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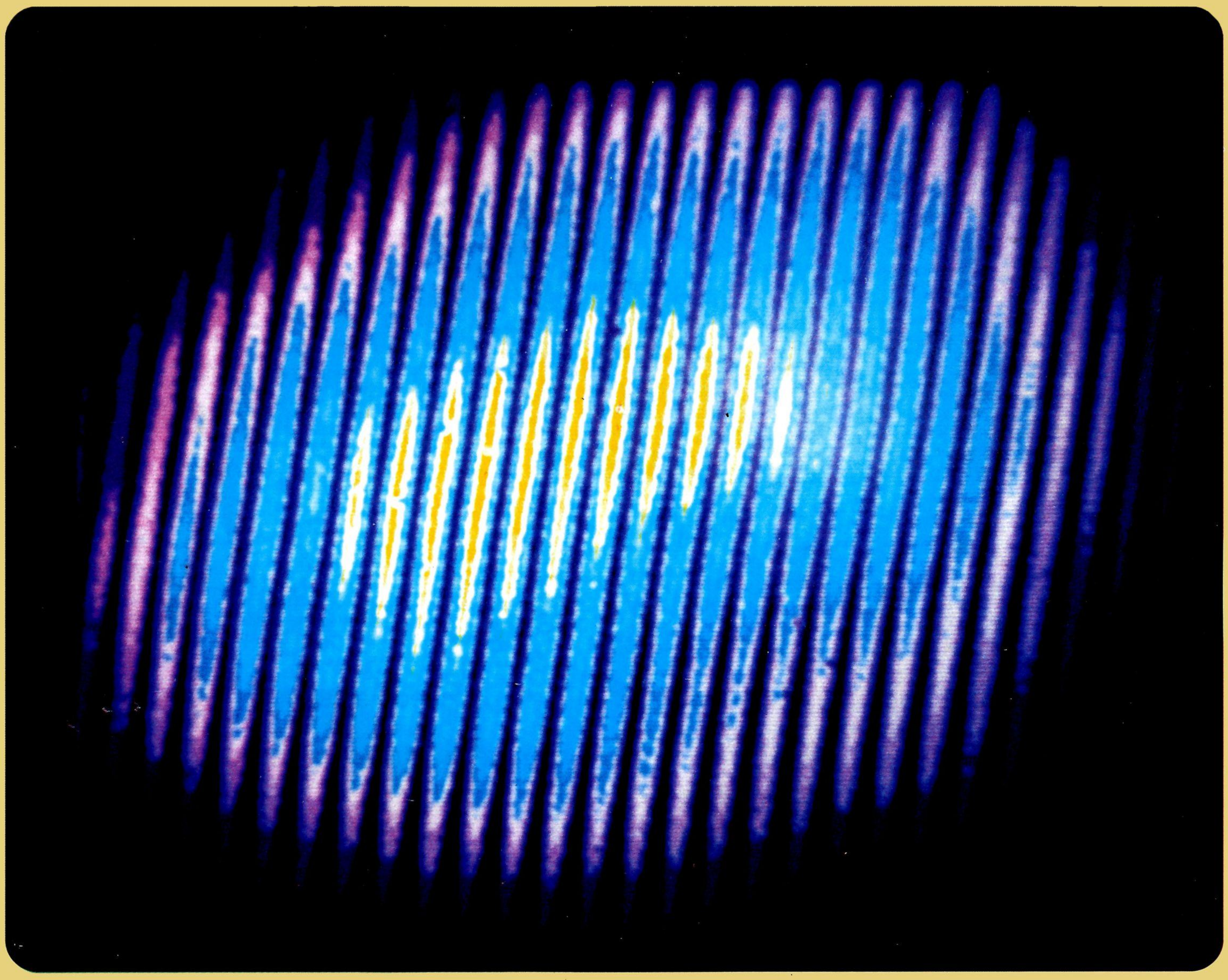

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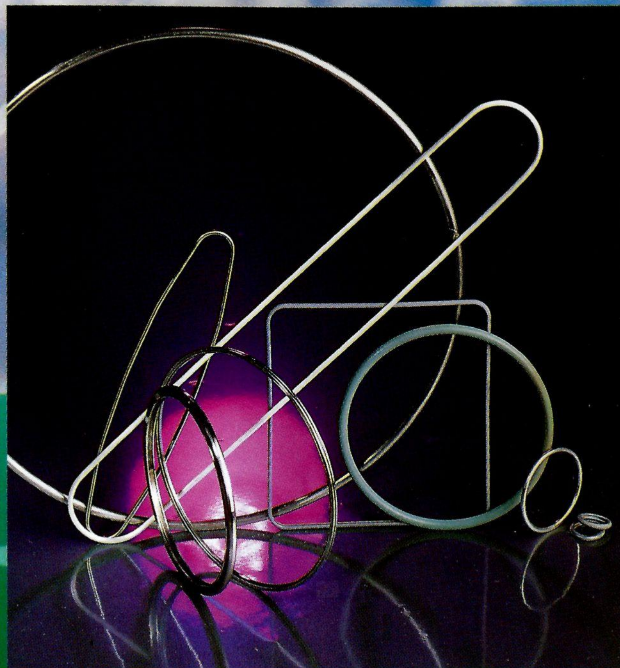

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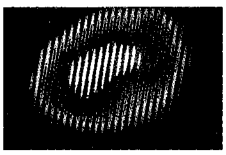
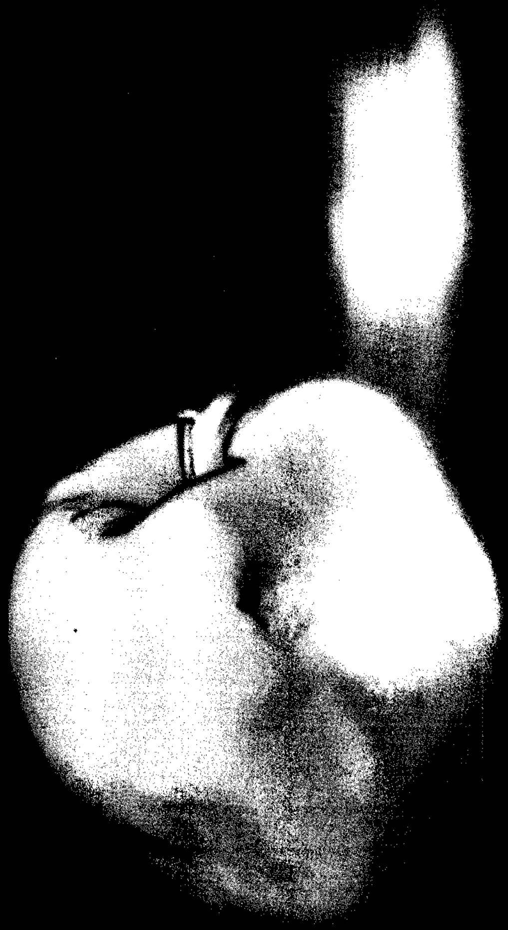


Cover photograph: How to measure tiny beams. An interference fringe pattern generated at the Japanese KEK Laboratory by overlapping two split beams from a YAG laser at a small crossing angle. The image was recorded by a CCD (Charge Coupled Device) camera and computer-processed to show its intensity histogram in colour. The fringe pitch is 200 microns. The first real monitor under design at KEK will use 0.5 micron pitch, allowing the electron beam size measurement down to 40 nanometres (see page 20).



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Neutrino sunshine

At the Neutrino 92 meeting held.in Grenada, Spain, from 7-12 June, Till Kirsten (left) of Heidelberg's Max Planck Institute gave a historic presentation of the first detection by the Gallex experiment of solar neutrinos from proton-proton fusion. Here he is with Angel Morales of Zaragoza, Chairman of the Conference Organizing Committee.

