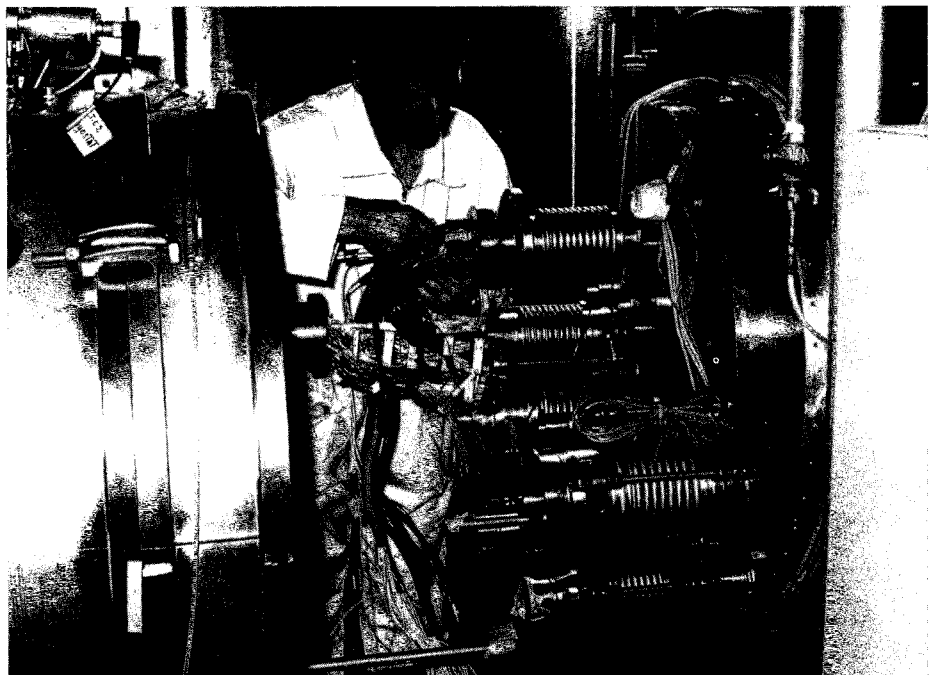
With test magnets for CERN's LHC proton-proton collider regularly attaining field strengths which show that 10 Tesla is not forbidden territory, attention turns to why and where quenches happen. If 'training' can be reduced, superconducting magnets become easier to commission. Tests have shown that quenches occur mainly at the ends of the LHC magnets. This should be rectifiable, and models incorporating improvements will soon be reassembled by the industrial suppliers.

New models are also being constructed to test different designs as well as alternative components and materials. A design with individual single collared coils is particularly promising, allowing the coils to be sorted according to multipole errors prior to installation. More single

aperture models are also foreseen to test coil and collar assemblies and a new conductor distribution will further improve multipole components.

A number of other models and prototypes are being built elsewhere including a twin-aperture model at the Japanese KEK Laboratory and another in the Netherlands (FOM-UT-NIHKEF). The latter will use niobium-tin conductor, reaching for an even higher field of 11.5 T. At KEK, a single aperture configuration was successfully tested at 4.3 K, reaching the short sample limit of the cable (8 T) in three quenches. This magnet was then shipped to CERN for testing at the superfluid helium temperatures to be used at LHC.

A full length twin-aperture magnet (TAP) built in industry has been tested at the French Saclay Laboratory (May, page 5). This uses coils developed for the HERA superconducting proton ring at DESY, Hamburg, with a correspondingly lower central field. At 4.5 K the coils be-



*At the French Saclay Laboratory, a high field twin aperture magnet of a type similar to that envisaged for CERN's LHC proton collider is prepared for tests.
(Photo CEA Saclay)*

