CERN COURIER

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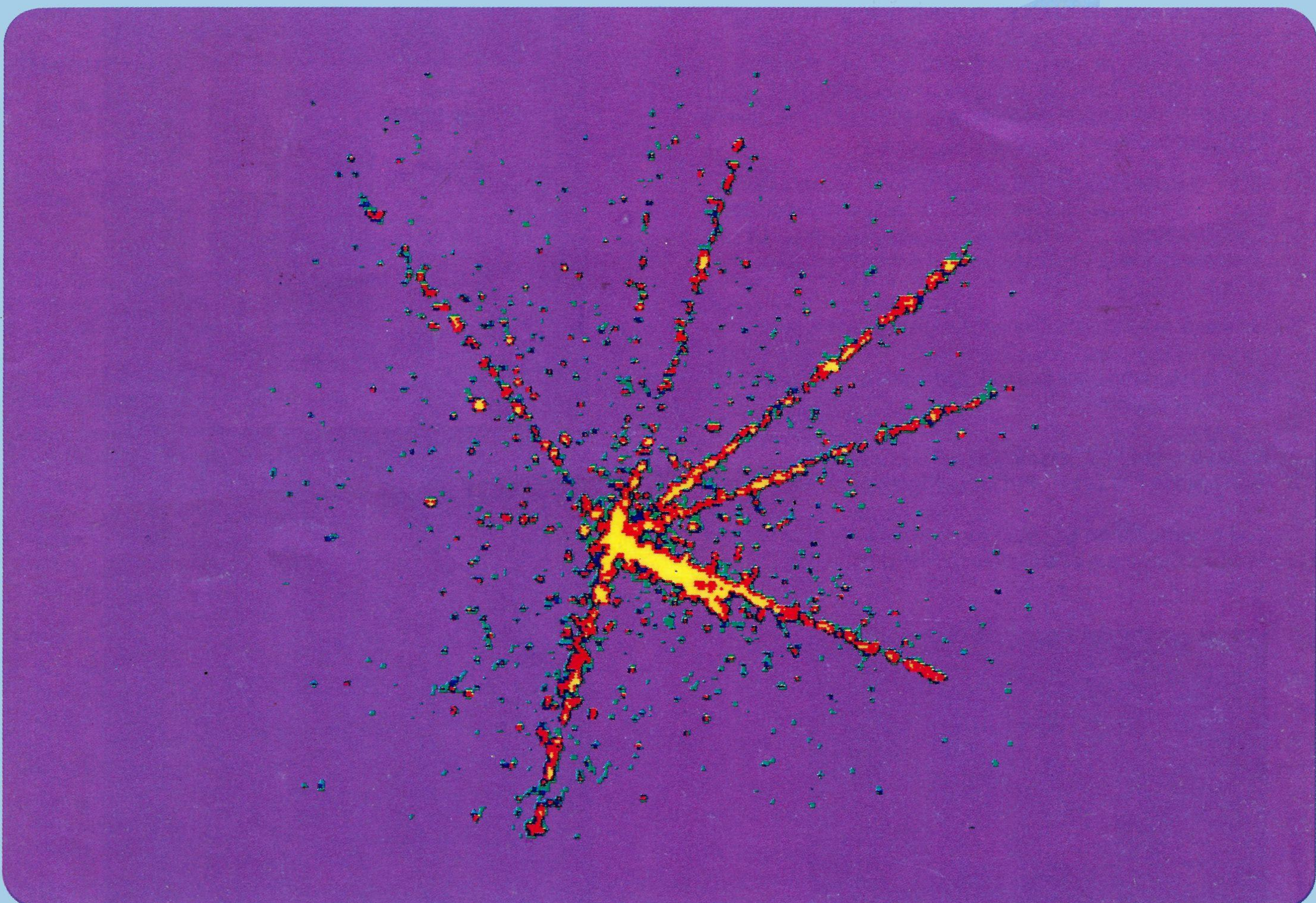

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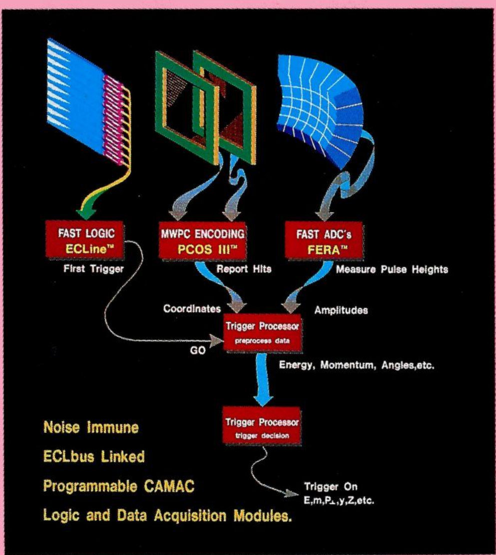

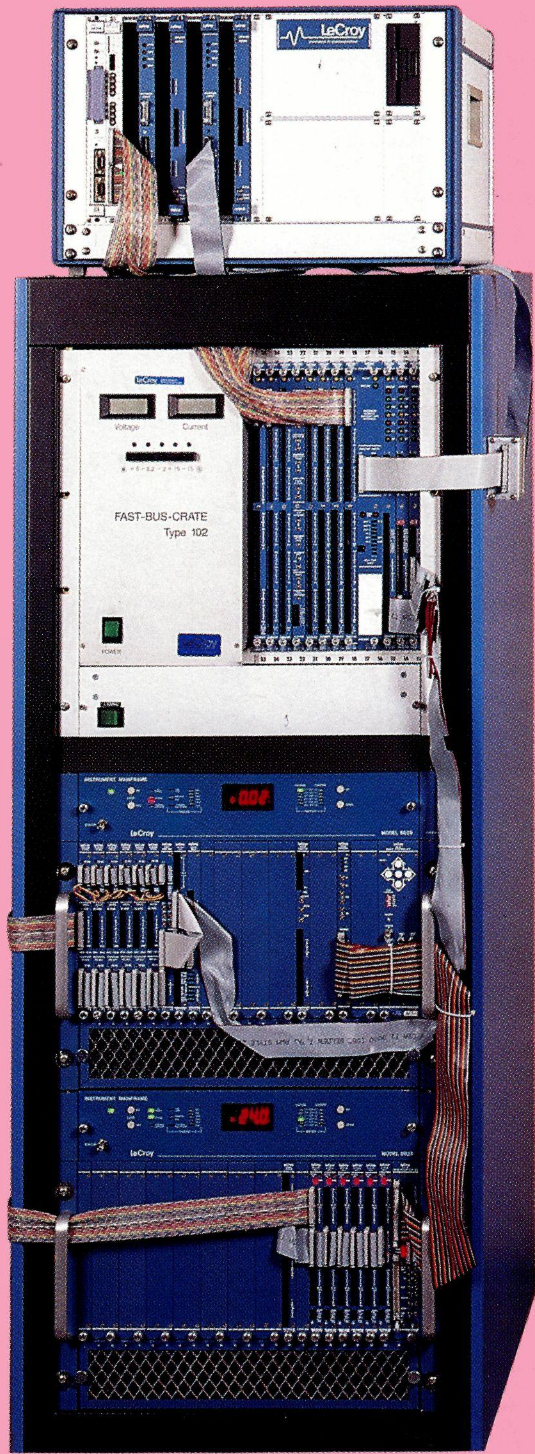

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Covering current developments in high energy physics and related fields worldwide

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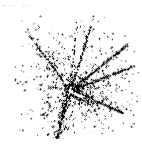
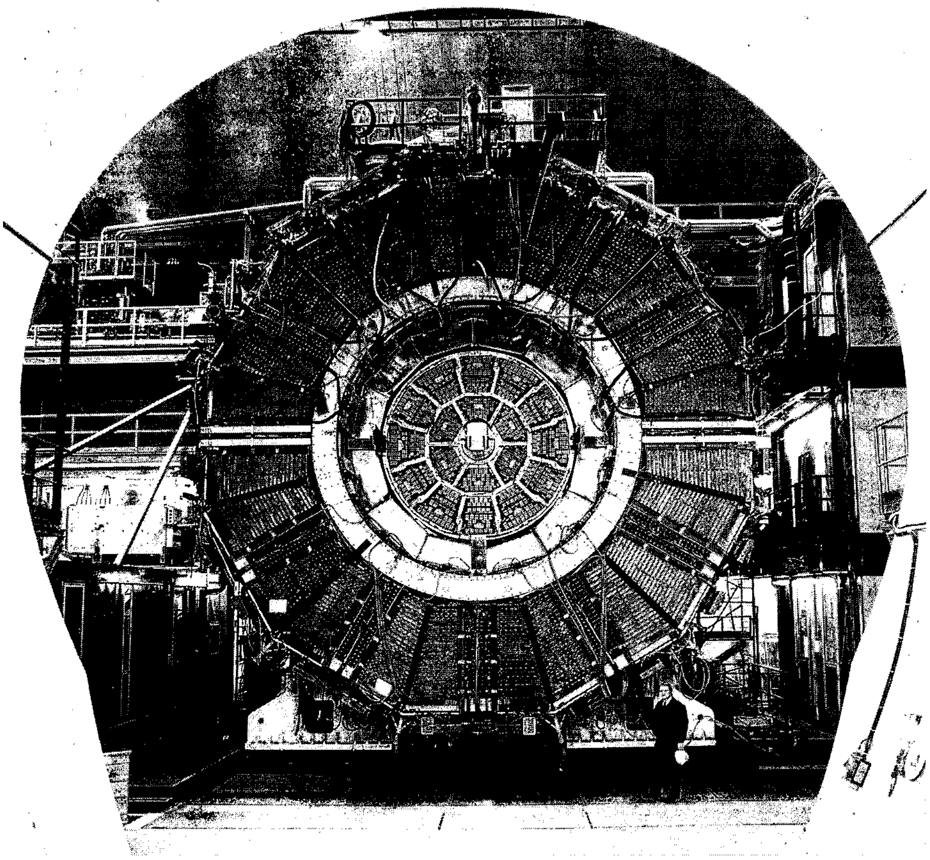


Cover photograph:
Tracks recorded in an array of 30-micron scintillating fibres exposed to a 340 GeV negative pion beam by the WA84 collaboration at CERN (see page 19), viewed perpendicular to the beam axis. Spatial resolution is about 18 microns. These results are very promising for the continued application of scintillating fibre techniques for particle tracking, particularly as recent work has shown how excess noise can be suppressed.

Aleph

A front view of the Aleph detector at CERN's LEP electron-positron collider, with local supervisor Peter Schilly dwarfed by the 12-metre high, 3,000 ton detector.

(Photo CERN 61.12.88)



This is the second in a series of articles on the four experiments at CERN's LEP electron-positron collider. Although only having completed several data-taking runs, these mighty collaborations have over ten years of history behind them. They involve over 2,000 physicists from CERN's Member States, plus Brazil, Bulgaria, Canada, China, Czechoslovakia, Finland, Hungary, India, Israel, Japan, Poland, the USA, the USSR, and the Joint Institute for Nuclear Research, Dubna.

In 1980, when the preparations for the LEP electron-positron collider began to gather momentum, a major neutrino experiment at the SPS proton synchrotron by a CERN/Dortmund/Heidelberg/Saclay collaboration was into its third year of operation.

Codenamed WA1, this had been the first experiment to be approved for the SPS when discussions on the experimental programme got under way in 1974 and went on to make valuable contributions to high energy neutrino physics.

Under the charismatic leadership of Jack Steinberger, WA1 was the successor to an earlier experiment at the PS machine by a CERN/Heidelberg group which had made important contributions to the study of CP violation in the decay of neutral kaons.

By 1980, with many of WA1's research objectives either fulfilled or clearly outlined, the group had to look to the long-term future. However for many of them, their enthusiasm for working together was as strong as ever, and many WA1 physicists chose to keep together for LEP. Thus Aleph – Apparatus for LEP physics – has a long tradition behind it.

(It was Sau-Lan Wu of Wisconsin who urged choosing an acronym to be a letter early in the alphabet. Aleph is the first letter in the Hebrew alphabet, in its early form the precursor of many later alphabets.)

While WA1 was considered large in its day, with more than 30 physicists on board, a LEP experiment needed a lot more help, and Orsay (France), Munich, the UK Rutherford Appleton Laboratory and Pisa, were contacted at an early stage. Eventually Aleph grew to attract many more researchers, including contingents from Beijing, Florida, Wisconsin, and very recently, Santa Cruz.