Neutrinos and 1492

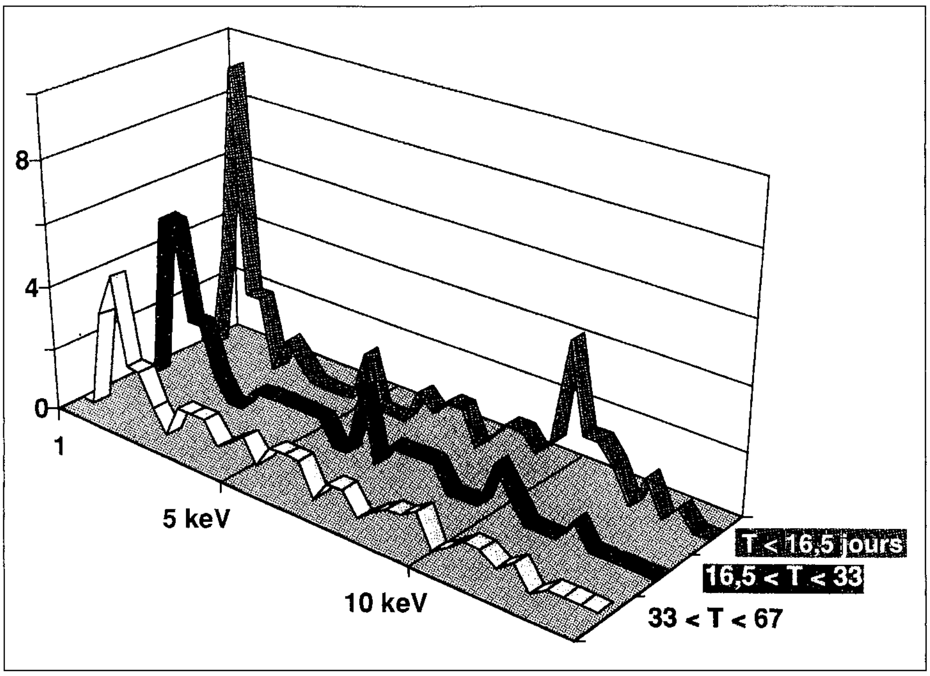
Particle physics seems to operate on a twenty-year cycle, suggested neutrino pioneer Fred Reines, introducing the international Neutrino 92 meeting in Grenada from 7-12 June. Twenty years ago, at the first meeting of this series, which took place at Lake Balaton, Hungary, participants had heard how Ray Davis had detected the first solar neutrinos in his giant tank of perchloroethylene. This year's meeting saw a second major solar neutrino milestone, with the Gallex gallium-based detector in the Italian Gran Sasso underground Laboratory reporting the first direct neutrino signal from the proton fusion chain which provides most of the sun's power.

This year, Spain is the scene of several major international events (Olympic Games, Seville Expo,....). Although Neutrino 92 was well down in this list, the meeting was held in the historic city of Grenada, where exactly 500 years ago the flag of Ferdinand and Isabella finally forced the surrender of the remaining Moorish bastion in Spain, marking the beginning of a new era of national history. One immediate outcome was Columbus' epic voyage westwards.

Most of the Sun's energy comes from the fusion of protons into deuterium. Sunshine is necessary for life, but the first evidence for the neutrinos which accompany and explain this basic process still makes science history. This result naturally dominated the Neutrino 92 meeting, held in Grenada, Spain, from 7-12 June. The talk, by Till Kirsten of Heidelberg's Max Planck Institute, formed part of a special solar neutrino session, with presentations from all experiments presently looking at this physics, and from theorists doing the complicated calculations on solar fusion.

It was in 1970 that Ray Davis and his team began taking data with a tank of 615 tons of perchloroethylene (dry cleaning fluid) deep underground in the Homestake gold mine, South Dakota. Some solar neutrinos convert chlorine nuclei into argon, and the count rate is determined by delicate radiochemical analysis.

For 20 years, the signal from this detector has been consistently below the value expected from calculations, hence the famous 'solar neutrino problem'. To explain this dearth of solar particles, new mechanisms have been put forward. Classically,



The footprint of neutrinos from proton-proton fusion deep inside the Sun. The active medium in the Gallex solar neutrino detector is gallium, where neutrino interactions produce germanium-71. This shows the characteristic initial signal of the detected germanium (rear curve) with two peaks and its subsequent radioactive decay with a half-life of about 16 days.

neutrinos come in three immutable types - electron, muon, and tau - according to their parentage. Those from the Sun should be electron-type. However under certain conditions, such as those deep inside the sun, neutrinos could oscillate between these three states, producing a marked change in solar neutrino composition

At Grenada, Kenneth Lande of Pennsylvania presented the latest results from the chlorine-based detector in the Homestake mine. Their signal is interpreted as coming from two solar process, one involving electron capture in beryllium-7, the other boron-8 decay. The count rate is consistently about one every two days, only about a half of what the calculations predict. New insights could come from a new project by this group, using an iodine-based detector sensitive to other areas of the solar neutrino spectrum.

The second major detector to look at this problem was the Japanese Kamiokande group, picking up Cherenkov light from neutrino interactions in some 700 tons of water. This detector was originally constructed to look for proton decay, and sees directional signals. A larger version ('Superkamiokande') is being prepared (May 1991, page 9). At Grenada, Kenzo Nakamura of Tokyo presented results from an improved Kamiokande set-up. Sensitive to the boron-8 process, this detector sees about 60 per cent of the expected signal. This boron fix is helpful to the Homestake mine team, who see a mixture of two solar processes.

However the majority of solar neutrinos come from the fusion of protons into deuterium. To get at this signal, two big new detectors, using gallium, have been built and commissioned in the last few years These are SAGE ('Soviet'-American Gallium Experiment) in the Baksan Neutrino Observatory, and Gallex, a collaboration from France, Germany, Israel, Italy and the US with a detector in the Italian Gran Sasso underground Laboratory.

The SAGE detector now uses 57 tons of gallium metal, although initial exposures used less, and there have been contamination problems. At Grenada, SAGE progress was covered by Tim Bowles of Los Alamos. With the analysis not yet complete it was too early to present a final number. Initial results already published (March, page 11), did not see a substantial signal, but this data is currently being reexamined.

And so to Kirsten's historic paper. Gallex data-taking, using 30 tons of gallium (as gallium chloride solution) began in May 1991, with 15 distinct exposures ('runs') ending in April. The experiment sees a clear signal for the neutrino conversion of gallium-71 to germanium-71 equivalent to about 83 'Solar Neutrino Units' (SNU).

Following Kirsten at Grenada came John Bahcall of Princeton, who has made a speciality of solar neutrino calculations. The total signal expected is about 132 SNU, of which 71 come from the proton-proton process, the remainder from heavier nuclei. Bahcall called for a laboratory investigation of beryllium-proton reactions to help clear up some of the uncertainties inherent in the calculations.

With the Gallex result still compatible with missing neutrinos, Bahcall said 'if you believed in new physics before Gallex, you should not be disappointed.'

Solar neutrinos are not the easiest things to calculate, and Sylvaine Turk-Chieze of Saclay described some alternative approaches which slightly reduce the expected signal.

In a continuation of the solar neutrino session, Sergei Petcov (who wrote the excellent solar neutrino article we published last year - May 1991, page 16) compared the suppression rates for the different

observed processes, and speculated on a connection between suppression of solar neutrinos and their energy.

Introducing the conference, Sheldon Glashow of Harvard alluded to the new solar neutrino results which everyone was eagerly waiting for. 'Does the Sun sputter?', he asked. 'Are there periodic or even chaotic fluctuations inside the Sun?' This message was relayed by Alvaro de Rujula of CERN in a final ('inconclusive') talk. Despite some solar properties being very well understood, the Sun could be more complicated than we think.

Other Grenada results

After the introductory talks, the Grenada meeting opened with a heavyweight review of neutrino properties by Alexei Smirnov of Moscow (one of the authors of the resonating neutrino oscillation idea). The minimal neutrino scenario is where all three types are massless and they do not mix. Smirnoff pointed to plenty of suggestions that this is not the case, but so far the minimal scenario cannot be excluded.

A series of talks underlined the improving limits on neutrino mass, particularly for the lightest, the electron-neutrino. Several experiments in fact come in with a negative result for the square of the mass, with mass limits deduced to be less than about 10 electronvolts. A new result comes from an experiment at Mainz with an electrostatic spectrometer, reported by Jochen Bonn, giving a mass less than 7.2 electronvolts.