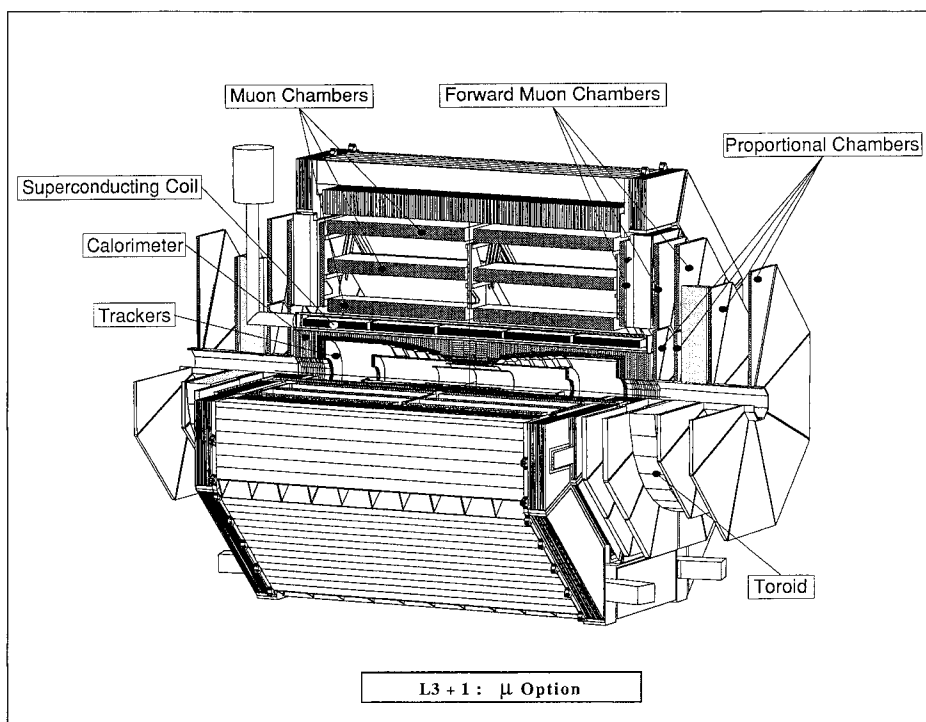
haved exactly as in the standard HERA magnets, going straight to 98% of their short sample field, while at 2 K the short sample field of 8.3 T was reached after only four quenches.

Manufacture of seven of the ten full-size prototypes being built in European industry is quite advanced, with three different variants of the mechanical structure, collars and yokes being used. The first magnet, in its cryostat, is scheduled for delivery early next year. Some of these will be used in the half-cell string tests next year, seen as an important milestone for LHC progress.

Meanwhile studies have shown how the LHC magnet lattice can be usefully optimized. The total length of LHC bending dipoles has been increased by five per cent, with each basic (half-cell) unit containing three magnets each 13.58 m long instead of four of 9.45 m as described in the original 'Pink Book' design. This reduces the magnetic field needed to hold the LHC beams in orbit while maintaining the maximum beam energy.

The original design aimed at four magnets per half-cell because it was then thought important to have central correctors. These central correctors are now replaced by small magnets incorporated in the ends of each dipole.

The new design requires fewer magnets (1152 instead of 1600) with correspondingly fewer connections. If training problems are confined to the ends of the magnets, longer ones should not be any harder to make (the US Superconducting Supercollider – SSC – uses magnets over 15m long). Fewer, longer magnets should also reduce production, testing and installation costs.



The muon option for the L3+1 idea for an LHC proton-proton collision detector could be set up rapidly from the existing L3 LEP electron-positron collision detector.

Lifted from L3

Among the major Expressions of Interest for studying proton-proton collisions at CERN's LHC collider (along with ASCOT, CMS and EAGLE – May, page 1) is the L3+1 scheme. This is based on the existing L3 experiment at the LEP electron-positron collider, where much effort went into taking a detector which would eventually be compatible with a high energy proton collider. The LEP tunnel was built with two colliders in mind.

For LHC operation, the L3 structure would have to be lifted

from its present position in the LEP beam to the LHC beam level about a metre above. Thus L3+1 is an upgrade in more senses than one.

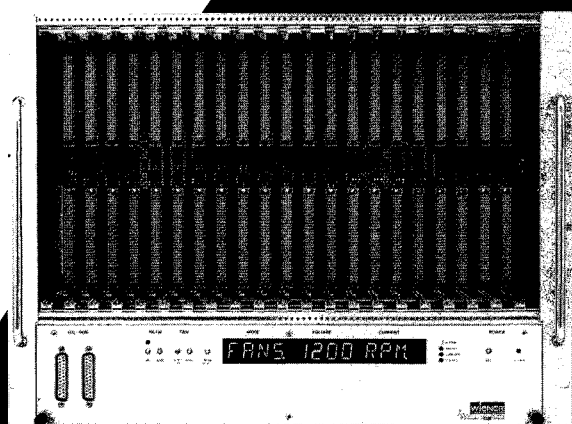
For L3+1, two options are being studied, both making use of the L3 magnet and existing muon chambers. A configuration studying muons and electrons could be set up rapidly, while a second alternative looking at electrons, muons and gammas uses the large magnetic volume, with electromagnetic detectors 3 metres from the interaction point.