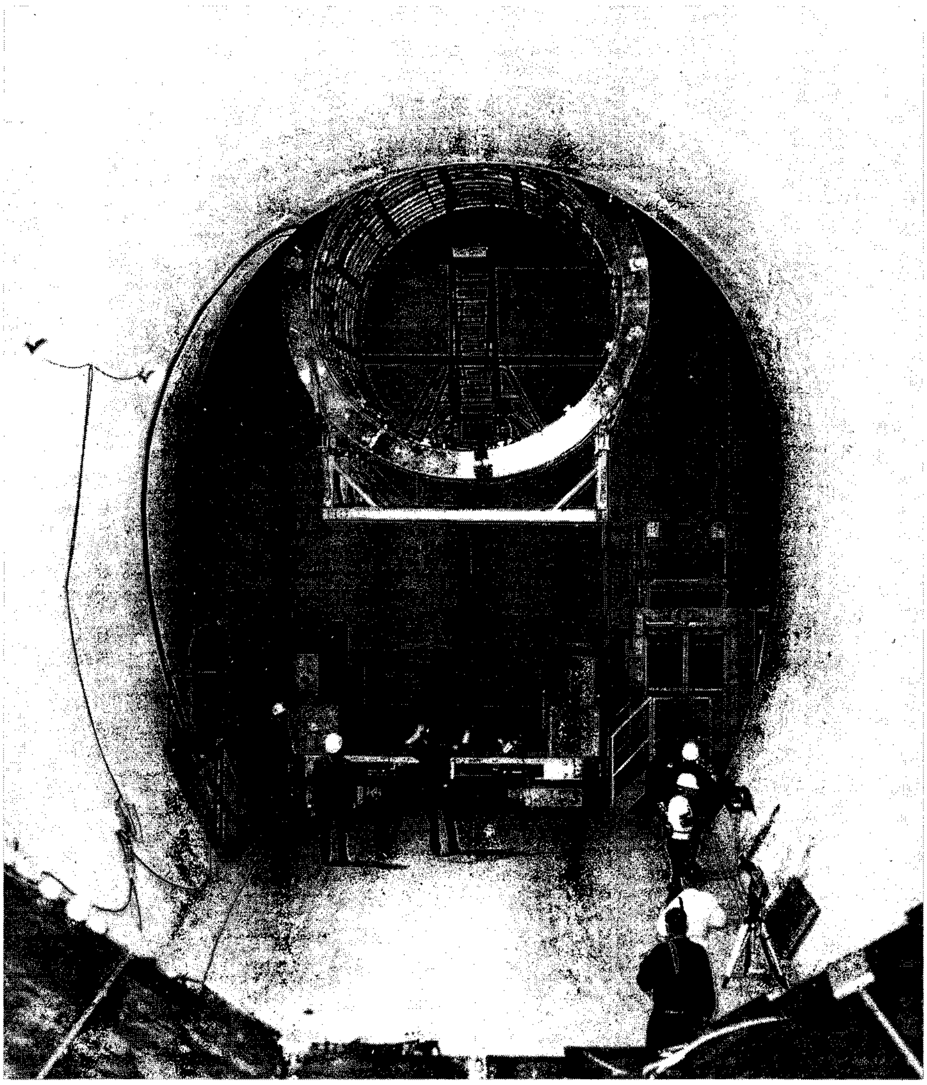
The stated goal of Aleph at LEP was to collect as much information as possible about each electron-positron collision and over a maximum spherical volume.

Initial ideas toyed with the possibility of a spherical magnet, but thinking soon converged towards the more conventional solution of a solenoid, with a design scaled up from that used in the CELLO detector in the PETRA ring at the DESY Laboratory, Hamburg. The magnet was built at the French Saclay Laboratory, and arrived at CERN in June 1987. Together with its cryostat it weighs some 60 tons, providing a field of 1.5 tesla at 5000 amperes.

For the central tracking detector inside this magnet, it had to be almost as large as the magnet itself

The 60-ton superconducting magnet for Aleph is eased into position 140 metres underground.

(Photo CERN 201.6.88)



to provide accurate measurements of particle momenta. With a conventional drift chamber, this would mean having to precision stretch wires five metres long.

In view of these difficulties, the Aleph team looked towards the Time Projection Chamber pioneered at Berkeley for the PEP collider at Stanford, where the ionization left in the wake of passing particles is drifted through a volume of gas before being recorded as it hits the end-plate.

Soon it became clear that a TPC, where particle trajectories are measured in three dimensions, would open the door to spatial pattern recognition, and a series of prototype studies got underway to seek an optimal configuration.

Built at CERN and Munich's Max Planck Institute, the Aleph TPC – 4.4 metres long and 3.6 metres across – is the world's biggest, and involved groups from Dortmund, Pisa, Trieste and Wisconsin as well as Munich and CERN.

Capitalizing on TPC experience at PEP, it was clear that the Aleph end-plates should be built up from interlocking rings of radial pads arranged in such a way that straight tracks never fall completely on a radial boundary. To ensure precise tracking, a laser calibration system was developed by Dortmund and Glasgow to compensate for residual magnetic field irregularities.

Apart from many detailed suggestions, the detector as a whole benefited from Steinberger's wisdom. From the outset, he stipulated that, as far as possible, standard solutions should be adopted. Thus the end-caps reflect the design of the central detector. He was also insistent that all presented solutions first had to be completely understood, and this discipline paid dividends.

Software engineering, new to physicists but highly necessary, also came in for a lot of attention, and many collaboration members remember vividly their introduction to program tools.

Inside the TPC is the inner tracking chamber developed by London's Imperial College. (The minivertex detector now closest to the Aleph beampipe appeared on the scene much later, the result of a Munich/Pisa joint effort.)

Either side of the inner detectors are a series of luminosity monitors developed and built by Copenhagen, Siegen and Barcelona.

The 2.25-metre radius, 130-ton 'barrel' electromagnetic calorimeter, based on a lead/wire chamber sandwich design, comes from a collaboration of major French research centres, while the end-caps, of similar design, came from the UK (Rutherford Appleton Laboratory and Glasgow).

The streamer-tube hadron calorimeter is an Italian effort, with Frascati having supplied the barrel and Pisa and Bari the end-caps. With outer and inner radii 4.68 and 3 metres respectively, the calorimeter weighs 2580 tons.

Also based on streamer tubes, the muon detectors were handled by Italy and Beijing, and contain some 44,000 readout channels.

With L3's position in the LEP ring (point 2) predetermined by its size, and with Opal's conventional magnet calling for Point 6, Delphi and Aleph were left with Points 4 and 8. There were glum Aleph faces when Director General Herwig Schopper's coin pointed Aleph to the former, 140 metres below the surface in the foothills of the Jura mountains. The handover date looked to be late, implying that Aleph would have its work cut out to instal the complex detector in time for LEP's first beams in 1989.

But this initial cloud turned out to have a silver lining. Point 4 became available before Point 8, and the extra overhead rock, while calling for deep shafts and lots of cabling, make for added protection against stray cosmic rays.

Aleph preparations placed great emphasis on preassembly, to make sure everything went as smoothly as possible once installation in the underground pit got underway. At CERN, the hadron calorimeter was preassembled in the old BEBC bubble chamber hall, while the old 2-m bubble chamber hall was the scene of TPC preparations, assembly of the multi-story electronic barracks ('the house that Jack built'), and a full-scale wooden replica of the complete detector for cabling design. In parallel, components were put through their paces in West Area test beams, coordinated by Horst Wachsmuth.

Assembly in the deep pit began on schedule in April 1988, and finished on time just 13 months later, thanks to sterling work by installation coordinator P. Lazeyras, mechanical coordinator M. Ferro-Luzzi and local supervisor P. Schilly. Progress during the latter stages of installation was monitored by a commissioning board, now disbanded.

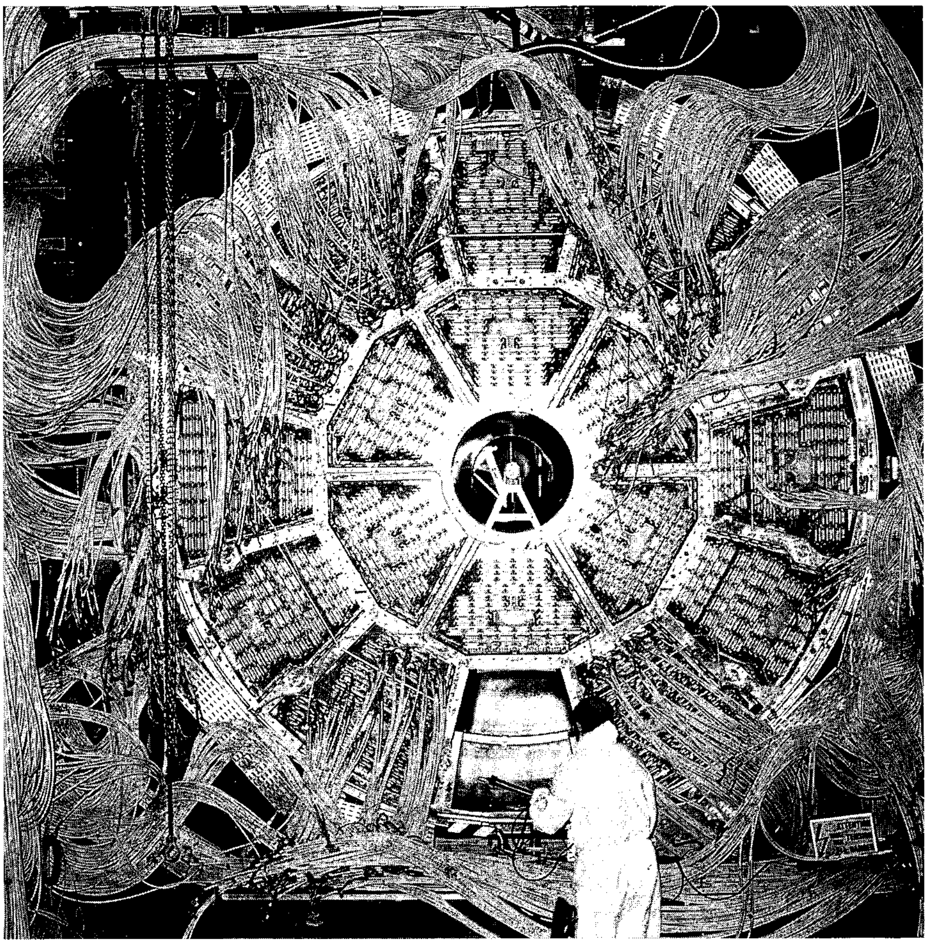
Jack Steinberger formally retired from CERN in 1986 at the age of 65, but with a staff position at Pisa, continued to lead Aleph until last year, when he passed the baton to Jacques Lefrancois of Orsay, who had been chairman of the Steering Committee, Aleph's 'governing board'. The Committee is now chaired by Adolf Minten.

Communications within Aleph are helped by four major collaboration-wide meetings per year, one of which is always held outside CERN and hosted by one of the collaborating institutes. The vital Aleph 'Who's who' is updated monthly to ensure accurate information.

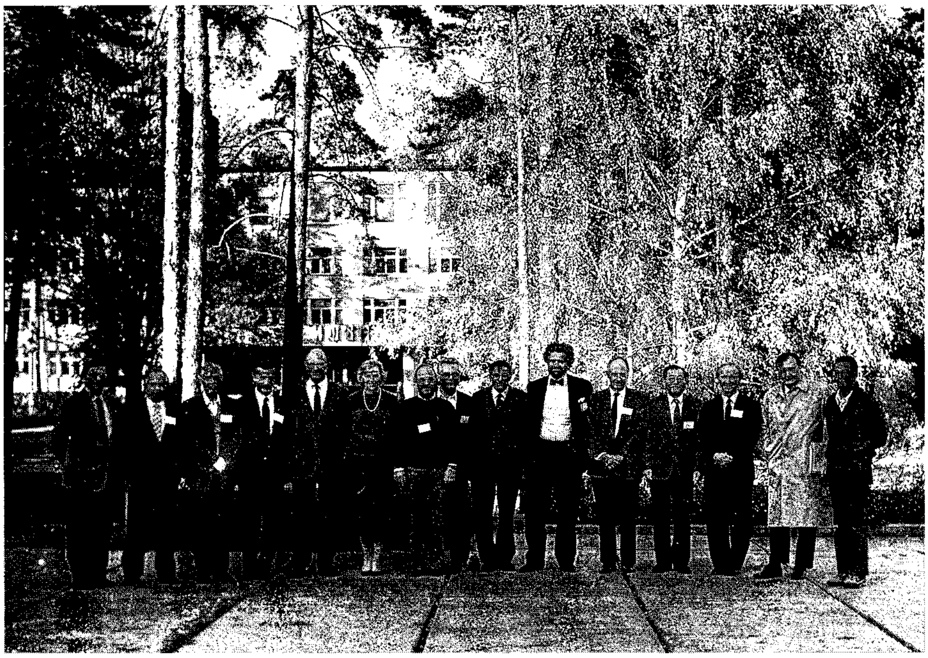
This year, a second layer of muon chambers and the arrival of the inner vertex detector will see the original idea of Aleph complete. However with improvements and upgrades in the pipeline for LEP itself, it is unlikely that the Aleph design will be frozen.