The 17 keV neutrino has been a dilemma for several years, with signals coming in from several experiments using semiconductor detectors, but no sign with magnetic spectrometers. (De Rujula describes this neutrino as 'magnetophobic'.) At Grenada, 17 keV neutrino proponent Andrew Hime of Los Alamos presented the latest evidence in favour, but admitted to be 'baffled' by initial negative reports from a new experiment still being analysed at Argonne.

Anti-17keV, Felix Bohm of Caltech had a lot to talk about, and pointed to the best limits coming from the recent experiment at the Japanese KEK Laboratory (April, page 15). The feeling at Grenada was that the credibility of the17 keV neutrino is, at least temporarily, diminished

Following the 1987 supernova, neutrinos now also have astrophysics status, and many new studies are now equipped, or are being equipped to look for neutrinos from outer space. Next time a near supernova goes off, there will be a lot of detectors looking at it.

John Learned of Hawaii sketched the impressive world-wide effort in this field, with neutrino telescopes sited underground, in lakes, in seas and oceans, and in the South Polar ice cap. Barry Barish of Caltech and Piero Galeotti of Turin described initial results respectively from the Macro and LVD underground detectors in the Gran Sasso Laboratory.

As well as solar neutrinos, the Japanese Kamioka detector sees neutrinos from cosmic ray interactions in the atmosphere. Yoji Totsuka of Tokyo described these as 'junk events' in the experiment's original search for proton decay. However atmospheric muon-type neutrinos appear to be reduced by about 40 per cent, suggested by some as evidence for neutrino oscillations. With several detectors now looking at it, this effect persists, concluded Totsuka.

With overwhelming evidence for most of the Universe being made of as-yet invisible 'Dark Matter', neutrino technology and thinking provide useful levers in this continuing search. This work got good coverage at Grenada.

Neutrino beams provide a major part of the diet for experiments at high energy accelerators. Talking point in this sector was a heroic presentation by an injured Sanjib Mishra of Harvard on double interactions seen in neutrino interactions by the CCFR detector at Fermilab's Tevatron.

In a careful analysis of 750,000 events, they see about nine candidates for contained double interactions, which could be interpreted as the primary neutrino interaction producing a second, much heavier, particle. The experiment has had these events for some time, but they have not been talked about before undergoing exhaustive data analysis.

Another new neutrino result came in initial data from the KARMEN experiment at the ISIS machine at the UK Rutherford Appleton Lab, which sees neutral current excitation of nuclei.

For completeness, the Grenada meeting also contained ample coverage of ongoing physics away from the strictly neutrino sector, with latest results from the four experiments at CERN's LEP electron-positron ring, and several other major studies. Here the Standard Model reigns supreme, and the results will come under detailed scrutiny at this summer's major high energy physics meeting in Dallas in August.

Neutrino physics is always interesting, but rarely moves quickly, with new results taking some time to

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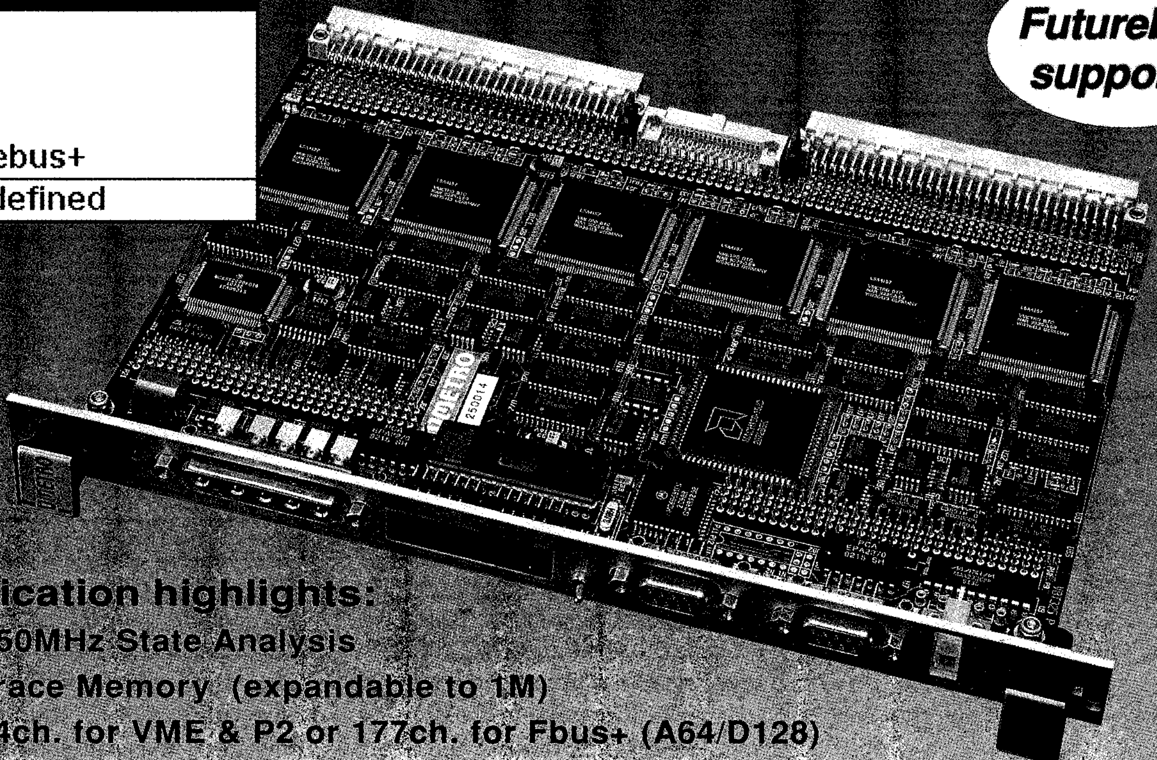

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Towards SSC machine and detectors

consolidate. 'Many of us have been coming to neutrino conferences for years waiting for something to happen,' remarked Sheldon Glashow in his introductory Grenada talk - 'Neutrinos, the endless frontier'. At Grenada, they were not disappointed.

Neutrino 92 was organized by a committee under Angel Morales of Zaragoza.

By Gordon Fraser

Massive neutrinos

A book which is certainly of interest to neutrino specialists is 'The Physics of Massive Neutrinos' by Felix Boehm and Petr Vogel of Caltech, published by Cambridge University Press (ISBN 0 521 41824 0 hardback, and 0 21 42849 1, paperback), now available in its second edition. Both authors gave presentations at the Grenada 92 meeting, Boehm on 'Not finding the 17 keV neutrino', and Vogel on 'Nuclear physics and the detection of solar neutrinos and dark matter'.

A stab in the back...

On June 17, just after the July/August issue of the CERN Courier went to press, the physics world was shocked and stunned by an unexpected vote by the US House of Representatives to kill the Superconducting Supercollider project, now under construction in Ellis County, Texas.