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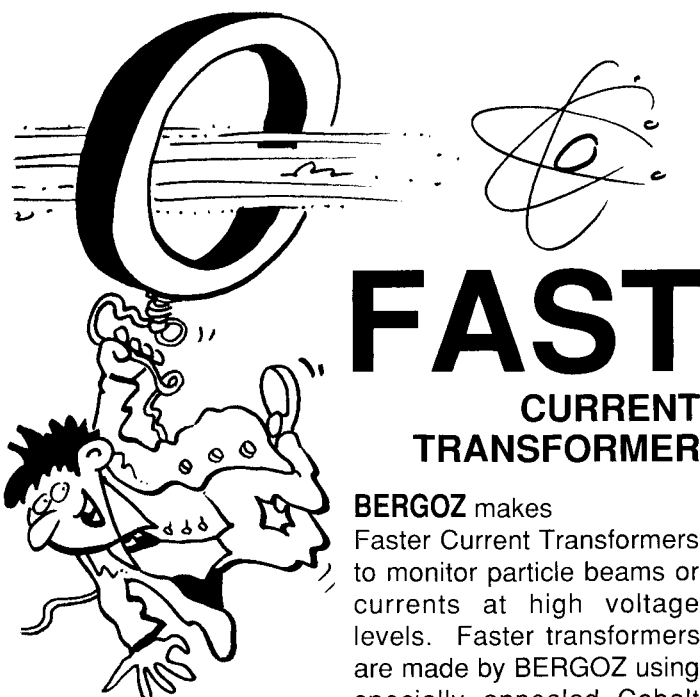


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A new setting for a CERN physics tradition. CERN Director General Carlo Rubbia inaugurates CERN's ISOLDE on-line isotope separator in its new home in a specially built experimental area at the 1 GeV Booster accelerator.
(Photo CERN 51.5.92)

Double celebration

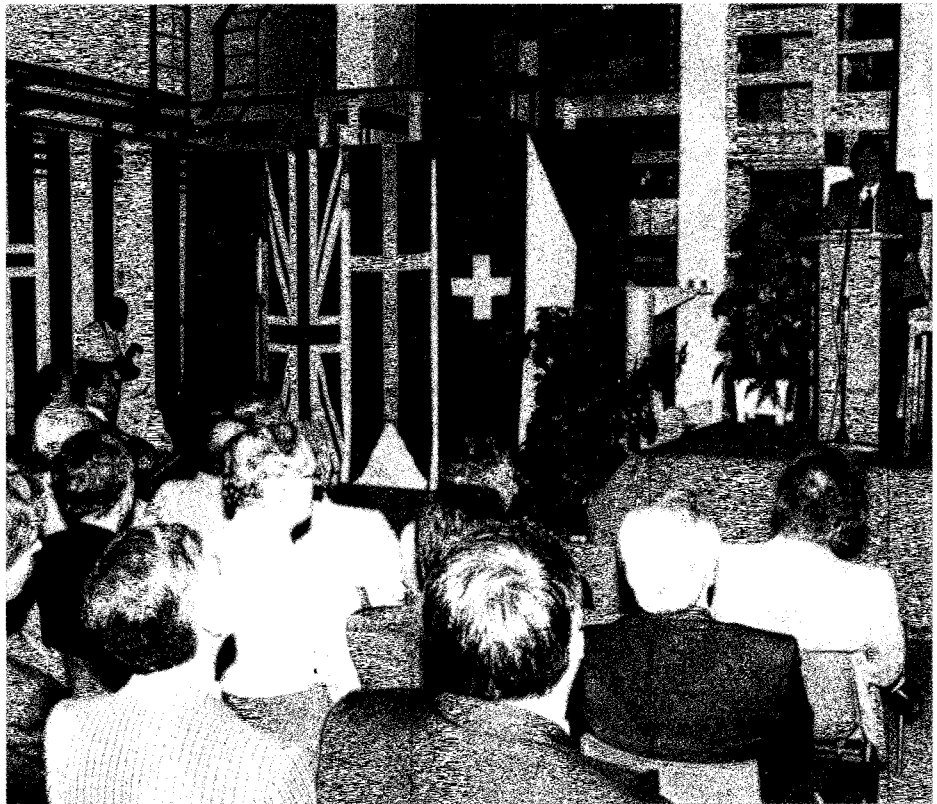
26 May was a double celebration at CERN – the formal opening of the ISOLDE on-line isotope separator at its new home at the 1 GeV Booster accelerator, and the twentieth anniversary of the first acceleration of Booster beam to 800 MeV, the machine's nominal energy before its upgrade to 1 GeV in 1988.