Particle tracking for Aleph is handled by the world's largest Time Projection Chamber, 3.6 metres across and 4.4 metres long.

(Photo CERN 390.4.88)



At the recent ICFA 'Future Perspectives' meeting, Protvino, USSR. Left to right – J.-E. Augustin, Yu. Ado, W.O. Lock, A.N. Skrinsky (ICFA Chairman), K. Strauch, Helga Schmal, E. Keil, V.I. Krishkin, G. Trilling, T. Ekelof, V. Soergel, T. Fujii, M. Craddock, C. Rubbia, R. Palmer.



ICFA
Protvino meeting looks at trends in international collaboration

International collaboration is the lifeblood of Big Science, and in high energy physics the triennial 'Future Perspectives' meeting organized by the International Committee for Future Accelerators (ICFA) provides a valuable opportunity to reappraise trends in this collaboration.

The latest meeting was held in October at Protvino, near Moscow, where the Institute for High Energy Physics is the scene of construction work for the 21-kilometre UNK proton rings and the projected home of a big new linear collider for electrons and positrons.

The four-day Protvino meeting attracted an impressive lineup of speakers and delegates from all over the world and provided a valuable survey of both progress and of the continuing attack on outstanding technological problems.

The previous meeting, at Brookhaven in 1987, had been convened at a time when the proposed US Superconducting Supercollider (SSC) had had a nod of approval from the US Administration, but little else – no staff, no funding, no site. Now the SSC has a home in Ellis County, Texas, initial construction is underway and contractors are being signed up.

International backing is urgently needed, but SSC ideas have continually emerged in a US national context. The sheer scale of the $8 billion SSC project means that meaningful contributions enter a new financial ballpark.

In Europe, CERN is playing its trump card of the LHC proton collider using the existing 27-kilometre LEP tunnel and aiming to capitalize on CERN's unrivalled beam infrastructure. Funded by 15 Member States (and with a queue of Central European nations at its door), CERN has blazed the trial for international scientific collaboration.

But building LHC, with its 27 kilometres of state-of-the-art superconducting magnets, would tax even these resources, and additional interest is being sought from non-Member States.

An innovative approach to international involvement was introduced by the HERA electron-proton collider soon to become operational at the DESY Laboratory, Hamburg, Germany. The HERA effort has benefited from contributions of equipment, manpower and knowhow from other interested nations, notably Italy, France, the Netherlands, Canada, Poland, Switzerland, the US, Israel and China. The KAON project now being groomed at the Canadian TRIUMF Laboratory in Vancouver would be another example of the HERA Model.

However at Protvino some ICFA delegates with big project experience were less enthusiastic about the HERA Model for the major machines of tomorrow. Because big new projects would be much more expensive than HERA, it might be difficult for one nation, or even geographical area, to dominate a project, and several major partners would have to share most of the initial development and construction costs between them.

With plans for the US SSC and CERN's LHC well advanced, the complementary sector of linear colliders pushing electron and positron energies towards the 1000 GeV level provides new scope for such international negotiation.

Work is going on at many major electron centres, with developments being pushed at CERN, DESY, Stanford, KEK Japan, and Novosibirsk.

The ongoing research and development work in this sector is well shared, both through formal collaboration agreements and through informal contacts, and linear collider workshops will be an increasingly important focus of attention.

ICFA's four Panels in key development areas – Instrumentation, Superconductivity and Cryogenics, Beam Dynamics, and New Accelerator Schemes and Technologies (now renamed Acceleration Technology) – continue to provide important stimulus.

These panels have an ongoing programme of activities and are continually adapting their approach to take account of new trends. Some Panel nominations are still outstanding, and a summary will be published in a forthcoming issue.

WORKSHOP
Waiting for the top quark

Four families: 1, neutrinos; 2, charged leptons; 3 and 4, quarks, including the long-awaited 'top'.

GENERATION / FAMILY	1	2	3	Electric Charge
1	ν_e	ν_μ	ν_τ	0
2	e^-	μ^-	τ^-	-1
3	u	c	(t)	$+2/3$
4	d	s	b	$-1/3$

Periodic Table of Elementary Particle constituents

The world of elementary particle physics is eagerly waiting for the top quark, probably the final element of the 'periodic table' of elementary particle constituents (see figure).

This table consists of two families of weakly interacting particles (leptons) – one series (the electron, the muon and the tau) carrying electric charge; the other (the corresponding three types of neutrino) being electrically neutral – together with a family of quarks carrying electric charge 2/3 (up, u; charm, c; top, t) and a family of charge -1/3 quarks (down, d; strange, s; beauty b).

It was then not surprising that the 1990 Theory Workshop at the DESY Laboratory in Hamburg in October, devoted this time to 'top physics', attracted some 200 physicists, substantially more than previous workshops in the series.

The top quark has escaped the hunt so far at the following electron-positron colliders – PETRA at DESY, PEP at Stanford, TRISTAN at KEK (Japan), SLC at Stanford and LEP at CERN – as well as the SPS and Tevatron proton-antiproton colliders at CERN and Fermilab respectively.

It is also expected to be out of reach at the energy-upgraded LEP and at the HERA electron-proton collider soon to be commissioned at DESY. But there is still hope that it might be found in the next few years at the Tevatron if it is lighter than 150 GeV. Otherwise it will have to wait for the next generation of supercolliders.

As reported by A. Barbaro-Galtieri (Berkeley), the top quark mass is more than 89 GeV, based on searches at the Tevatron. Thus the top quark is at least 18 times heavier than the b quark and probably heavier than the W and Z bosons, at 81 and 91 GeV respectively the heaviest particles discovered so far.

Despite its reluctance, the top quark has to exist, as emphasized at the meeting by M. Peskin (Stanford). Its absence would totally invalidate the so-far perfect agreement of the Standard Model of physics with a vast amount of experimental data, in particular the re-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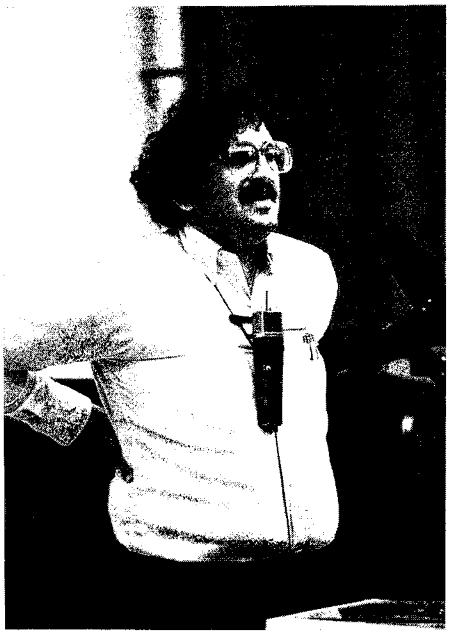
M. Peskin (Stanford) – no doubt that the top quark is there.



cent LEP results. The internal consistency of this model requires all elements of the periodic table to be filled. Moreover the observed properties of the b quark indicate very clearly that it must have a charge +2/3 partner. The violation of CP symmetry in the neutral kaon system requires at least six quarks, pointed out already in 1973 by Kobayashi and Maskawa.

While the top quark must exist, its mass is not predicted by the Standard Model, nor is the model capable of telling us on pure theoretical grounds whether it is indeed the final quark. Fortunately experimental data can shed some light on these two questions, and studies of Z decays at LEP and SLC (described by D. Schaile of Freiburg) show very clearly that the number of light neutrinos (i.e. the number of columns in the periodic table) is three. If there are only light neutrinos in nature, then top is the last quark.

This information is extremely important for any phenomenology of the Standard Model as it bounds the number of free parameters. Most of these parameters are in the quark mass spectrum and in the (unitary) Cabibbo-Kobayashi-Maskawa (CKM) matrix containing the inter-quark weak coupling strengths.

For three generations (three columns in the periodic table) the 3 x 3 CKM matrix depends on four free parameters. This number is increased to nine if one additional column is added. As reported by M. Danilov (ITEP) the 3 x 3 CKM matrix is already reasonably well determined by present experimental data, despite its containing three couplings related to the undiscovered top quark. In particular the coupling of the b to the top quark is predicted to be maximal, indicating that future B-Meson factories will also probe top physics.

For the top quark mass, virtual (loop) effects present in any quantum field theory mean that the top quark, although still invisible, still has an impact on presently measurable quantities, and in this way some information on the mass can be inferred.

Basically there are two sources of such information. One is based on 'vertical mass splittings' in the periodic table (the t-b mass difference) referred to as 'weak isospin breaking' and which have an impact on the physics and the parameters of W/Z physics. As reported by A. Denner (Würzburg) and D. Haidt (DESY), detailed studies of this type using LEP measurements indicate that, if the Standard Model is the whole story, the top quark should lie between 100 and 170 GeV, good news for Tevatron physicists.

The second source of information comes from 'horizontal mass splittings' (t-c), governing delicate neutral current processes such as neutral B meson mixing and CP-violating decays. As reported by J. Rosner (Chicago) and S. Bertolini (Munich) the top mass values from this type of analysis are compatible with those from the other approach, although considerable theoretical uncertainties do not yet allow for very firm conclusions.

All these arguments contain some uncertainty and no one can completely exclude the possibility that top lies beyond 200 GeV. If top is really that heavy some spectacular effects may occur. Certain branching ratios, like that for a charged kaon going into a pion and two neutrinos, may be substantially enhanced, making the life of experimental physicists easier. On the other hand, certain CP-violation parameters could become very small, making life extremely difficult.

As discussed by W.A. Bardeen (Fermilab) the heavy top scenario can be used to generate the W/Z masses dynamically without resorting to elementary Higgs scalars which have also so far escaped detection (P. Zerwas – Aachen). In such a scenario the breakdown of electroweak symmetry is triggered by a condensation of top quarks into a composite Higgs. This bears some analogies to the BCS theory of superconductivity with top-antitop condensates playing the role of the Cooper pairs. Could these ideas help resolve some of the outstanding questions on the origin of mass?

Whether the dynamical symmetry breaking is triggered by a heavy top quark or some other mechanism, its implications are certainly worth pursuing (R. Peccei – Los Angeles, M. Peskin). Various simplest scenarios such as some versions of technicolour models may even be ruled out now. The strongly interacting Higgs sector is anoth-

Behind the scenes at the recent DESY Theory Workshop – left to right – Chairman and Organizer Andrzej Buras of Munich with Helga Laudien, Ingeborg Schwartz and Fridger Schrempp of DESY.

er related aspect which should be well tested at future supercolliders.

Lattice gauge calculations provide new theoretical insights into mass spectra, and J. Jersak (Aachen/Jülich) and M. Münster (Münster) looked at some of the implications of a heavy top quark. New insight should come in the coming year through extensive lattice calculations.

The final morning of the workshop coincided with the 'Grand Unification' of Germany, demonstrating clearly that superstring theories cannot be 'Theories of Everything' since at least this unification had not been predicted!

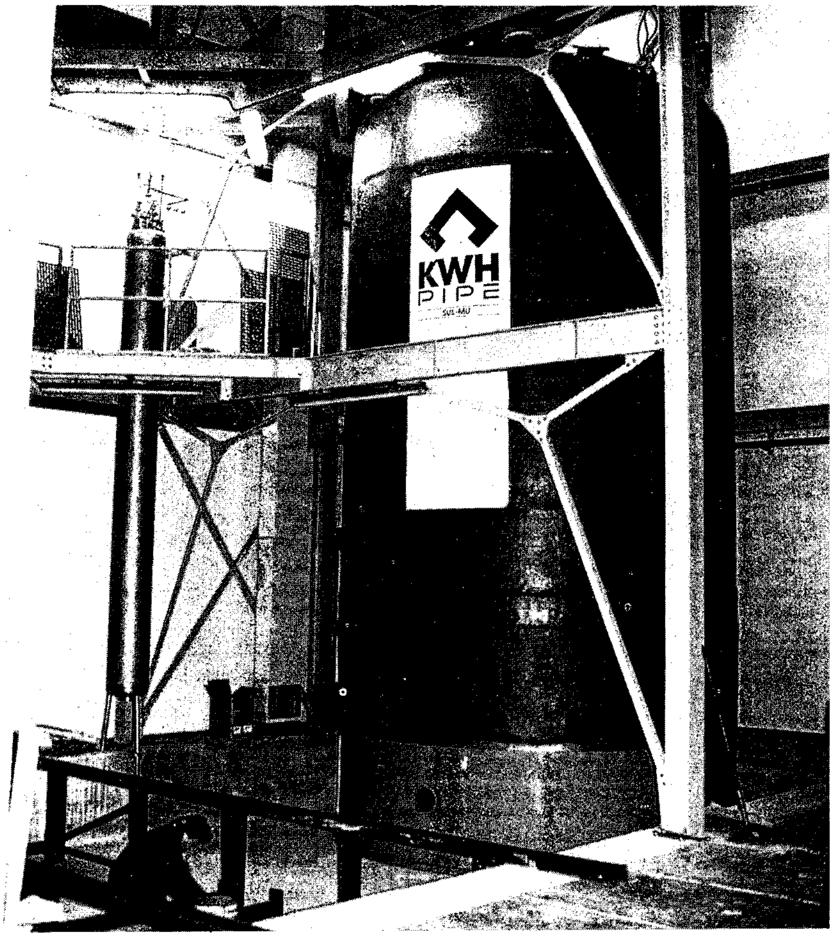
The workshop certainly showed that there can be a lot of fun in waiting for the top quark – predicting its mass and its weak couplings, plotting curves, writing papers and arranging meetings. However if this situation continues for another decade, it could lead to a budget crisis in particle physics. Let's hope it's found soon!