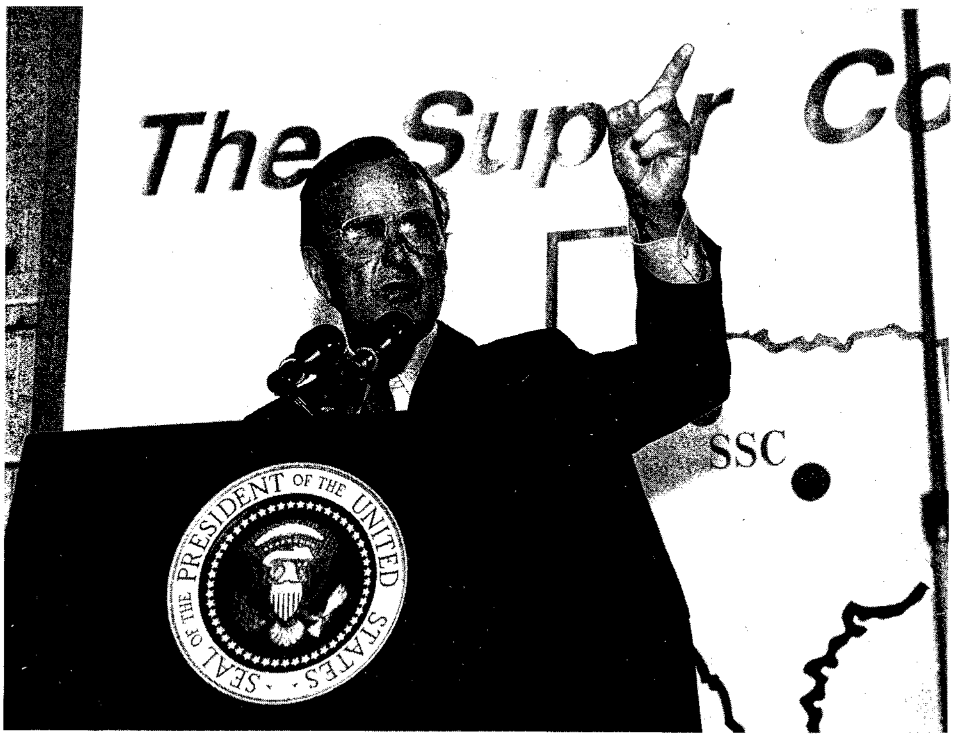
By a 232-181 majority, a House preoccupied with balancing the US budget excluded any significant ongoing SSC funding in a big package of energy-related items.

CERN management immediately issued a statement saying that it was 'shocked by the vote, and hopes that it will be reversed lest it creates an alarming vacuum in an important field of scientific research'.

'European high energy physicists have maintained excellent relations in scientific cooperation with their American colleagues and have shared freely the use of larger facilities,' the statement continued. 'In that spirit, CERN's project for a Large Hadron Collider and the US SSC were from the start intended as complementary machines. Both Europeans and Americans have been engaged for years in friendly competition on the fascinating road towards the discovery of the most basic constituents of matter. There is no doubt that cancellation of the SSC would adversely affect the progress of knowledge in the field of elementary particle physics.'

The fate of the SSC was in the hands of the US Senate, and on 3 August the pro-SSC motion was voted in, 62-32..

...and a pat on the back



On 30 July, shortly before the pro-SSC Senate vote, US President George Bush visited the Superconducting Supercollider (SSC) Laboratory in Ellis County, Texas, saying 'I will fight hard and continue to fight hard for the Supercollider'. After alluding to Columbus' voyage five hundred years ago, the President continued 'Our adventure is not to sail the open ocean, but rather to go to the edge of the Universe and see birth of space and of time. Our vessel is not called Santa Maria. It is the Supercollider.'
(Photo John Bird)

Several milestones in machine construction and in preparations for the experimental programme have been reached at the Superconducting Super Collider (SSC) Laboratory recently.

On site, the first access shaft, at the N15 area on the western edge of the future ring, has been excavated using a converted offshore drilling rig. From there, horizontal tunnels emerge and a boring machine is heading off to carve out the first 4 kilometres of the ring tunnel; this sector will be turned over to the Lab late next year. Of the nine contracts for boring the 85-kilometre tunnel, three have already been placed. The last sector of the tunnel will be handed over by the end of 1996.

Construction of the linac, traditionally the first element of any accelerator, started in June. More significantly, preparations are complete for the 'Accelerator Systems String Test' (ASST), where a 220 m long building at N15 houses an SSC half-cell of five 17-metre superconducting dipoles, a superconducting quadrupole, and spoolpieces (the spaghetti junctions of the machine where the cryogenic and power connections are made and which contain recoolers, corrector magnets and beam monitors).

Dipoles are now performing comfortably above specification and all five dipoles in the string test were industrially produced. The superconducting quadrupole is a first prototype; it also met expectations when tested at Brookhaven. The cold mass was assembled at Berkeley and the cryostat at the SSC Laboratory with industrial partner Babcock and Wilcox.

The vacuum system and all power supplies will also be operated in the string test. A large cryogenic plant is in action alongside the ASST; it is the first of ten such stations which will cool the Collider. Cooldown of the magnets for the string test began in June and they are expected to be powered ahead of the scheduled 1 October date.

The ASST building can take up to 20 dipoles, equivalent to two full cells, and can be used for further tests on magnet performance and on magnet installation procedures.

The first of the big detector collaborations, the Solenoidal Detector Collaboration (SDC - March, page 13), presented its Technical Design Report in April and had its first-stage review. It had benefited from a strong research and development programme funded by the Laboratory and by the Texas National Research Laboratory Commission (TNRLC). The review went well, though construction funding has yet to be finalized.

SDC hopes to have the green light at the second-stage TDR review in good time for construction to start at the end of the year. Construction is anticipated to take four years, followed by three years of installation and testing at the machine, so that the SDC detector will be ready to start physics when beams are available in 1999. There are now over 900 physicists and engineers in the collaboration; Tom Kirk has been appointed SDC project manager.

The second large detector collaboration, GEM, which came together later, hopes to have its TDR ready in October. To be ready for action at the machine startup, the GEM collaboration, now numbering over 600 physicists and engineers, are keen to start building their mighty magnet as soon as possible. For both the machine and detectors, international involvement is high on the agenda. Interlaboratory agreements are in place, or are being negotiated, between the SSCL and national Laboratories in China, India, Japan, Korea, and Russia.

They cover such items as the Low Energy Booster (LEB) magnets, correctors, injection elements and magnet measurements from Novosibirsk, who will also build the radiofrequency cavities for the Medium Energy Booster (MEB) and possibly the Booster r.f. power supplies. Magnet power supply modules and quench protection heater supplies are being discussed with the Efremov Institute. There are now discussions with the Institute of High Energy Physics, Serpukhov, near Moscow, home of the UNK machine, about the supply of dewars, cryogenic transfer lines and use of magnet test facilities. Other possible items from Russia include the ceramic vacuum chamber for the LEB and steel for the SDC detector.

A meeting in Beijing in May brought together SSC collaborators from Asia. China will supply the cavity coupled linac, a superconducting dipole corrector for the High Energy Booster (HEB), and possibly the magnet supports for the HEB and Collider. Discussions are underway on the supply of substations and 69 kV cable. India will supply the corrector and beamline magnets for the linac. There are negotiations with Korea on the building of the MEB dipoles, while intense discussions are underway with Japan with a view to a major contribution.

While work on the machine and detectors pushes ahead, the second declared aim of the SSC Laboratory has not been neglected. This is to serve as a national resource for science education in response to the clear need for improvements in the teaching of science, mathematics and technology. With the support of the TNRLC, a strategic plan for science education at SSCL has been prepared.

The plan has ambitious aims for the development of education programmes for schools, colleges, universities and the general public and for establishing an education complex on the Laboratory campus, including a 'Colliditorium' exhibition hall and a hands-on hall of science and engineering.

Much has already been done, ranging from operating a Ph.D. programme in accelerator science, to direct contact with over 20000 students in schools throughout the country conveying information about the SSC. 200 students participate in the work of the Laboratory this summer.

The most impressive activity so far has been the development of a curriculum for schools from pre-kindergarten to ninth grade (young teenagers). It aims to introduce the excitement of physics and to teach some of the basic concepts of science and mathematics leaning heavily on the work of the SSC. A written curriculum covering up to fifth grade has had a pilot test and an improved version will soon be used in a second pilot test with strong external evaluation. The programme has the name 'Adopt a Magnet' because completion of a curriculum entitles the school to have its name on one of the Collider magnets. The students will know its location in the ring and will receive news 'from the magnet' about progress at the Laboratory. There has been incredible demand to participate in the programme from throughout the USA and from schools in Canada, Japan, Mexico, the Philippines, South Africa, Sweden and Switzerland.

An interactive version of the programme is being developed by Threshold Communications, who are investing $2 M in the project. Four interactive compact discs will be prepared by the end of 1994 aimed at Elementary, Junior High, High School and the general public.