Introducing the proceedings, held in the new ISOLDE experimental hall, CERN Director General Carlo Rubbia sketched the evolution of the ISOLDE idea at CERN from initial thinking in the early 1960s and the commencement of operations in 1967 at the 600 MeV synchrocyclotron (SC).

After its distinguished career at the SC, closed in December 1990, ISOLDE now reemerges in its new Booster environment. The old SC was a stand-alone machine, never integrated into the CERN beam network, so with ISOLDE resited at the Booster all CERN's experimental facilities become interconnected.

Rubbia pointed out how the Booster, after twenty years valiant work as a 'service' machine, now has its own experimental area, while the new ISOLDE benefits from the Booster's higher energies, pulsed beams and easier availability. The result demonstrates CERN's increased effectiveness, addressing wide scientific horizons and catering for a broad scientific community with an improved, and at the same time more economical, facility. Finally the Director General pressed the button to bring online the Booster beam for ISOLDE.

Bjorn Jonson of Göteborg, Chairman of the ISOLDE Experiments Committee, outlined the broad sweep of the new ISOLDE physics pro-



gramme, where initial experiments approved last year (December 1991, page 3) have now been joined by four more. As well as exotic nuclear decays and nuclear properties, the ISOLDE programme covers particle physics topics such as searches for axions and heavy neutrinos, the very interesting new field of nuclear astrophysics to study how heavy elements could have been formed in supernovae, and specialist areas of nuclear solid state physics with implications for materials science, together with biophysics and nuclear medicine. In addition, the ISOLDE tradition of research and development work for new types of nuclear beams will continue.

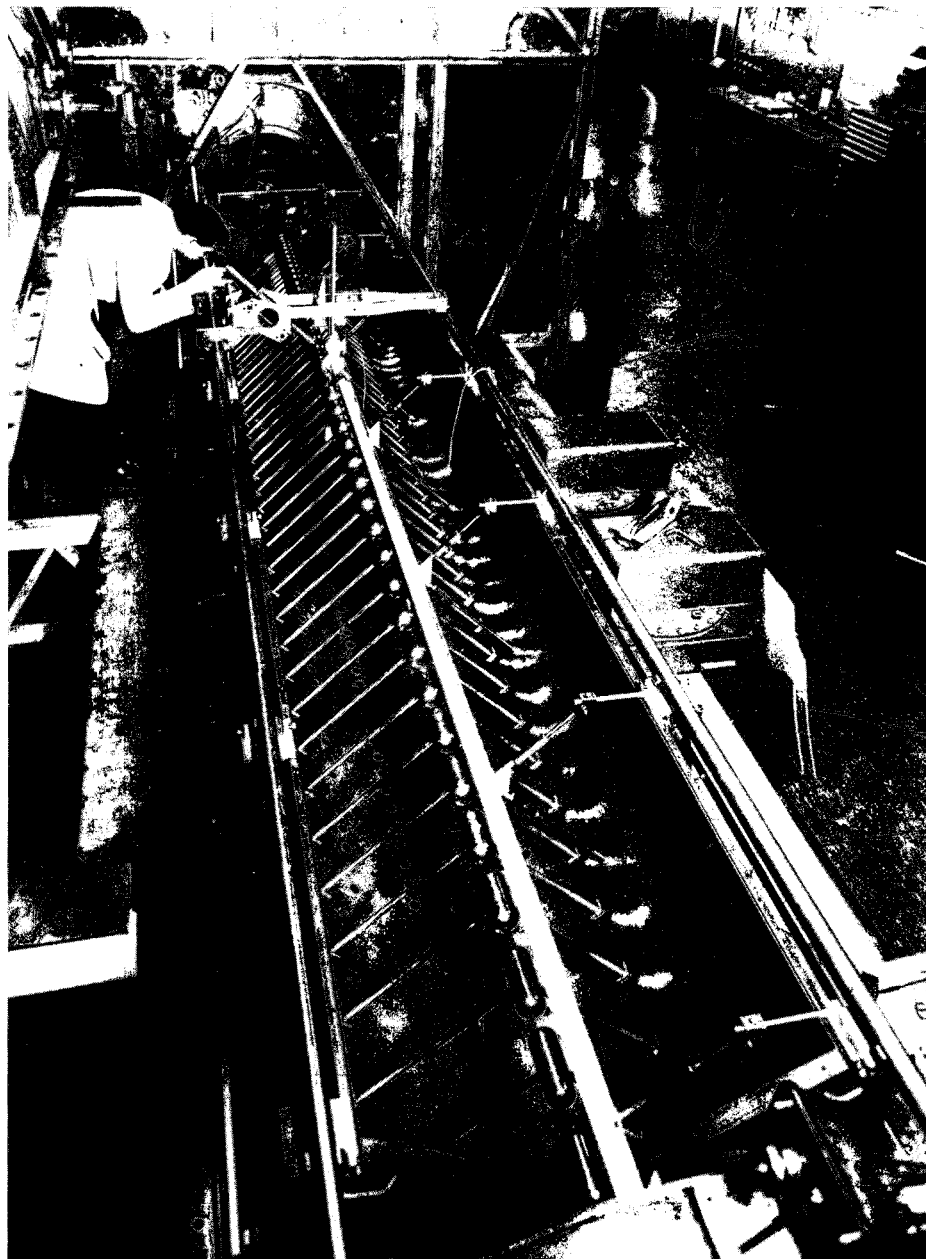
Nuclear Physics European Collaboration Committee (NuPECC) Chairman Claude Detraz praised the achievements of international scientific collaboration and underlined the