By Andrzej J. Buras, Munich

GRAN SASSO
Gallex underway

Although the experiment actually started collecting its solar neutrino data last Summer, November 30 saw the official inauguration of the Gallex experiment. A collaboration between Heidelberg, Karlsruhe and Munich in Germany, Saclay and Nice in France, Milan and Rome in Italy, Rehovot in Israel and Brookhaven in the US, Gallex uses 30 tonnes of gallium (as gallium chlo-

One of the target tanks of the Gallex solar neutrino experiment, which uses 30 tonnes of gallium (as gallium chloride solution) in the Gran Sasso underground Laboratory 150 kilometres from Rome.



ride solution) to intercept neutrinos from the sun.

Housed under 1200 metres of rock in the underground Gran Sasso Laboratory in the Appenine range, some 150 km from Rome, Gallex is well shielded from less penetrating cosmic rays. Neutrinos hitting the target form radioactive germanium-71, with a half-life of 11.4 days.

The possibility of using gallium for solar neutrino detection was suggested by Soviet theoretician V.A. Kuzmin in 1966. Independently, solar neutrino pioneer Ray Davis of Brookhaven had also taken note of this possibility, but in those days the world supply of gallium was only about a tonne.

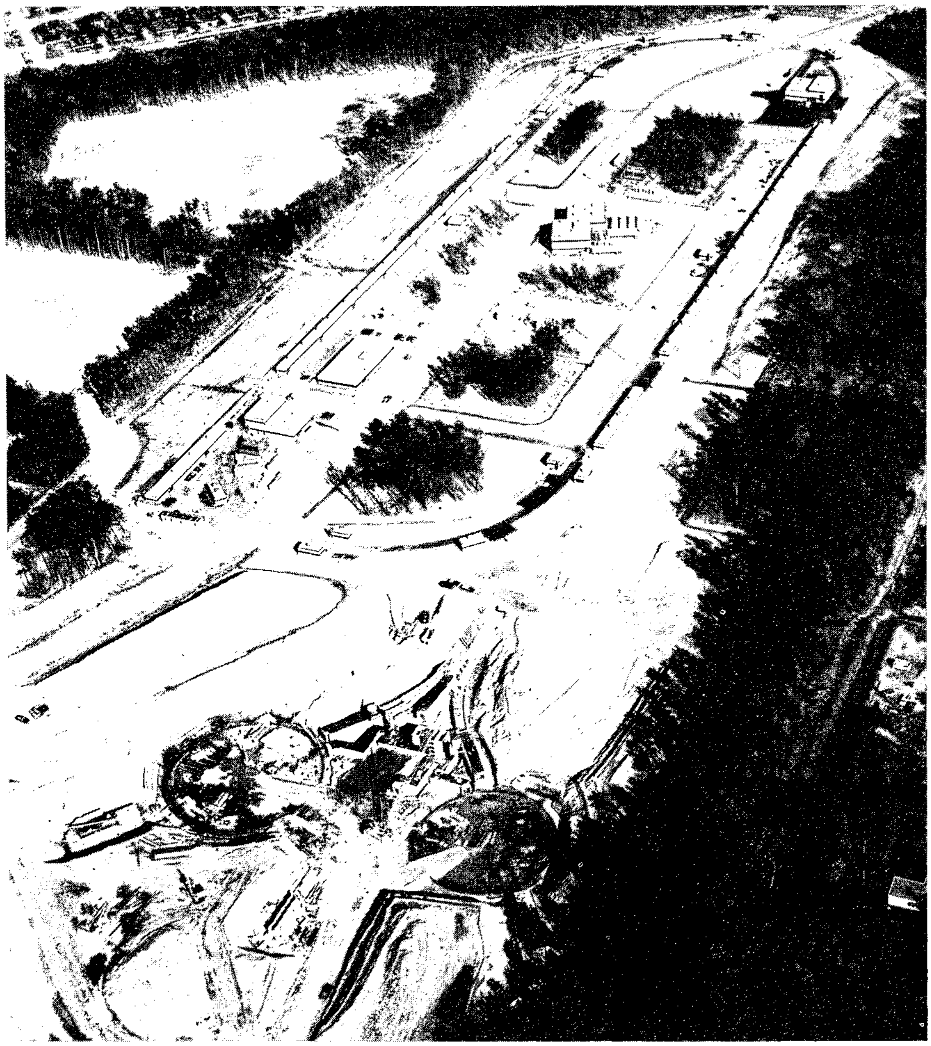
As the world market for gallium expanded, a Brookhaven/Munich (Max Planck Institute) group undertook a pilot study. This continued until 1984 and some of the key participants in this early work are still Gallex members.

After a declaration of intent from a strong European group, funding for the gallium came from the German Science Ministry and the Alfred Krupp von Bohlen und Halbach Foundation.

First results are expected this spring, and will help to understand the mechanics of solar interactions, where in particular the number of neutrinos intercepted on earth is only a fraction of the level expected from otherwise reliable calculations ('the solar neutrino problem'). Gallium is well-matched to solar neutrino energies.

Another solar neutrino gallium detector, the SAGE Soviet/US project in the Baksan facility (North Caucasus) also got underway last year. It will take time before reliable data samples can be built up and an accurate picture of solar neutrino behaviour can emerge.

Surface buildings trace the racetrack shape of the completed 1.4-km accelerator tunnel for the CEBAF Continuous Electron Beam Accelerator Facility being built at Newport News, Virginia. In the foreground the three circular end-stations are under construction.



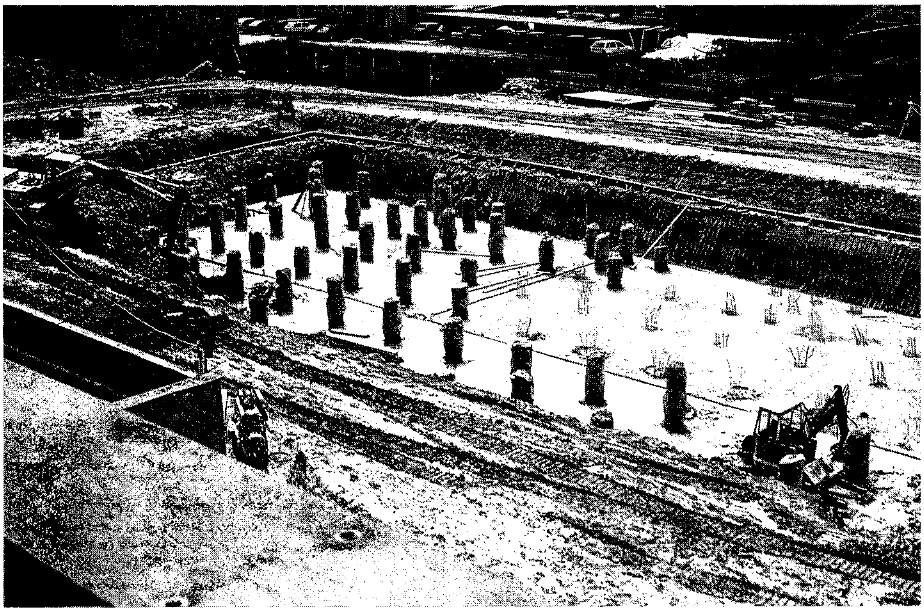
CEBAF Injector tunnel in action

On 28 October, a 100 kV DC electron beam was generated in the injector tunnel at the Continuous Electron Beam Accelerator Facility (CEBAF) being constructed at Newport News, Virginia. In this first tunnel operation, the beam was transported from the electron gun via the room-temperature section to the injector's first superconducting section (5 MeV). The gun and beam steering subsystems behaved as designed, under control from the main control centre.

After successful 5 MeV operation in CEBAF's test lab, tunnel assembly of the full 45 MeV injector had begun on 1 August, and an eight-cavity, nominal 20 MeV cryomodule has been connected downstream from the twin-cavity 5 MeV quarter-cryomodule.

The near-term goal is a 25 MeV front-end test to demonstrate integration and operation of subsystems identical to those slated for the twin linacs of the 4 GeV recirculating accelerator itself. The central helium liquefier, now in acceptance testing and commissioning, will provide cryogenics.

Meanwhile in the test lab, the highest accelerating gradient yet seen in a CEBAF superconducting cavity was attained – 16.9 MV/m. Quality factor, Q, specified as minimally 2.4 x 10^9 at the 5 MV/m design gradient, measured 6.6 x 10^9 at the high gradient. At design gradient, Q surpassed 10^{10} for both cavities in the operationally configured pair under test.



Not the excavations of a Roman temple but construction of the foundations for the new ALPI superconducting linac at the Italian INFN Legnaro Laboratory, near Padua.

(Photo R. Pengo)

LEGNARO ALPI superconducting linac taking shape

Under construction at the Italian INFN Laboratory at Legnaro, near Padua, is the ALPI superconducting linac to accelerate a wide range of ions (up to uranium) to more than 6 MeV/nucleon.

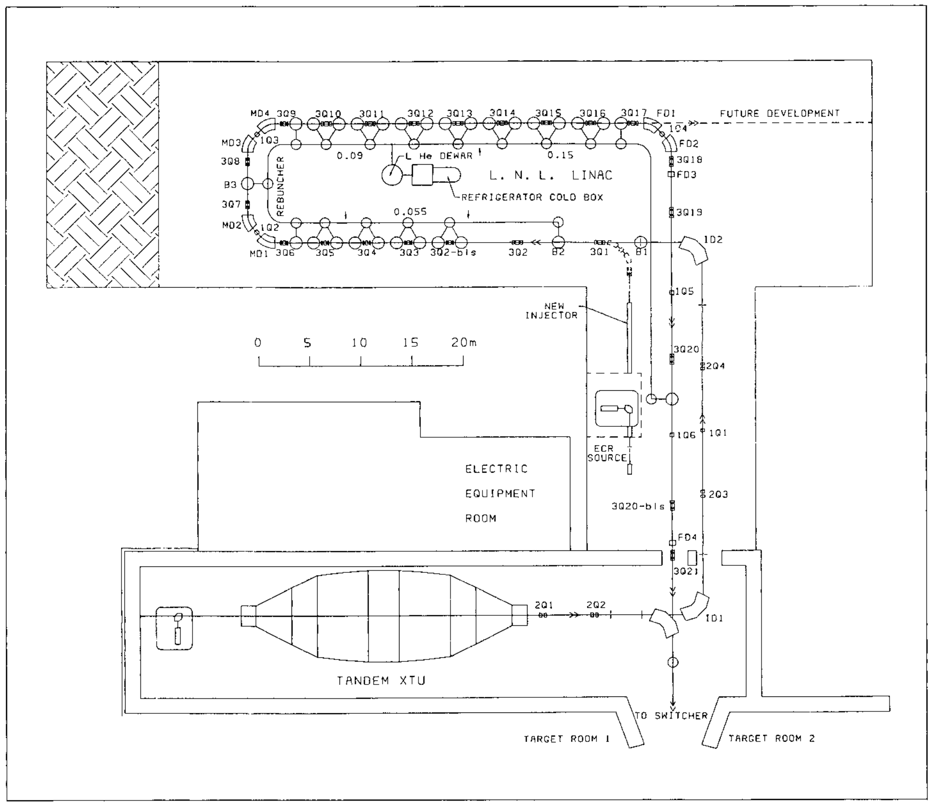
A first phase with 48 160MHz superconducting accelerating cavities will go operational prior to installation of the full complement of 93 cavities.

The Laboratory's existing 17 MeV tandem will initially be used as injector, but eventually an electron cyclotron resonance ion source will be installed.

As well as pure and applied nuclear physics, the objectives of the project are to give the Laboratory team important experience in accelerator design, building and commissioning.

A meeting at Legnaro in December surveyed the science expected to be covered with the new machine.

Layout of the ALPI scheme, below.



Simon van der Meer retires

CERN's big Auditorium was packed on Friday 23 November for a 'Simon van der Meer Feest' to mark the formal retirement of the gifted Dutch accelerator physicist who has made so many valuable contributions to his field and to CERN's success.