Superconducting magnets in the SSC ASST Facility. A string of five 17-metre dipoles, a quadrupole and spool pieces, together with associated vacuum and power supplies, are now under test. This photograph was taken at a preinstallation stage when the superposition scheme for the separate dipoles to carry the two proton beams was being investigated. The actual tests will use a single magnet string. The ASST simulates the ring tunnel exactly except for the curved roof; note the curvature of the tunnel visible in the slight arc of the lights.

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Making history

While the Standard Model is still the unchallenged picture of modern particle physics, a recent international symposium showed how it nevertheless goes back long enough to have become science history.

The International Symposium on the History of Particle Physics, held at the Stanford Linear Accelerator Center (SLAC) from 24-27 June, and entitled 'The Rise of the Standard Model' attracted a wide audience - teachers, sociologists and science historians as well as physicists. The list of speakers included nine Nobel prizewinners.

Under the imaginative guidance of scientist and science writer Michael Riordan of SLAC and physics historian Lillian Hoddeson of Illinois, the symposium traced the beginnings and evolution of the Standard Model - the twin picture which rather brutally pairs the electroweak unification of electromagnetism and weak interactions on one hand with the quantum chromodynamics field theory of quarks and gluons on the other.

The timespan covered by the Symposium - up to about 1980 - did not include the ultimate triumphs of the Standard Model, with the discovery of the W and Z carriers of the weak force at CERN in 1983 and the confirmation by CERN's LEP electron-positron collider that everything is in high precision order.

The Rise of the Standard Model is marked by a series of momentous experimental milestones - the J particle at Brookhaven in 1974 (Sam Ting); the psi particle and charmed mesons at the Mark I detector at SLAC's SPEAR ring from 1974 to 1977 (Gerson Goldhaber); the tau lepton, a saga which began in 1970 at SLAC and still continues (Martin Perl); the upsilon at Fermilab in 1977 and the subsequent elucidation of the fifth quark (Leon Lederman); CP violation at Brookhaven in 1963 (James Cronin); neutrino beams in the early 1960s (Mel Schwartz); neutral currents at CERN in 1973 (Don Perkins); weak-electromagnetic interference at SLAC in 1979 (Charles Prescott); baryon and meson spectroscopy culminating in the discovery of the omega minus at Brookhaven in 1963 (Nick Samios); quark scattering at SLAC in 1967 (Jerome Friedman); hadron jets and the discovery of gluons at DESY in 1979 (Sau-Lan Wu).

The International Symposium on the History of Particle Physics, held at the Stanford Linear Accelerator Center (SLAC) from 24-27 June, and entitled 'The Rise of the Standard Model' brought together science historians and philosophers as well as particle physicists. Left to right, Science philosopher Michael Redhead of Cambridge, Symposium co-chairman and science historian Lillian Hoddeson of Illinois, and science historian Robert Seidel of Los Alamos.

All these discoveries needed the right accelerators to provide the particle beams and the right detectors to see the outcome. Burt Richter spoke on 'The Rise of Colliding Beams', Kjell Johnsen covered CERN's Intersecting Storage Rings, and Robert Wilson the creation of Fermilab, while Roy Schwitters, speaking from the Superconducting Supercollider Laboratory via a voice link, outlined the development of today's large detectors for colliding beam machines.

But the Standard Model is a theory, albeit not of the most elegant kind. The theoretical side was covered by Makoto Kobayashi (mixing in a six-quark picture), Martinus Veltman and Gerard 't Hooft (the momentous realization that the electroweak theory is renormalizable, allowing consistent calculations to be made), Steven Weinberg (the electroweak theory itself), David Gross, Leonard Susskind and Alexander Polyakov (the role played by quarks in quantum chromodynamics), Harry Lipkin (the quark model), Sidney Bludman (neutral currents), and James Bjorken (the characteristic scaling of quark interactions).

Add to this perceptive and entertaining comment by historians and sociologists. An evening discussion on science policy and sociology gave much food for thought, while the following day a panel discussion of spontaneous symmetry breaking mechanism included Peter Higgs and Robert Brout, who looked back to around

Standard Model Dynamics

Dynamics of the Standard Model is the title of a new book from Cambridge University Press by John F. Donoghue, Eugene Golowich and Barry R. Holstein (ISBN 0 521 36288 1). The underlying theoretical ideas of the Standard Model are covered in many books, but this one concentrates instead on the techniques which link the model to observable physics.

The book is the second in the Cambridge series of Monographs on Particle Physics, Nuclear Physics and Cosmology after Klaus Winter's recent title on Neutrino Physics (March, page 24).

1964, when they and other specialists were exploring how to avoid the massless (Goldstone) bosons which were plaguing attempts at symmetry breaking. Yoichiro Nambu and Jeffrey Goldstone had originally been scheduled for the discussion but were unfortunately unable to attend.

In all, a meeting which will be long remembered.

Neutral currents and spontaneous symmetry breaking, two pillars of the Standard Model. At the SLAC History Symposium Don Perkins of Oxford (right) covered the discovery of the neutral currents at CERN in 1973, while Peter Higgs of Edinburgh took part in the panel discussion on spontaneous symmetry breaking.

Installation is well underway for the first of the two main superconducting linacs for the Continuous Electron Beam Accelerating Facility (CEBAF) in Newport News, Virginia. With first physics scheduled to start in Spring 1994, CEBAF's science will use intense continuous electron beams of up to about 6 GeV to explore the middle ground between conventional nuclear physics, viewing the nucleus as a bound state of protons and neutrons, and the particle physics picture of nucleons as assemblies of quarks and gluons. With this nuclear-particle interface not well understood, the CEBAF physics programme could go on to reveal important new insights.

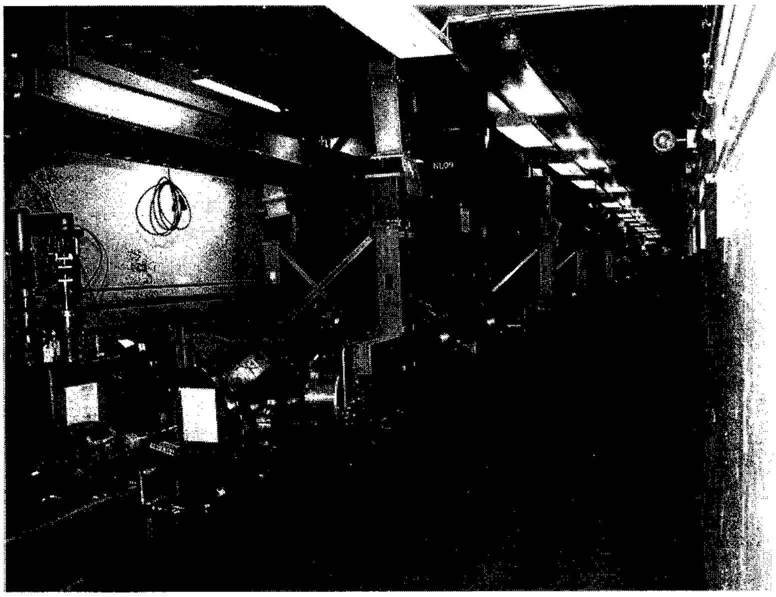
CEBAF also introduces US nuclear physics research to a new scale of operations, with large experimental halls housing big spectrometers of a size usually seen only in particle physics Laboratories.

With construction almost complete, CEBAF breathed a collective sigh of relief with a decision by a special subcommittee of the US Department of Energy's Nuclear Science Advisory Committee to recommend a basic annual operating budget of $55 million. This was considerably up on a figure which had somehow been on the books for several years, but was never considered realistic by CEBAF. Despite the applause greeting the new operating budget figure, Laboratory Director Herman Grunder sees it only as the minimum that the gleaming new facility would need.

Following the successful testing of the injector (July, page 11), several cryomodules per month are being installed for the first (North) linac. (Each cryomodule contains four twin-cavity cryounits.) Installation work for the 42.25 cryomodules for the

prepares its debut

Installation of cryomodules for the CEBAF Continuous Electron Beam Accelerator Facility, Newport News, Virginia, is running ahead of schedule.



complete machine (2 antiparallel linacs) is running ahead of a schedule which foresees 800 MeV beam from a single pass (one revolution) in 1994, and multi-pass (several revolution) beams by the end of that year.