potential of new physics using radioactive ion beams, a topic highlighted in the recent NuPECC report (March, page 1). With the advent of new nuclear beams, 'astrophysics becomes a laboratory science,' remarked Detraz, who looked forward to ISOLDE's continued success.

End of the line for Linac1

In May, CERN's oldest functioning machine, the Linac1 linear accelerator, was finally switched off after a varied career lasting 33 years. After several weeks this year providing sulphur ions, a typical final act included supplying oxygen ions to the nearby LEAR low energy 'antiproton' ring in some tests exploring the heavy ion beam cooling procedures

Examining CERN's linear accelerator prior to commissioning in 1959. This machine, later known as Linac1, remained operational for 33 years, and was finally switched off in May.



which eventually will be needed to inject ions into the LHC ring to be installed in CERN's 27-km LEP tunnel.

Built using tried and tested techniques as the injector for CERN's 28 GeV proton synchrotron, Linac1 came into action at its 50 MeV design energy in 1959. Despite its conservative design, it surpassed all expectations, going on to supply proton

currents well above 100 milliamps.

Despite these sterling performances, the machine began to show signs of wear and tear (or so people thought), and in 1973 construction began of a new linac, Linac2. This came into operation in 1978.

Linac1 soon found a new role supplying beams of deuterons and alpha particles for subsequent

acceleration, as well as test beams for the nearby LEAR ring. With the arrival of the compact r.f. quadrupole preinjector, the old Cockcroft-Walton apparatus could be taken away, liberating space in a linac area crowded by transfer lines. Linac1 was pushed back 12 metres and additional shielding installed, making for more comfortable conditions, and enabling installation work for the heavy ion project to proceed in parallel with normal PS working.