It is no accident that CERN's two most important scientific discoveries – that of the W and Z particles (the carriers of the weak force) in 1983, and the neutral current of the weak interaction ten years earlier – were both made possible by ingenious van der Meer inventions enabling unruly particles to be fashioned into strong beams.

His idea and subsequent development of stochastic cooling made CERN's antiproton project possible and opened the way for the W/Z discovery, for which he and Carlo Rubbia, now CERN's Director General, were awarded the 1984 Nobel Prize for Physics.

An earlier invention, the 'magnetic horn', focuses parent charged particles before they decay, boosting the intensity of resulting neutrinos and greatly increasing their physics potential, so that rare processes like neutral currents become easier to spot.

Feest chairman Ugo Amaldi introduced the proceedings by recalling the first time the antiproton scheme based on van der Meer's stochastic cooling was described in public at CERN, in a 1976 seminar by Carlo Rubbia subtitled 'just one of those unthinkable ideas'! At the retirement event, Carlo Rubbia was on hand with an elegant personal explanation of stochastic cooling.

Particle accelerators work in phase space – a combination of ordinary space and momentum – and their working domain, or acceptance, is defined by a phase volume. Secondary particles, such as antiprotons, produced when a primary beam hits a target, are spread out over a wide phase volume, and handling them efficiently means compressing this volume.

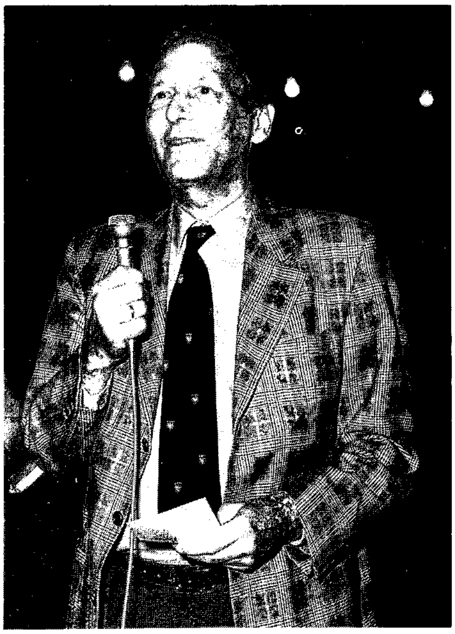
It is a fact of life (Liouville's theorem) that phase volume cannot be compressed using ordinary conserved forces. The electric and magnetic fields used in accelerators merely distort the phase volume, and to change the density calls for something else.

While others looked at schemes based on foils and eventually collisions with collinear beams (called 'smart foils' by Rubbia) which turned out to be better suited to lower energy projects, Simon van der Meer's genius led to a radically different approach. High energy particles circulating in a storage ring are monitored by pickups, and appropriate signals are fed to kickers diametrically opposite to catch the same particles as they pass and give them a small nudge. In this way a wide statistical spread can be successively damped and a more orderly, or 'cooler', beam built up.

Despite initial appearances, Liouville's theorem is still OK - the empty phase space around each particle is preserved, but these individual phase spaces get rearranged. The stochastic cooling idea, both elegant and practical, exploits this emptiness of accelerators' phase space, pushing sparse particles together and empty regions outwards.

After Carlo Rubbia's tribute, Jack Steinberger turned to van der Meer's magnetic horn brainchild.

Simon van der Meer – ingenious accelerator ideas.



These fearsome-looking devices compress charged kaons and pions into a cone so that their resultant neutrinos, otherwise uncontrollable, are confined in a narrow beam.

Steinberger underlined the physics implications. As well as its neutral current triumph, CERN's early neutrino beam programme showed that the deep interior of the nucleon as seen by neutrinos was the same as that seen at Stanford in high energy electron studies, and went on to enable the tiny 'parton' constituents seen by these beams to be identified with the quarks of the static nucleon picture. Later came the precision high energy work at the SPS, which is still continuing.

Van der Meer has even a third claim to fame, described at the Feest by Giuseppe Cocconi. At CERN's Intersecting Storage Rings (closed in 1984) van der Meer developed a precision method for vital measurements of the machine's luminosity by determining the vertical distance between two beams. This exploited the ISR's remarkable *precision and ability to maintain stable conditions, and quickly led to the early precision determinations of the proton-proton reaction rate (cross-section) in the new energy range opened up by this pioneer machine.*

In conclusion, Giorgio Brianti sketched van der Meer's remarkable 35-year career at CERN, paying tribute to his remarkable insight and inventiveness. 'If there was a problem, then Simon could find us a solution'.

With characteristic modesty, van der Meer has shunned publicity after his Nobel triumph, preferring to work quietly on fresh challenges. Fortunately for CERN and for particle physics as a whole, he will continue to tinker with these problems, hopefully for a long time to come.

VIEWPOINT
Mind over matter – the intellectual content of experimental physics

According to my experience, the most brilliant physics students at any university want to become theoreticians, and this on both sides of the Atlantic ocean. It is rare that a person of the intellectual power of, say, a Gell-Mann or a Cabibbo decides to embark on a career in experimental physics.

It is obvious that this fact entails a serious loss for physics, since physics is primarily a natural science. I have often asked myself about the reasons for this regrettable situation; once these are established, perhaps remedies could be suggested.

I have come up with two reasons. The first is the style in which physics is taught essentially everywhere. There are two models, A and B, both of which fail to convey to the students the intellectual content of important experiments.

In model A, the student is told that some great genius, identified by name, predicted a remarkable dependence y(x) of one observable upon another. That dependence was then subsequently brilliantly confirmed by experiment – by some unspecified person.

In model B, one presents an observed dependence y(x) that constituted at its time a great puzzle. Again a great genius (name given) came along and presented a theory which fitted the observations perfectly.

In either model, the intellectual accomplishment of the experimentalist is generally not conveyed to the students. I shall illustrate this by two examples: (1) in Okun's masterful book 'Leptons and Quarks', experiments are rarely described – although the authors are given – their results are merely quoted, as 'one finds.....'; (2) I once gave a course 'Great Experiments in Modern Physics' at MIT. It was attended by young students and ..... senior theorists. Many of the latter learned for the first time how Willis Lamb had actually determined 'his' shift, how many brilliant insights he had had to have to achieve his goals. Quite a few people concluded correctly that there was as much intellectual content in the Lamb experiment as in the quantum electrodynamics explanation of it. (This example is marred by the fact Lamb was actually an accomplished theorist!).

Val Telegdi – mind over matter

A second, altogether different reason derives from what I might call the 'theory of the father image': in practice, all our physics courses are theoretical, whether the title of the course says so or not. The theorists teaching theory mostly know what they are talking about, and the experimentalists frequently do not. So the student (who though he may himself not understand the subject, still infallibly catches the lack of understanding of the lecturer!) says to himself: 'I do not want to become like him (insert name of experimentalist) but like him (insert name of theorist)'.

What can we do to remedy this situation? Two things: first, we must postpone the difference in training of future experimentalists and theorists as far as possible. The difference is one of technique and not one of intellectual competence. Second, we must teach courses in which brilliant experiments of great significance are analysed in some detail. There is no shortage of candidate material!

Val Telegdi

(This essay, supplemented by an analysis of several interesting and incisive experiments, is published as a CERN 'Yellow Report', CERN 90-09.)

CERN
End of an era

After twelve years, the UA1 experiment at CERN's proton-antiproton collider is over.

The idea of a big detector to provide information on all emerging particles was an integral part of Carlo Rubbia's bold 1976 proposal to harness antimatter for research.

Over the next few years a major collaboration built up, eventually to involve almost two hundred physicists. The experiment, codenamed UA1 for 'Underground Area 1', was formally approved by CERN's Research Board on 29 June 1978, and work got underway in earnest for the mighty 2,000 tonne detector to be installed and checked out in its LSS5 pit, ready to intercept the first proton-antiproton collisions in the summer of 1981.

The rest is physics history. Initial collision rates were low, and spirits sank when an accident in 1982 delayed the start of serious data-taking. But with the collider benefiting from this enforced rest, performance exceeded expectations and the first Ws were intercepted late that year.

The 1983 Spring run provided the rarer Zs, and the champagne flowed. In 1984 came the Nobel Prize for Carlo Rubbia and for Simon van der Meer, whose invention of stochastic cooling had made the whole antiproton project possible. Rarely had a Nobel Prize been awarded so promptly.

Subsequently UA1 went through a major refit to exploit an increased supply of antiprotons and consolidated our knowledge of this physics, in particular the study of 'jets' - well-defined clusters of emerging particles, signalling violent collisions between the quarks and gluons hidden deep inside the protons and antiprotons, and the production and decay of particles containing heavy quarks.

Vital to UA1's success was its sophisticated data acquisition and processing systems, ensuring that interesting events could be isolated quickly. The use of innovative computer graphics gave these events a strong visual appeal.

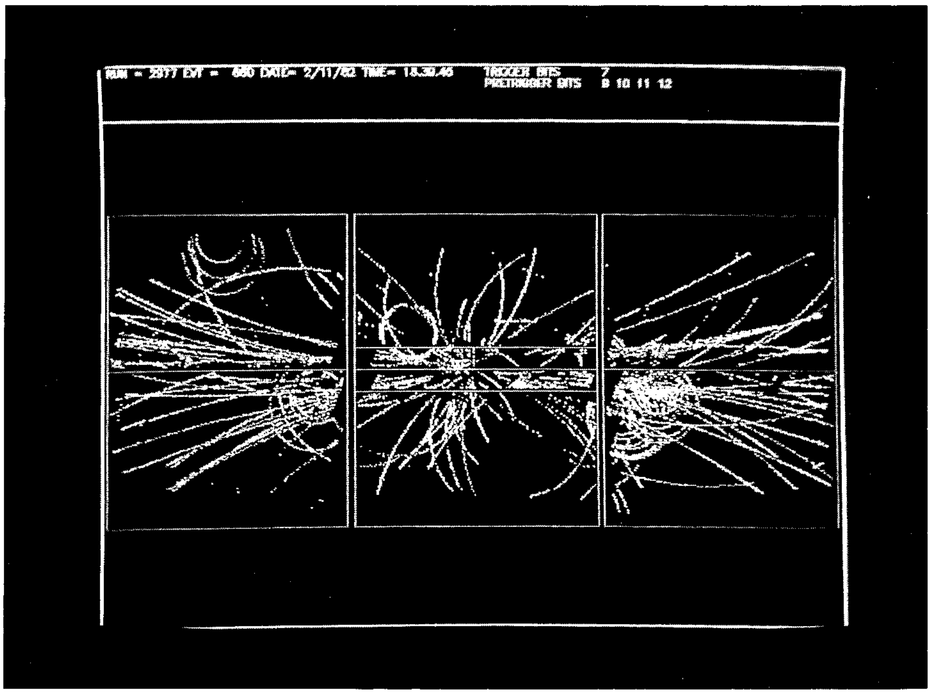
The experiment had a long list of distinguished and able collaborators, many of whom have gone on to take up important positions elsewhere. Although not as big as the LEP experiments which came later, UA1 blazed a trail for major collaborations and for collider physics.

The three-month 1990 run at CERN's proton-antiproton collider (in which the companion UA2 experiment was still collecting data) finished in December with a healthy collision score. Integrated luminosity was of the order of 7 inverse picobarns, and peak luminosity attained 5.9 x 10^{30} per sq cm per s.

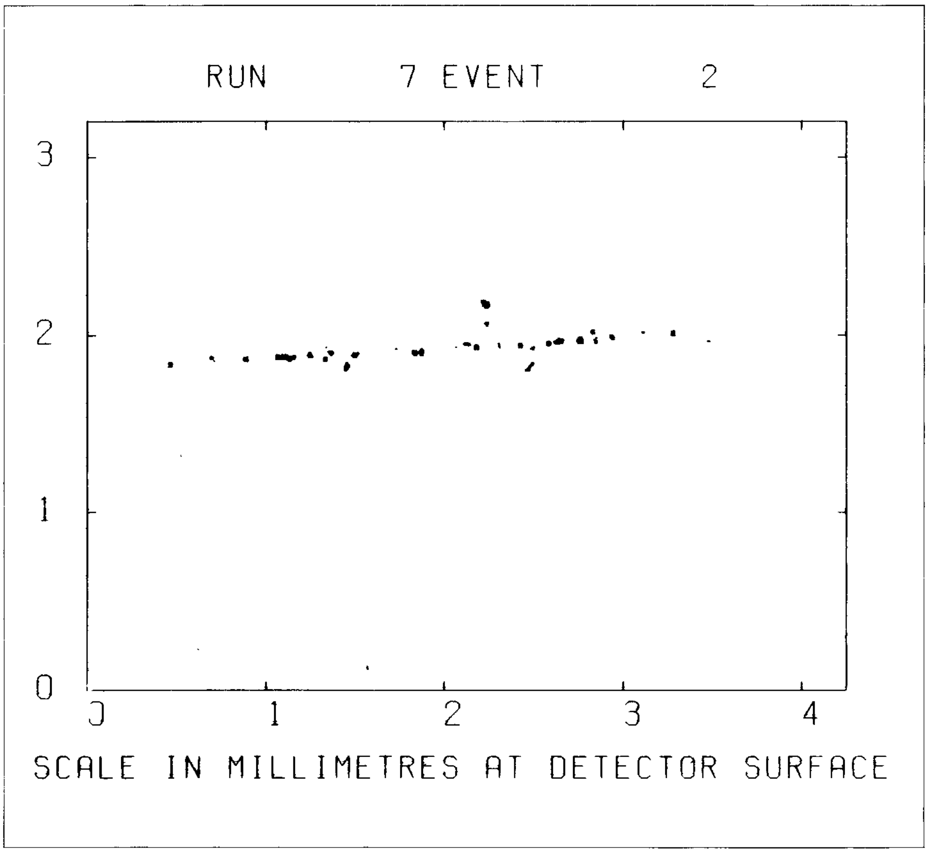
Integrated daily luminosity at the UA2 experiment in this run often exceeded 200 inverse nanobarns, more than was achieved in the whole of the three-month run in the Spring of 1983, when the Z particle was discovered! UA2 has now finished data-taking, but has a lot of new data still to be analysed.