The CEBAF design uses two antiparallel linacs linked by semicircular arcs. Each time the beam passes through a linac, its energy is increased, calling for a recirculating arc with correspondingly higher bending power. Beam will be recirculated five times.

The electron beam energy depends on two things - the installed accelerating power and the number of times the beam is recirculated. Energy could be boosted by installing additional accelerating power in the linacs, but this costs money. An earlier design had foreseen only four recirculations, but a subsequent compromise solution introduced a fifth circuit. A multi-pass solution also increases the possibilities for multi-energy operation, with beams being tapped from different recirculating arcs.

CEBAF will have one klystron driving each superconducting accelerating cavity for optimal control and flexibility. The cryogenic system will operate at 2K, and will eventually be the world's largest at this temperature.

The superconducting niobium cavities, supplied by Interatom in Germany, are carefully prepared and processed at CEBAF before being fitted into cryostats. This careful treatment also benefits from experience, so that now cavity resonance and accelerating gradient performance almost invariably exceeds design specifications (2.4 x 109 and 5 MeV/metre respectively), sometimes by an impressive margin. Electron beams around 6 GeV, rather than the conservative 4 GeV design figure, are now confidently predicted.

CEBAF will have extracted beams of independent intensity and energy feeding the three major experimental halls. The beams could be tapped from any one of the recirculating arcs as well as the end of the linac. The initial recirculating experiment using the injector has confirmed that potentially troublesome beam break-up (analogous to coupled bunch instabilities in a conventional storage ring) is mastered using the higher-order mode damping developed at Cornell and built into CEBAF's cavities.

Polarized beams would be an integral part of CEBAF's programme and work is going ahead for a polarized injector using a laser-irradiated photocathode. This work benefits from investigations at the University of Illinois, and polarization specialist Charles Sinclair has recently moved across from SLAC to CEBAF.

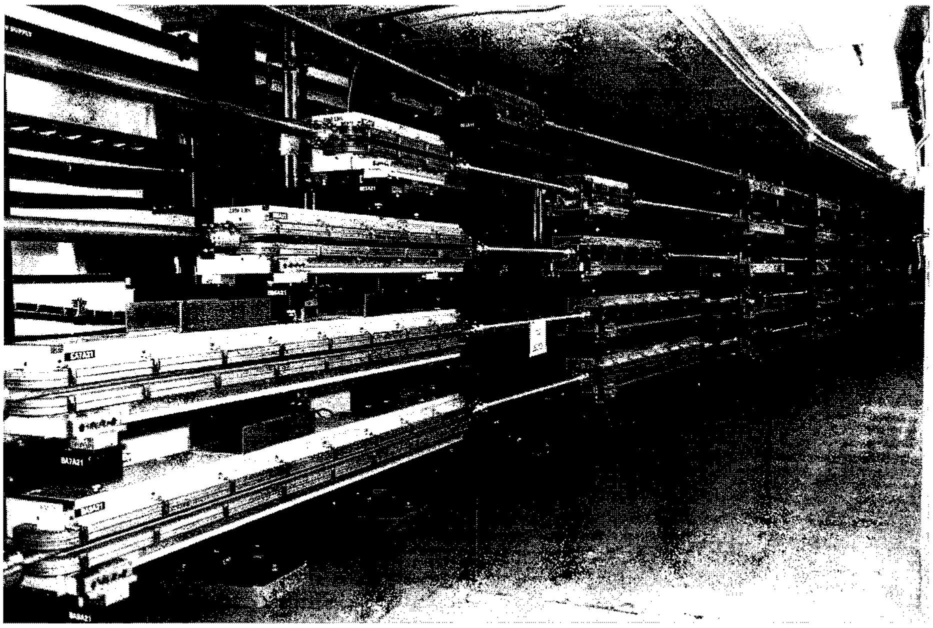
Under a Department of Energy directive to work for technological R&D work and technology transfer, CEBAF is proposing a free-electron laser facility, with some funding from industrial partners. The State of Virginia has also indicated its interest, although this would be contingent on Federal funding. The FEL could operate both in the infrared and ultraviolet regions, using electron pulses diverted from the injector and one linac arm respectively. It would not interfere with the physics programme.

Equipped with complementary spectrometers, the three CEBAF experimental halls will house a wide physics programme which should help crumble traditional barriers between particle and nuclear physics. The barriers are administrative as well as scientific.

An important initial scientific milestone is a special workshop on parity violation studies using polarized electron beams. This will propose guidelines for how these important experiments can be approached.

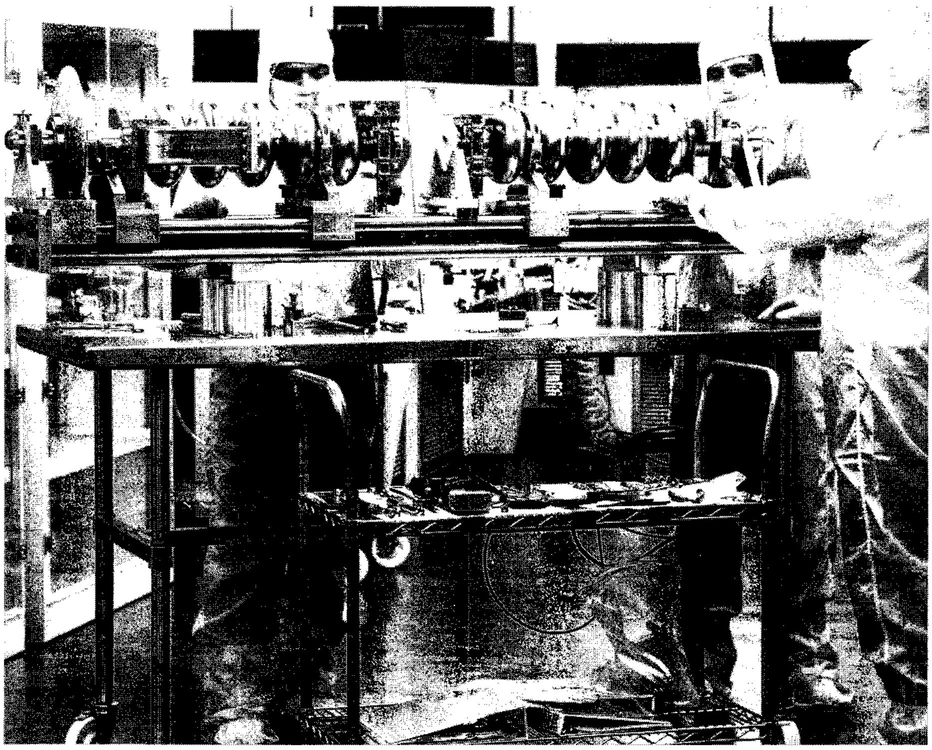
The central objective is to investigate what basic quark-gluon

Electrons will be recirculated five times in CEBAF to attain their maximum energy. The recirculating arcs have to bend progressively higher energy beams on each turn.



field theory can say about the uncanny stability of nucleons composed of three quarks, and vice versa. The unfashionability of this kind of physics in recent years has not been helped by restricted experimental possibilities. However periodic hints from experiments using nuclear targets or polarized beams have kept interest alive.

At CEBAF, two halls will be equipped with large spectrometers to



CEBAF's superconducting niobium accelerating cavities, supplied by Interatom in Europe, undergo careful treatment and surface processing at CEBAF before final installation. (Photo Frank Hoffman)

Stimulating science

At CEBAF, BEAMS stands for Becoming Enthusiastic about Math and Science. The people at CEBAF, as at other major US Labs, are concerned about science education in the US. BEAMS is a partnership between CEBAF and local schools in which young teenagers and their teachers visit the Lab for a chance to supplement their normal school curriculum with direct exposure to modern science and its environment. This year, 1250 students and 50 teachers are taking part, but these figures could eventually be doubled. To extend this effort to the whole of the United States would need about 1500 science centres.

This summer, seven national US Labs opened their doors to outstanding high school students to carry out research under the US Department of Energy's High School Science Honors Program. As well as 373 US students, the intake also included 41 students from foreign countries.