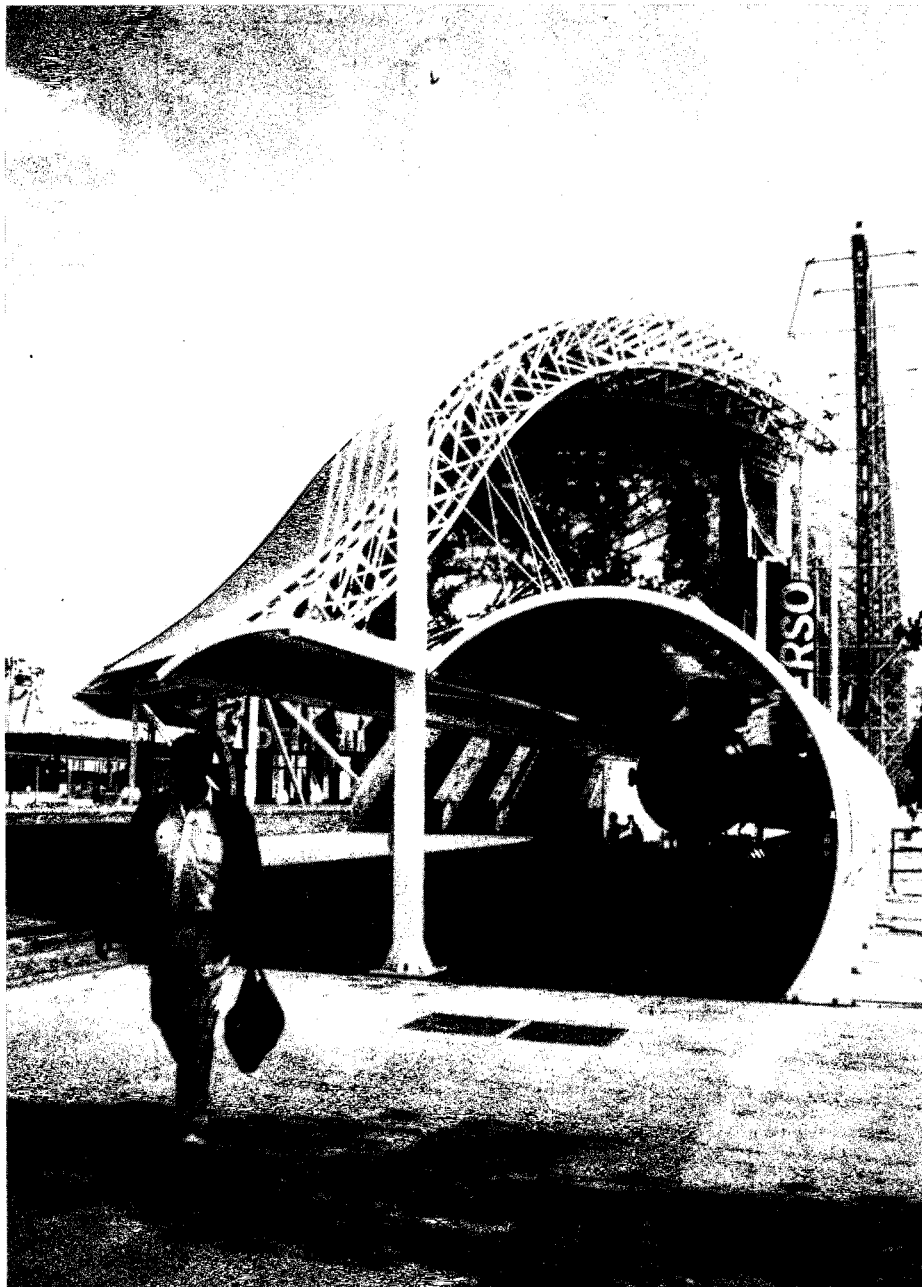
Soon after came a proposal to embark on a new CERN experimental programme using beams of oxygen ions. Despite a crowded schedule at CERN, the project got underway as a collaboration between CERN, the Darmstadt GSI Laboratory (beam transport) and Berkeley (radiofrequency quadrupole preinjector). Grenoble was GSI's contractor for the ion source. The elements gradually came together, and the refurbished Linac1, with 33% higher accelerating fields, came back online in June 1985.

A few years later, an upgraded ion source, again supplied by GSI Darmstadt and built by Grenoble, was installed to supply experiments with sulphur ions.

For the future, with experiments using still heavier ions, a new linac will be supplied by a collaboration of European and Indian laboratories, and with additional finance from Sweden and Switzerland (April, page 10).

See CERN at Seville

A six-month fiesta is underway in the unique Spanish city of Seville, where the EXPO '92 World Fair opened in April. It was in Seville five hundred years ago that Columbus planned his



*CERN features prominently in and around the 'Pavilion of the Future' at the EXPO '92 World Fair in Seville.. A 25-metre mock-up of the tunnel for CERN's LEP electron-positron collider has been erected outside, and the entrance hall of the building is adorned with a huge painting of an event from the Delphi experiment at LEP.
(Photo CERN EM36.5.92)*

epic voyage of discovery. With discovery the theme of EXPO '92, science has much to contribute.