In the early 80s, innovative computer graphics were the trademark of the UA1 experiment at CERN's proton-antiproton collider.

(Photo CERN X511.11.82)



Track recorded in December from a 5 GeV negative pion beam at CERN by a collaboration of the WA84 and CHARM II groups using a new opto-electronic set-up and a recently-developed target made of glass capillaries 20 microns in diameter and filled with liquid scintillator. Spatial resolution is better than 14 microns and the noise level is very low (see also cover photograph).



Scintillating fibre tracking in action

In the quest for new detection techniques for the coming generation of higher energy proton accelerators (LHC at CERN, the SSC Superconducting Supercollider in the US, and UNK in the USSR), one objective is high precision tracking in large multiplicity events with components that can withstand the radiation levels. A promising approach uses scintillating fibres (scifi).

Development work in the US has been pushed for a Fermilab experiment looking for short-lived particles, while the SSC provides parallel motivation. A Brookhaven experiment also makes use of these techniques.

At CERN three groups are busy with R and D on scintillating fibres. One, in the context of the Italian-funded LAA project, is looking to develop concentric shells of fibre tracking, with a particle passing at right angles to the fibres (April 1990, page 18). Another group in the framework of the CHARM II collaboration aims at the application of scifi techniques in neutrino physics.

A third group at CERN has developed a solution in the context of a particular experiment. Following a suggestion by the late Colin Fisher of the Rutherford Appleton Laboratory, the WA84 collaboration has investigated the possibility of using a high-resolution scifi active target to study the decay of short-lived particles (for example those containing the b-quark) in a fixed target.

A typical WA84 target consists of a coherent bundle of about 30,000 fibres, each about 30 microns in diameter and having a core of polystyrene doped with 1-phenyl-3-mesityl-2-pyrazoline (PMP), as developed by the LAA Scintillating Fibres Group. The fibre axes are parallel to the incoming beam, and at the end face of the target the light trapped in the fibres is bent out of the beamline and intensified using an opto-electronic chain and read out via a CCD (Charge-Coupled Device) composed of about 160,000 pixels. The pulse height of each pixel is recorded.

The resulting images are reminiscent of track photographs from bubble chamber experiments. A pattern recognition program provides a good quality reconstruction of tracks and vertices. The measured spatial resolution is about 16 microns. The amount of noise on an image frame is large (about 40% of the total pulse height), due in part to noise induced in the opto-electronic chain and in part to crosstalk between fibres.

Recently tests have been carried out by a collaboration between the WA84 and CHARM II groups with a modified version of the WA84 opto-electronic chain and new targets made of glass capillaries 20 microns in diameter and filled with liquid scintillator. Excellent results have been obtained with targets having an absorber layer between each capillary, noise being essentially eliminated.

These results indicate that scintillating fibres are very promising for different particle physics applications and encourage continued investment in R and D programmes to develop scifi detectors for future accelerators.

KEK B factory plans

To boost the study of B mesons (carrying the heavy b quark), the Japanese KEK Laboratory is looking to construct a B-meson 'factory'.

B-mesons have revealed unexpected and important quark physics. Well-known examples are the long lifetime of the B-mesons, indicating a large gap between the third and second quark generation (compared to that between the second and the first), and relatively large mixing of the neutral B-meson and its antiparticle, now interpreted as being due to a heavy sixth ('top') quark (see page 5).

However the potential richness of B-meson physics has not been fully explored. In particular a large violation of CP symmetry (combined left-right reflection and particle-antiparticle reversal) is expected with B-mesons. (The only CP violation observed so far, in the neutral kaon sector, is a small effect.) A long-standing mystery, CP violation might have played an essential role in the formation of the present matter (rather than antimatter) universe. Also quark generation mixing reflecting possible new physics can be examined at the deepest level through B-meson decays. Thus a variety of B-meson physics projects are being discussed worldwide (June 1990, page 10).

The particle physics programme at KEK aims for a clean and detailed study of quark-lepton physics with electron-positron collisions. While R and D work is rapidly gaining momentum for the Japan Linear Collider (JLC), which will attack the TeV energy scale, B meson physics can be started earlier by making full use of the existing TRISTAN complex.

The current plan for the KEK B-Factory is a double-ring collider of unequal energies, to be installed in a newly constructed tunnel 1.2km in circumference. The TRISTAN Main Ring is also a possibility. The beam energies, 8 GeV on 3.5 GeV, are optimized for CP studies at the upsilon 4S peak. More asymmetric collisions, 12 GeV on 2.5 GeV, may also be required for the measurement of rapid oscillation between the neutral B_s meson (containing the strange- and b-quarks) and its antiparticle. This is also accommodated in the design.

The beams would be supplied from the upgraded 2.5 GeV Linac, stored and accelerated in the TRISTAN Accumulation Ring, and then injected into the storage rings. The design luminosity at the first stage is 2×10^{33} per sq cm per s, with 400 bunches colliding head-on, eventually reaching 10^{34} with 2000 bunches colliding at an angle.

To appraise the present design, an International Workshop on Asymmetric B-Factory Accelerators was held at KEK from 4-6 October. Thirty experts from abroad and forty from Japan participated in four working groups – lattice design, beam-beam interaction, hardware issues and the interaction region. The KEK design employs a small beta compression, small bunch spacing and a high tune-shift limit as well as a large dynamic aperture. No serious problem has been identified.

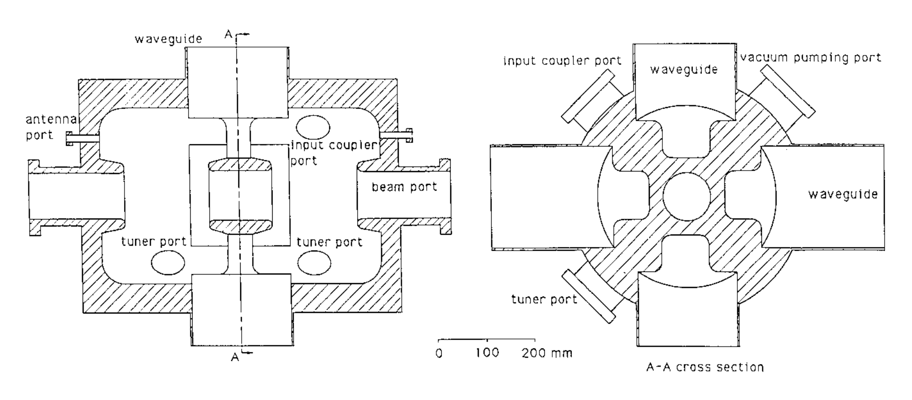
However, any high event rate factory-type accelerator is full of technical challenges. In particular closely spaced particle bunches are susceptible to coupled-bunch instabilities in accelerating cavities. Damped cavities under investigation at KEK (Palmer-type) and at Cornell (superconducting single-cell) are both viable, but need to be fully investigated. A feedback system will also be necessary to suppress the instabilities. There is a practical design for high vacuum, but ideas are needed for cooling a beam pipe at the collision point.

The next steps are to identify critical beam experiments possible at existing storage rings, and to initiate international collaboration on important items such as cavities, a feedback system, beam ducts and the beam pipe at the collision point.

Detector construction would benefit from TRISTAN experience. Tracking chambers and electromagnetic calorimeters can be based on presently available techniques. A large superconducting solenoid of 1 Tesla class and an iron structure currently operating in the TRISTAN experiments will also become available.

However there are special requirements for a detector at an asymmetric B factory. Excellent vertex resolution, better than 100 microns, in the beam direction is necessary to separate the decays of 'moving Bs', and a double-sided silicon-strip detector is under intensive study. Fast readout electronics is another requirement, resulting from a short beam-crossing interval and a high event rate. VLSI technology will be fully incorporated. Finally, the detector should be able to fully reconstruct as many individual B decays as possible, requiring ingenious combinations of detector techniques, either existing or shortly to become available.

Funding negotiations with the Japanese government project have begun. If everything goes well, construction will start next year and finish by the end of 1995, with most of the work done while TRIS-



When a storage ring is operated with multiple beam bunches, even distant bunches can interact with each other through resonating accelerator components, such as radiofrequency cavities. This can produce unwanted cavity fields, giving coupled-bunch instabilities and poor performance.
In the damped cavity design for the proposed B-factory at the Japanese KEK Laboratory, harmful field components are minimized.

TAN continues to run.

An International Workshop on Physics and Detectors for the KEK Asymmetric B-Factory will be held from 15-18 April to give the final polish to the experimental plan and to discuss ongoing international collaboration. Further information from F.Takasaki (Fax 0298-64-2580, Bitnet TAKASAKI at JPNKEKVM).

SUPERCOLLIDER Preparing initial experiments

The Superconducting Supercollider (SSC) Laboratory in Ellis County, Texas, has taken an important step toward its scientific programme.

While three letters of intent for large detectors had been invited, only two could be considered due to funding limitations. Two letters were received from existing collaborations (SDC and L*) and one from a merger of (EMPACT and TEXAS).

The SSC Laboratory has decided that the SDC collaboration will have support for a full technical proposal. The Laboratory will carry out a detailed cost review of the proposed L* detector. EMPACT/TEXAS was not approved and the Laboratory will help these physicists participate in the programme.

In the current financial year, SSC funding from federal sources amounts to $267M ($243M of new money plus $24M of 1990 construction money held over) compared to the $318M requested, but the State of Texas has compensated with an additional $60M to give $149M, hence total funding of $416M, including $7M for Department of Energy management.

High energy electrons for probing nuclei

It is becoming increasingly clear that the quarks hidden deep inside the proton and neutron constituents of nuclei can play an important role in nuclear behaviour.

With quark field theory (quantum chromodynamics – QCD) one of the twin pillars of today's Standard Model, the implications of this physics at the nuclear level are being widely investigated.

This new emphasis has been marked by the migration of hundreds of nuclear physicists to new research pastures at high energy Laboratories – CERN's LEAR antiproton ring, and ion beams at CERN and Brookhaven.

In addition, medium energy electron machines (around 1 GeV) have demonstrated their usefulness in probing details of nuclear structure, and in the US, the CEBAF Continuous Electron Beam Accelerator Facility being built at Newport News, Virginia, to provide energies up to 4 GeV will open up new nuclear physics horizons.

In France, a report published last year (May 1990, page 17) underlined the importance of setting up an essentially European project to provide nuclear physicists with electron beams of even higher energies, beyond 10 GeV

To push this message home, a workshop was organized late last year at Dourdan, France, attended by some 200 participants, including many young researchers.

Pushing for European nuclear physics – Ingo Sick of Basle, left, with Bernard Frois of Saclay.

(Photo Maurice Jacob)

People and things

Sir William Mitchell (UK) is the new President of CERN Council.

Laboratory correspondents

Argonne National Laboratory, USA
M. Derrick

Brookhaven National Laboratory, USA
A. Stevens

CEBAF Laboratory, USA
S. Corneliussen

CERN, Geneva
G. Fraser

Cornell University, USA
D. G. Cassel

DESY Laboratory, Fed. Rep. of Germany
P. Waloschek

Fermi National Accelerator Laboratory, USA
M. Bodnarczuk

GSI Darmstadt, Fed. Rep. of Germany
G. Siegert

INFN, Italy
A. Pascolini

IHEP, Beijing, China
Qi Nading

JINR Dubna
B. Starchenko

KEK National Laboratory, Japan
S. Iwata

Lawrence Berkeley Laboratory, USA
B. Feinberg

Los Alamos National Laboratory, USA
O. B. van Dyck

NIKHEF Laboratory, Netherlands
F. Erné

Novosibirsk Institute, USSR
V. Balakin

Orsay Laboratory, France
Anne-Marie Lutz

PSI Laboratory, Switzerland
J. F. Crawford

Rutherford Appleton Laboratory, UK
Louise Hall

Saclay Laboratory, France
Elisabeth Locci

IHEP, Serpukhov, USSR
Yu. Ryabov

Stanford Linear Accelerator Center, USA
M. Riordan

Superconducting Super Collider, USA
N. V. Baggett

TRIUMF Laboratory, Canada
M. K. Craddock

CERN Council

At its December meeting, CERN Council took a number of important decisions, in addition to admitting Poland as the Organization's 16th Member State (see this page).