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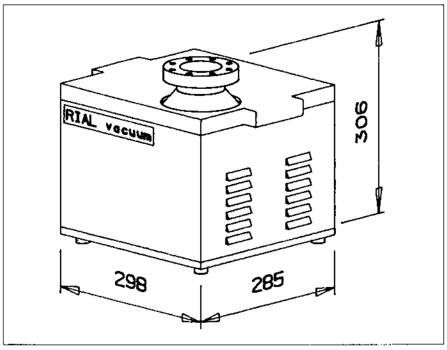

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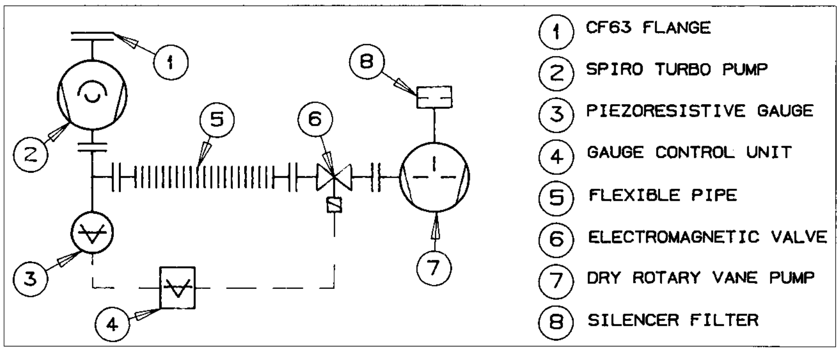

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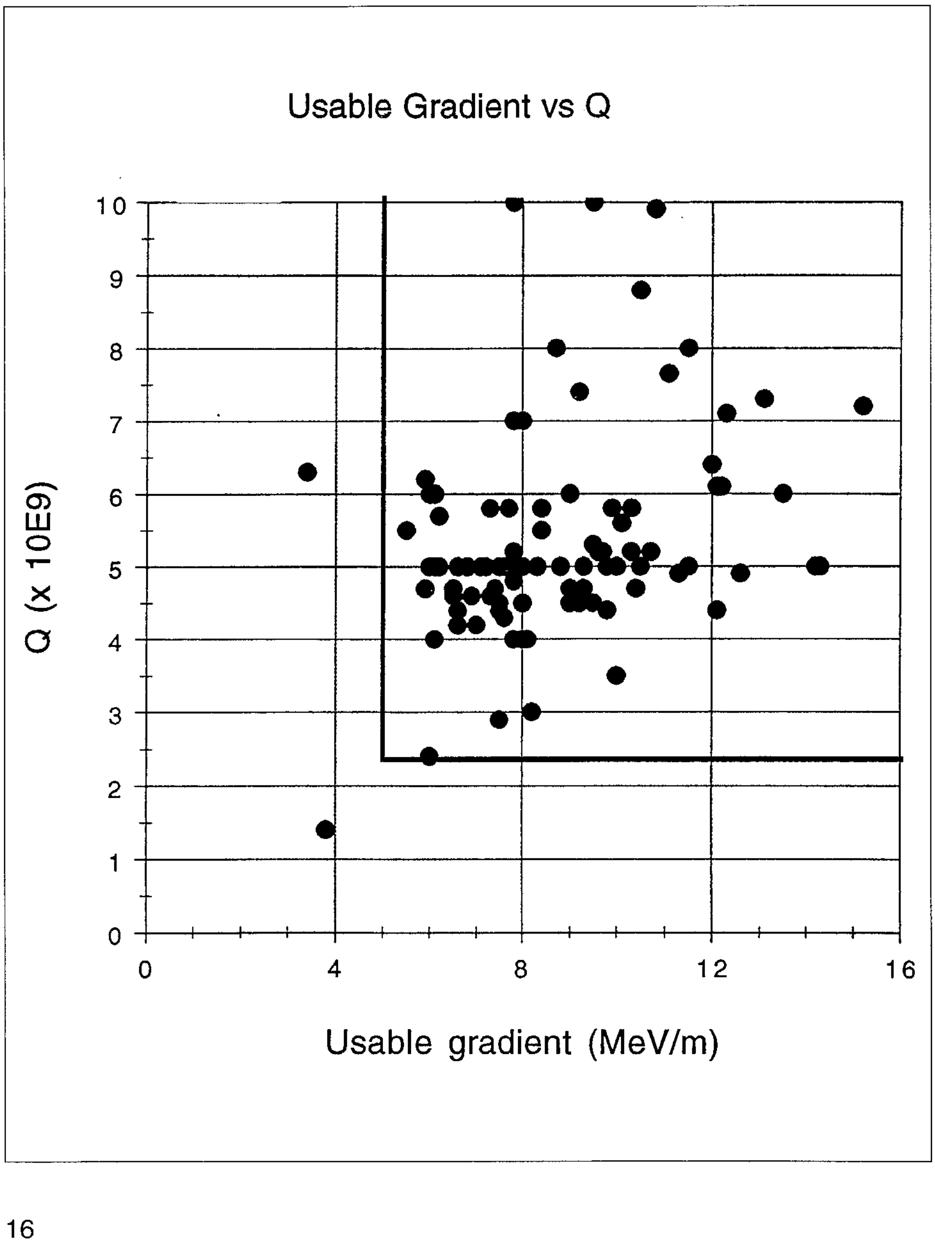
66 *Circle advertisement number on reader service form* look for coincidence particles - simultaneously emitted secondary particles produced by the same incident electron. Another hall will be fitted with a 'large acceptance' spectrometer to catch as many secondaries as possible. This uses an unusual toroidal field configuration and is designed to measure complicated decay patterns.

CEBAF's experimental programme is expected to attract about 400 physicists. But there will be many more people eagerly awaiting the first experimental results.

The performance of CEBAF's accelerating cavities suggests that the 4 GeV design goal of the machine could be surpassed without too much trouble.



CERN
Towards the LHC experimental programme

As preparations for the experimental programme at the LHC proton collider to be constructed in CERN's 27-kilometre LEP tunnel gain momentum, some regrouping of the initial experimental proposals has taken place, while top-level presentations of LHC and its physics potential have been organized for Russia, Japan and China.

These presentations follow the 'Towards the LHC Experimental Programme' meeting earlier this year at Evian-les-Bains, near Geneva, which provided a stage for the first public presentation of initial ideas (Expressions of Interest) for LHC experiments (May, page 1). The success and enthusiasm generated by this meeting led to the idea of an international LHC roadshow with specially geared agendas for each 'mini-Evian' venue.

An optimal initial LHC experimental programme would require two, possibly complementary, detectors to study proton-proton collisions up to the highest luminosity, one dedicated ion detector (with the ion physics menu complemented by one or both of the proton-proton detectors) and at least one experiment exploring more specific physics topics, in particular beauty (B-particle) physics. In principle two new underground experimental areas would be opened in the tunnel, with the potential of using in addition the existing four LEP experimental areas, either by adapting LEP detectors or by having

the Laboratories

The LHC proton-proton collider for CERN's 27-kilometre LEP tunnel will operate at superfluid helium temperatures. A superfluid helium cooling loop has been built and operated at CERN to simulate and optimize the cryogenics of an LHC magnet half-cell.

(Photo CERN AC 1.6.92)

new apparatus mounted in push-pull to alternate with LEP running.
To meet this demand, a wide range of Expressions of Interest have been tabled. Initially there were four ideas for large proton-proton collider detectors (ASCOT, CMS, EAGLE and L3+1) - general purpose setups designed to operate at the highest LHC luminosity. However they follow complementary experimental approaches, using different detection techniques and magnet designs. At the same time they should be able to reap the harvest of interesting physics at lower luminosities, in particular in the top, beauty and tau sectors. After their initial formulation, ASCOT and EAGLE subsequently agreed to join forces.