CERN's particle physics research is a prominent feature of the 'Universe' exhibition in the 'Pavilion of the Future'. The hall is easy to spot because a 25-metre mock-up of the tunnel for CERN's LEP electron-

positron collider has been erected outside, and the entrance hall of the building is adorned with a huge painting of an event from the Delphi experiment at LEP.

Inside the hall, 16 square-metre banks of spark chambers reveal the cosmic ray particle messengers from outer space. Alongside is a Charpak-type detector showing the activity from gently radioactive elements.

The research tools of CERN are depicted with a huge aerial photograph on which LEP beams swirl and collide. LEP events from all four detectors – Aleph, Delphi, L3 and Opal – explode on large TV screens and even at a tenth of the scale, a model of the L3 detector communicates the size and complexity of modern physics apparatus.

Dominating the wall of the exit hall is a spectacular 8-metre diameter back-lit photograph of the Aleph 'rosette' with a laser beam, traversing the length of the hall, simulating the orbiting particle beams. Over seven thousand people a day are visiting.

For more formal contacts, CERN also has a stand in the Ambiente Pavilion, where the emphasis is on technology. In view of its special contributions both to the expo and to European science, CERN has been accorded a special day on 30 September – the anniversary of the signing of the CERN Convention in 1954 and always looked upon as CERN's birthday. The 'CERN Day of Science' will feature a parade, 'physics in the street' – a contact with the public, an award ceremony for young scientists, a televised debate on science and the future, and a ballet with the theme 'The birth of the Universe'.

Canada's pavilion features the Sudbury Neutrino Observatory



project (January/February 1990, page 23).

Join the fiesta!

Accelerator school

Anyone eavesdropping on a technical discussion among accelerator experts might be forgiven for thinking that their main business concerned the construction of huge electromagnets of both the warm and cold variety. It might therefore come as a surprise to find that the recent course on Magnet Measurement and Alignment organized by the CERN Accelerator School (CAS) was the first of its kind in the CAS series of specialist courses. (There has been a crowded menu of schools on other topics such as superconductivity and radiofrequency.)

But it was no surprise to find that the new topic turned out to be very popular. There were well over a hundred participants from almost a

The CERN Accelerator School "Magnet Class of '92" on the lakeside at in the mid-March sunshine enjoying a brief break from a crowded programme.

score of countries, eager to learn the arts of making and using search coils and using both Hall probes and NMR to make the numerous high precision measurements necessary to ensure that large accelerators perform as they should. The lectures also covered the basic classification of magnets and design theory as well as the state of the art in aligning them to their ideal geometry.

The next CAS events are the General Accelerator School (7-18 September) at Jyväskylä in Finland and the Joint US-CERN School on electron-positron Factories (29 October-4 November) at Benalmadena in Spain. The deadlines for applications are 15 June to CASFIN@CERNVM.CERN.CH and 1 Aug to CASUS@CERNVM.CERN.CH respectively, or by fax to +41 22 782 4836.

ORSAY CLIO free electron laser

CLIO – Collaboration for an Infrared Laser at Orsay – is in operation and will soon provide a high peak power source of coherent infrared radiation with adjustable wavelength.

Conventional lasers amplify light by exciting bound electrons. They generate light with a well defined wavelength, but some applications ask for a broad range of wavelengths. This flexibility, together with massive intensities, is provided by free-electron lasers (FEL).

CLIO at Orsay is the latest in a line such lasers. John Madey at Stanford in the mid 1970s was the first to demonstrate the idea. Since then, numerous FEL projects have seen the light of day in different parts of the world. Some 15 devices have 'lased' so far.

Two or three machines of the CLIO type are operating in the United States, while in Europe, there are two such machines: FELIX (20-100 microns) in the Netherlands and CLIO (2-20 microns) in France. One is nearing completion at Darmstadt in Germany, and another, LISA, is under construction in Italy.

CLIO began in 1987 as an initiative of Orsay's Electromagnetic Radiation Utilization Laboratory (LURE), in collaboration with LAL, the Linear Accelerator Laboratory, which contributed in a major way to the project (15-20 people). A French Atomic Energy Commission team was also involved.

The electrons in CLIO's laser drive beam are arranged in very short (10 ps) microbunches grouped together in 'trains' of 10 microsecond bursts