After a report of studies organized by the European Committee for Future Accelerators (ECFA), Council reconfirmed its conviction that the LHC Large Hadron Collider should be CERN's next major project, with formal approval foreseen for 1992.

Sir William Mitchell (UK) was elected Council President for the coming year, with Pierre Lehmann (France) and Mrs. Birgitte Sode-Mogensen (Denmark) as Vice-Presidents.

At CERN, Kurt Hübner becomes Head of PS Division, succeeding Roy Billinge, Willem Middelkoop becomes Head of Personnel Division, succeeding Georges Michel, and Bastiaan de Raad becomes Head of the Technical Inspection and Safety Commission, succeeding Keith Potter.

Poland joins CERN

Delegates at CERN's Council meeting in December voted unanimously to admit Poland as the Organization's 16th Member State. Finland became the 15th Member State on 1 January, and the Polish flag will officially go up on 1 July.

CERN is the first Western European organization which Poland has joined, while Poland will become CERN's first Member State from outside Western Europe. Informal negotiations are already underway with Czechoslovakia, Hungary and Yugoslavia.

On people

The American Physical Society's Panofsky Prize goes to Gerson Goldhaber of Berkeley and François Pierre of Saclay for their 1976 discovery of charmed (D) mesons at the SPEAR electron-positron ring at Stanford.

Abdus Salam, Director of the International Centre for Theoretical Physics, Trieste, and President of the Third World Academy of Sciences, has received the Catalonia Prize from King Juan Carlos of Spain.

Stanley Wojcicki of Stanford becomes Chairman of the US High Energy Physics Advisory Panel (HEPAP), taking over from Francis Low of MIT.

Kaoru Yokoya of the Japanese KEK Laboratory's Accelerator Department has been awarded the 36th Nishina Memorial Prize for his distinguished theoretical work on beam-beam interactions and polarization phenomena in high energy accelerators in general and for a li-

near collider in particular. This prize is awarded annually in memory of Yoshio Nishina, a pioneer of atomic and nuclear physics in Japan.

At Brookhaven Theo Sluyters has been appointed Acting Deputy Chairman of the AGS Department, and Bill Weng has been appointed Head of the Accelerator Division of the AGS Department.

Robert Hofstadter 1915-1990

Electron scattering pioneer Robert Hofstadter died on 17 November, aged 75.

His promising career was interrupted by World War II, when he worked for the US National Bureau of Standards and helped develop proximity fuses for anti-aircraft shells. After the war, he recommenced research work at Princeton, where he discovered the potential of sodium iodide as a scintillator and went on to exploit its use in detectors.

In 1950 he moved to Stanford, where W.W. Hansen and his talented team were developing their famous series of linear machines to accelerate electron beams. Mark III was delivering 180 MeV electrons by 1951, while Hoftstadter had initiated a comprehensive programme of research to exploit the new beams, scattering electrons off nuclei.

From 1953, these experiments displayed clearly the now well known spectra indicative of nuclear structure. With the linac energy boosted to 600 MeV, he moved his attention to smaller nuclei and the proton itself. For the first time, it became clear that the proton and the neutron are not point particles, but their electric and magnetic properties are smeared out, and could be described by 'form factors'.

In addition to paving the way for subsequent higher energy studies which went deeper inside the proton and revealed its constituents, these experiments hinted at other new behaviour, heavy mesons such as the omega and rho particles. For this epic work on nuclear and nucleon structure Hofstadter shared the 1961 Nobel Prize with Rudolf Mössbauer.

These new insights made Stanford a mecca for young experimenters, among them the talented trio of Jerome Friedman, Henry Kendall and Richard Taylor who went on to demonstrate that the proton had a substructure, a feat which earned them the 1990 Nobel Physics Prize.

With electrons proving such efficient probes, Hofstadter pushed for the construction of the largest possible such machine. Under the guidance of first Edward Gintzon and then W.K.H. Panofsky, this project evolved into the mighty Stanford Linear Accelerator Center, a national US Laboratory which outgrew its university origins.

In later years Hofstadter made valuable contributions to angiography, using radioactive tracers to monitor heart functions.

Science for Peace

The first Ettore Majorana (Erice, Sicily) Science for Peace Prize has been awarded in three equal parts to Edward Teller, to Viktor Weisskopf, and in memory of the late P.A.M. Dirac, P.L. Kapitza and A.D. Sakharov (received by Mrs. M. Dirac, Mrs. A. Kapitza and Mrs. E. Bonner Sakharova).

The Ettore Majorana Centre for Scientific Culture in Erice is directed by Antonino Zichichi.

Zbigniew Bochnacki 1935-1990

Zbigniew Bochnacki, Director of the H. Niewodniczanski Institute of Nuclear Physics, Krakow, died on 30 September. As a theoretical nuclear physicist he made important contributions to the theory of nuclear structure, and his contribution to understanding spin-spin interaction and its influence on magnetic moments of nuclei or to the theory of the so-called 'scissor' modes of nuclear transitions and collective motion is well known and highly appreciated.

As the Director of the Institute of Nuclear Physics in Krakow from 1977 until his death he was active in establishing and promoting strong links between the Institute and CERN.

David Gray retires

After having been at the centre of accelerator developments and operations at the UK Rutherford Appleton Laboratory for 35 years, David Gray retired last year. He is succeeded as the Laboratory's Associate Director, Science, by Bob Voss, one-time Deputy Director of the Daresbury Laboratory and formerly Head of the UK Science and Engineering Council's Engineering Division.

Too hot to handle

Now available in the UK (published by W.H. Allen) is 'Too Hot to Handle', a new book by theorist and author Frank Close on the history of the cold fusion claims which burst on an unsuspecting world in March 1989.

Last last year saw the 60th birthday of two eminent Geneva theorists – Henri Ruegg (left) and Raoul Gatto.

60th birthdays

Late last year several distinguished theoreticians based in and around CERN celebrated their 60th birthdays.

In November, a symposium 'Theoretical Particle Physics at the Beginning of the 90s' at the University of Geneva honoured Henri Ruegg and Raoul Gatto, who have spent most of their careers at Geneva and have helped build up the close collaboration between the University and CERN.

Another symposium, held at CERN, honoured Torlief Ericson, who personifies the bridge between nuclear and particle physics. With his strong intuitive approach based on a deep understanding of many branches of physics, he has made many fundamental contributions, and his involvement in what has become known as the 'PANIC' (Particles and Nuclei International Conference) series helped establish intermediate energy physics on the international research scene.

1991 JINR-CERN School of Physics

After a very successful CERN School of Physics in September in Palma de Mallorca, attended by students not only from the Member States but also Eastern Europe and Canada, the programme for the next JINR-CERN School has just been published. This will take place from 5-18 May in Alushta, Crimea, USSR. The topics covered will include Field Theory, Electroweak Interactions, QCD, Beyond the Stan-

Torlief Ericson receives his 60th birthday Festschrift from Achim Richter of Darmstadt.

(Photos Maurice Jacob)

Faculty Position in Experimental Particle Physics

York University

Applications are invited for a tenure track appointment as assistant or associate professor in the Department of Physics and Astronomy at York University. Applicants should have a Ph.D in physics, and postdoctoral experience with experimentation at high energy colliding beams. The successful candidate will be expected to pursue an active international career in experimental high energy particle physics, and to teach and supervise undergraduate and graduate students. York experimenters are currently helping construct the ZEUS ep collider experiment to search for quark and electron substructure at DESY in Hamburg, and are helping design SDC, to search for the Higgs boson at the new energy frontier provided by the TeV Superconducting Super Collider in Texas.

Applications should be sent to Professor Roman Koniuk, Appointments Committee Chair, York University, 4700 Keele Street, North York (Toronto), Ontario M3J 1P3. Deadline: 91/3/31.
(Tel: 416-736-2100 Ext. 66480)

In accordance with Canadian immigration requirements, this advertisement is directed to Canadian Citizens and permanents residents of Canada. York University has a policy of employment equity, including affirmative action for women faculty. This position is subject to final budgetary approval.

GROUP LEADER FAST ANALOG ELECTRONICS

The Continuous Electron Beam Accelerator Facility in Newport News, Virginia is searching for an electrical engineer or physicist to establish and lead a group charged with developing fast analog front end electronics to be utilized with various particle detectors. These detectors will be employed in the nuclear physics research program to be carried out at the 4 GeV superconducting electron accelerator now under construction.

Required is an applicable degree plus several years experience in development of such circuits for use in physics research. Additional experience in obtaining small scale industrial production of them would be useful. The group will be part of the CEBAF Physics Division and will be expected to work closely with the physicists developing the detectors.

We offer a very competitive total compensation package and a stimulating work environment.

For prompt consideration, please send resume, specifying position number **PR3102**, with salary history to: **Employment Manager, CEBAF, 1200 Jefferson Avenue, Newport News, VA 23606.**

CEBAF

The Continuous Electron Beam Accelerator Facility

An Equal Opportunity, Affirmative Action Employer.

DEPUTY GROUP LEADER PHYSICIST

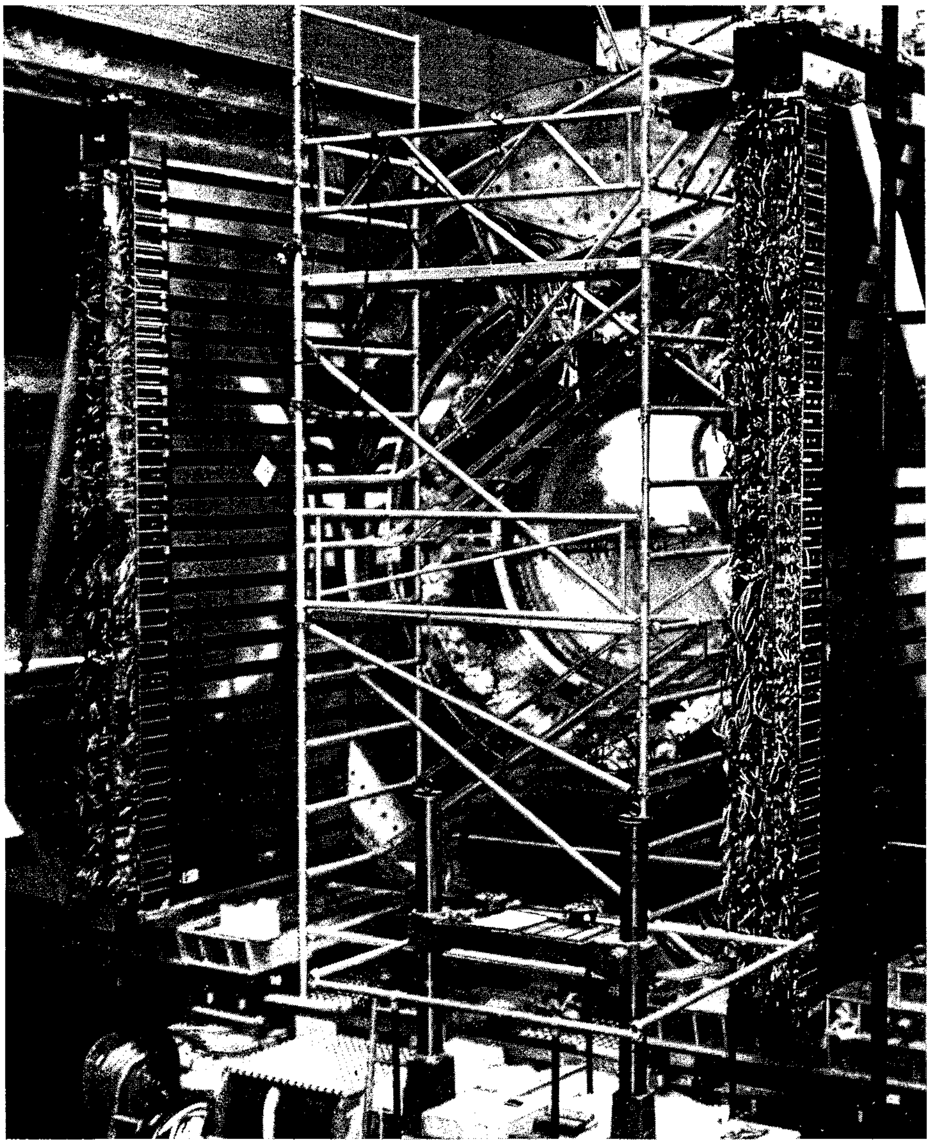
Join Argonne National Laboratory in the construction of its 7-GeV Advanced Photon Source (APS) Project. —A Project that will contribute to the development of new materials and impact industries worldwide.

Argonne is seeking a Physicist to provide physics design, analysis and testing of ultra-high vacuum systems for the APS particle storage ring, synchrotron and other associated subsystems. Candidate will also impart ideas and perform analytical/experimental procedures for the surface preparations of the APS vacuum chamber systems, and be responsible for the program of vacuum R&D as well as Deputy Group leader of the Vacuum/Mechanical Engineering Group.

A Ph.D. in Physics and at least ten years experience in accelerator vacuum chamber systems are required. Extensive knowledge of ultra-high vacuum physics and technology, surface physics and experimental techniques of surface science, and safety practices is necessary.

Outstanding challenges and an excellent compensation package are available. For confidential consideration, please forward resume to **Walter D. McFall, Box J-APS-0005-88, Employment and Placement, ARGONNE NATIONAL LABORATORY, 9700 South Cass Avenue, Argonne, IL 60439, USA.** Argonne is an equal opportunity/affirmative action employer. (Use your PC to learn more about ANL and other available opportunities. Dial (508)263-3857 and key in the password ARGON.)

ARGONNE NATIONAL LABORATORY • UNIVERSITY OF CHICAGO •



Installation of the uranium-scintillator calorimeter started recently for the Zeus detector at the HERA electron-proton collider soon to be commissioned at the DESY Laboratory in Hamburg. The picture shows the first modules of the forward calorimeter in place in front of the solenoid.

dard Model, Heavy Flavours and CP Violation, and Detectors; with additional lectures on collider physics, LEP results and astrophysics.

Further information from Miss S.M. Tracy, CERN School of Physics, CERN/DG, CH 1211 Geneva 23, Switzerland, e-mail tracy at cernvm.cern.ch , telex 419000 cer ch , phone + 41 22 767 27 24, fax + 41 22 782 30 11; or Mrs. T.S. Donskova, International Department, Joint Institute for Nuclear Research, 141980 Dubna, USSR, telex 412621 dubna su, phone +7 095 9262251/9262278, fax +7 095 2002283. Applications should be made immediately.

Fortran 90 book

The success of Fortran as the major programming language for scientific and numerical computing goes hand in hand with the steady evolution of the language. The X3J3 technical committee has worked in conjunction with an ISO committee to develop a new standard, Fortran 90, incorporating new features for supercomputer applications but retaining all the cherished ones.

A complete description is in a new book, Fortran 90 Explained, by Michael Metcalf of CERN and John Reid (Oxford University Press, 0-19-853772-7).

Pisa Semester

Called Infinite Dimensional Algebras and Algebraic Geometry, an International Semester, organized by Corrado De Concini and Victor Kac, will be held from January to June at the Scuola Normale Superiore in Pisa, with most activity in March, April and May. Topics covered will include Infinite Dimensional Algebra and Algebraic Geometry, Geometry of the Moduli Space of Riemann Surfaces, Conformal Field Theory and String Theory, Quantum Groups. Further information from Caterina D'Elia, Secretariat, Scuola Normale Superiore, Pisa, tel (+39) 50 597111, fax (+39) 50 563513.

Desktop synchrotrons

Compact synchrotron light sources are in demand for X-ray microlithography of a new generation of compact computer chips. IBM contracted Oxford Instruments to supply such a 'desktop' machine, while work at the US Brookhaven Laboratory is geared to developing a superconducting machine to supply 700 MeV beams.

A recent Brookhaven success was accelerating an electron beam, supplied by the booster also used for the US National Synchrotron Light Source, in a 200 MeV prototype compact synchrotron using room temperature magnets and measuring just four metres long and two across.

Correction

Particles and Fields '91, sponsored by the Division of Particles and Fields of the American Physical Society and the Division of Particle Physics, Canadian Association of Physicists, will be held from 18-22 August at the University of British Columbia, Vancouver. Contact PF91 Secretariat, TRIUMF, 4004 Wesbrook Mall, Vancouver, BC, Canada V6T 2A3, tel (604) 222-1047, fax (604) 222-1074, bitnet pf91 at triumfcl.

Francis Muller 1925-1991

With deep regret we learnt of the death of our dear friend and colleague Francis Muller on 1 January.

Francis came to CERN in 1962 from Leprince-Ringuet's Laboratory at the Ecole Polytechnique, Paris, where he had been working as part of the internationally-known group led by Bernard Gregory and Charles Peyrou. This group operated a cloud chamber at the Pic du Midi in the Pyrenees and made significant contributions to particle physics in the productive 1950s. During this time he spent a sabbatical year with Oreste Piccioni's group at the Berkeley Bevatron, where he made an important contribution to the problem of neutral kaon regeneration.

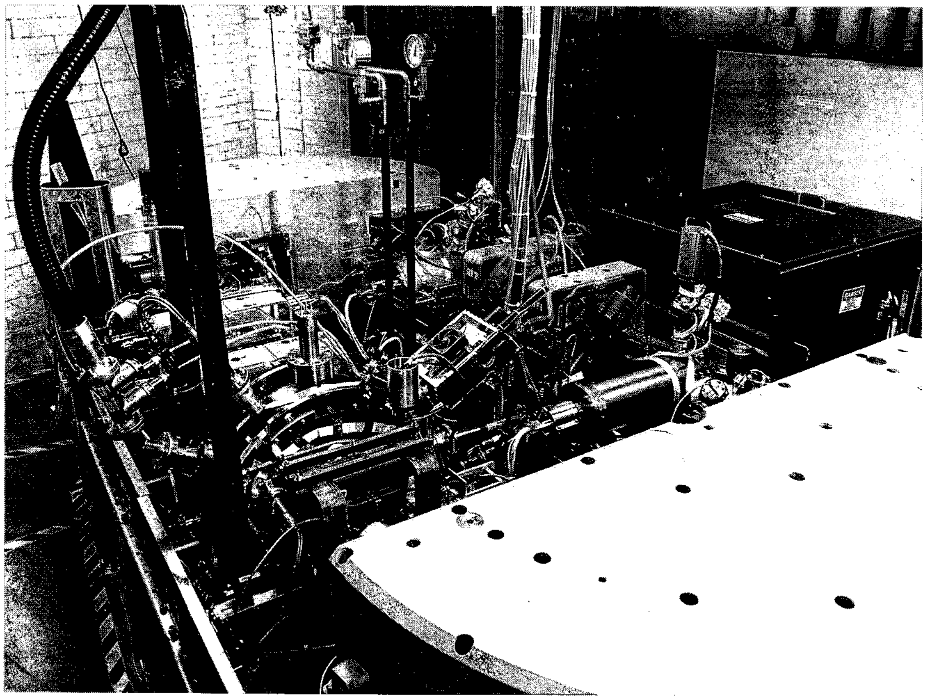
At CERN he joined the bubble chamber group and after helping to set up the first medium energy electrostatically separated beam at the CERN PS, concentrated on hyperon-antihyperon production by 3-4 GeV antiprotons in the Saclay 80cm hydrogen chamber. In particular he directed analysis leading to the discovery of an anti-ksi. Subsequently he worked with Max Ferro-Luzzi on resonances in positive kaon-proton reactions.

In 1971 he turned his attention to electronic techniques, participating in several ISR experiments with Carlo Rubbia, and helped in pioneer studies of the mass spectrum of the charmed lambda baryon. With the advent of the SPS proton-antiproton collider, he was part of Carlo Rubbia's UA1 collaboration which discovered the W and Z bosons. From 1984 he worked in a group studying charm and beauty production at the Omega spectrometer, also spending a year at SLAC, where he worked on beauty lifetime and B-meson mixing measurements with the MAC group.

In all these experiments, he brought his deep knowledge of physics and a mathematical prowess to help ensure their success. His love of nature and his extensive culture, particularly in history with his phenomenal memory, were much appreciated by all who had the fortune to know him. He was awarded the 'Legion d'honneur'.

His passing leaves a hole in our lives which cannot be filled.

His friends



Just four metres long and two across, this prototype synchrotron at Brookhaven is designed to provide 200 MeV electron beams, en route to a final 700 MeV superconducting machine for X-ray microlithography of compact computer chips.

17 keV neutrino?

Several laboratories report sighting evidence for a heavy 17 keV neutrino. More news next month.

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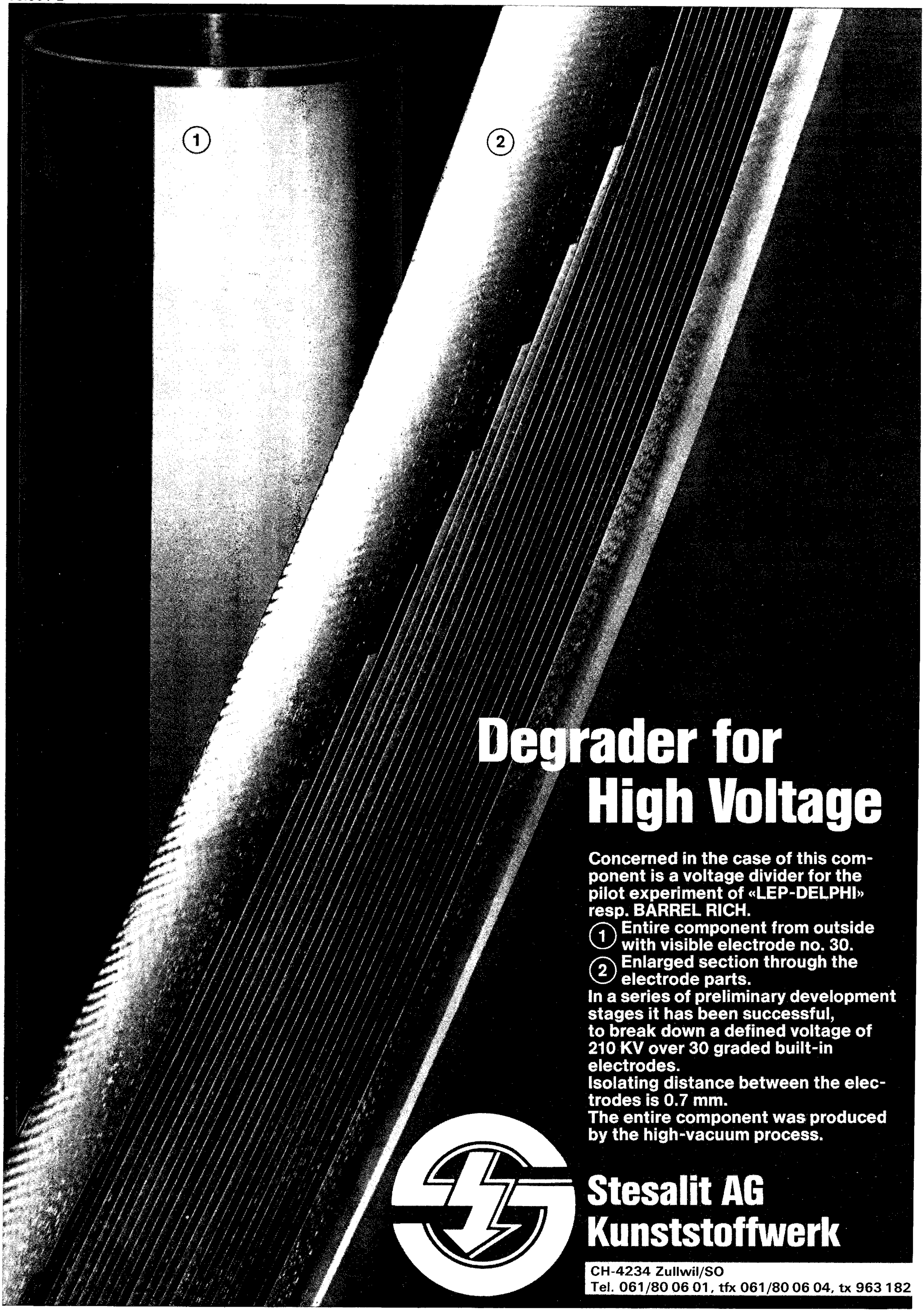
1
2
Degrader for
High Voltage
Concerned in the case of this component is a voltage divider for the pilot experiment of «LEP-DELPHI» resp. BARREL RICH.
1 Entire component from outside with visible electrode no. 30.
2 Enlarged section through the electrode parts.
In a series of preliminary development stages it has been successful, to break down a defined voltage of 210 KV over 30 graded built-in electrodes.
Isolating distance between the electrodes is 0.7 mm.
The entire component was produced by the high-vacuum process.
Stesalit AG
Kunststoffwerk
CH-4234 Zullwil/SO
Tel. 061/80 06 01, tfx 061/80 06 04, tx 963 182