While the main thrust of the LHC physics programme will be the study of high energy proton-proton collisions at high luminosities, an important additional element of the physics programme will be the study of heavy ion collisions. This unique physics opportunity exploits in a natural way the existing CERN infrastructure and the expertise accumulated in the past years in accelerating heavy ions at the SPS and the ongoing plans for handling lead ions (April, page 8). Collision energies of up to 1300 TeV will be reached in lead-lead collisions at the LHC. Energy densities and temperatures in these collisions are expected to exceed the values at which a new phase of matter - the quark-gluon plasma - is formed. Possible experimental setups for these heavy ion studies include a dedicated general purpose detector, while another stresses the potential of one of the proposed proton-proton detectors (CMS).

Among the remaining Expressions of Interest, three propose studying the production of B-mesons, with as main objective the observation of CP-violation in B-meson decays: one uses the LHC in collider mode, the other two intend using the high energy LHC protons in fixed target set-ups. Two proposals cover neutrino physics, in particular the tau-neutrino. Other Expressions of Interest look at total cross-section, elastic scattering and diffraction dissociation in proton-proton interactions. (For the moment the possible study of electron-proton collisions in LHC is being kept open until the eagerly awaited first results from HERA indicate the research directions to follow.)

While the initial challenges of LHC physics looked daunting, continual investigations by the experimental community make physicists feel confident that detectors can be built to meet the requirements posed by LHC's high luminosity environment. Here, an important factor has been and continues to be the successful detector R&D programme under the Detector Research and Development Committee, which selects new projects and monitors their progress.

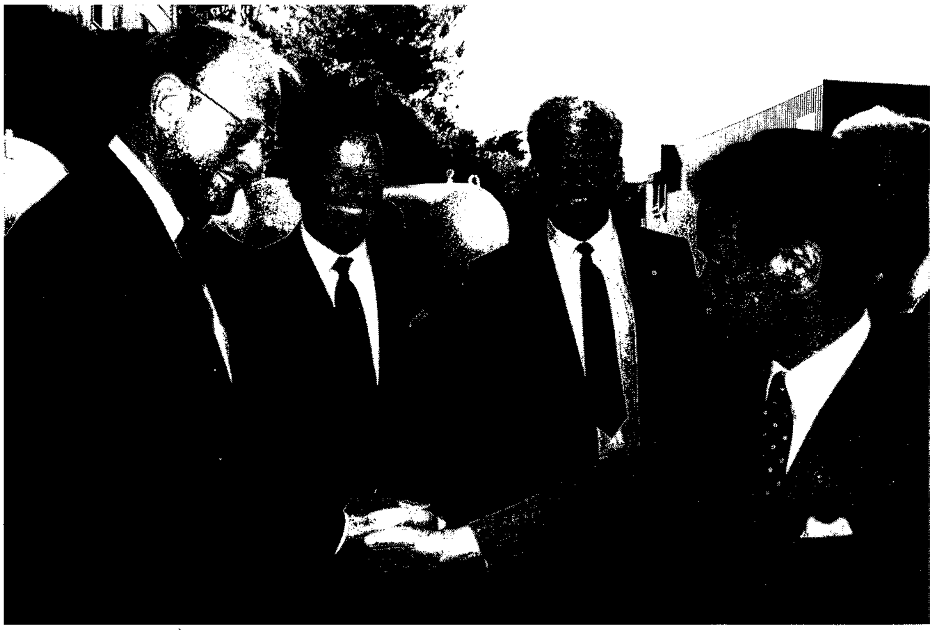
The road to approval of the LHC experimental programme has to reflect primarily that the LHC is a discovery machine charting completely new physics territory in challenging experimental conditions. This is markedly different from the situation with some other machines, notably CERN's LEP electron-positron collider, where the physics goals were clearly defined and the experimental solutions, although far from trivial, were well understood at the outset.

The LHC detectors have to be sufficiently flexible to cope with the unexpected and require technologies pushed to new levels of performance, while maintaining costs to acceptable levels. As a consequence the detector technology should not be frozen too early and a subsequent 'adiabatic' evolution of the final detector is being looked for.

At CERN, an LHC Experiments Committee (LHCC) has been set up under the chairmanship of Jean-Jacques Aubert of Marseille to supervise the transition from natural evolutions of the Expressions of Interest tabled earlier this year at Evian to the next stage - Letters of Intent - and eventually the full Technical Proposals. This Committee will work in close cooperation with the Detector Research and Development Committee.

Deadline for the Letters of Intent for the proton-proton detectors is 1 October, and the LHCC will hold its first meeting immediately afterwards. Towards the end of this year, the Committee will recommend which two groups should proceed with preparations for a technical proposal. A precise definition and a cost estimate of the initial experimental programme will then be in place by the end of 1993 to meet the approval schedule of CERN Council.

Stan Hagen, left, former minister in the regional British Columbia government, has been nominated by Ottowa as national representative for the KAON project at the TRIUMF Laboratory in Vancouver. This album 1989 picture shows him with then British Columbia premier W. Vander Zalm welcoming then Japanese Prime Minister Toshiki Kaifu. On Kaifu's right is TRIUMF director Eric Vogt.



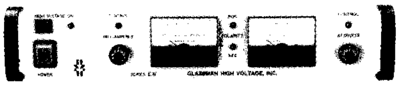
TRIUMF
Regional government offers KAON operating costs

After a period of uncertainty, confidence in the major KAON project for the Canadian TRIUMF Laboratory in Vancouver was boosted on 28 May at a rally of about a thousand KAON supporters in downtown Vancouver when the regional government of British Columbia announced its willingness to pay part of KAON's operating costs.

The regional government is prepared to offer to the federal government all of the hydro costs during the construction and ramping up stages of the KAON project and a portion of the subsequent $13 million-a-year hydroelectric costs.

The province's contribution towards operating costs would now be negotiated with Ottawa. Talks between the two governments had effectively stalled after the provincial election last October which brought in a new government. After an initial period when many ongoing projects were put on hold, the new regional administration has now decided to line up in favour of KAON.

Meanwhile former B.C. Minister Stan Hagen has been nominated by Ottowa as Canada's representative for the KAON project. In this capacity he will spearhead Canada's



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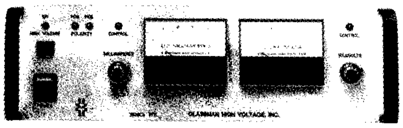

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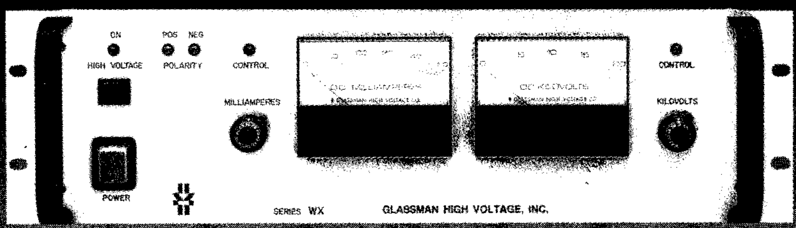

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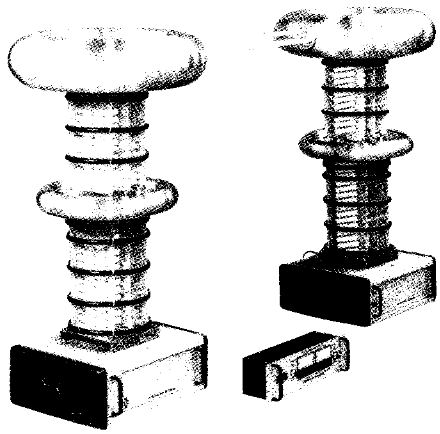

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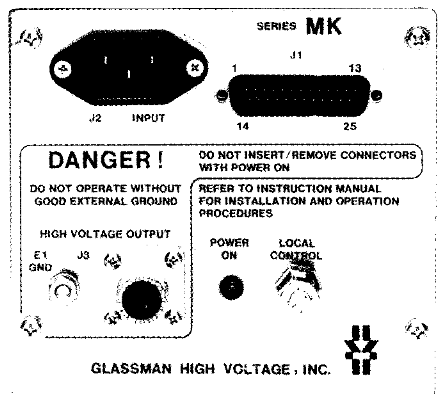

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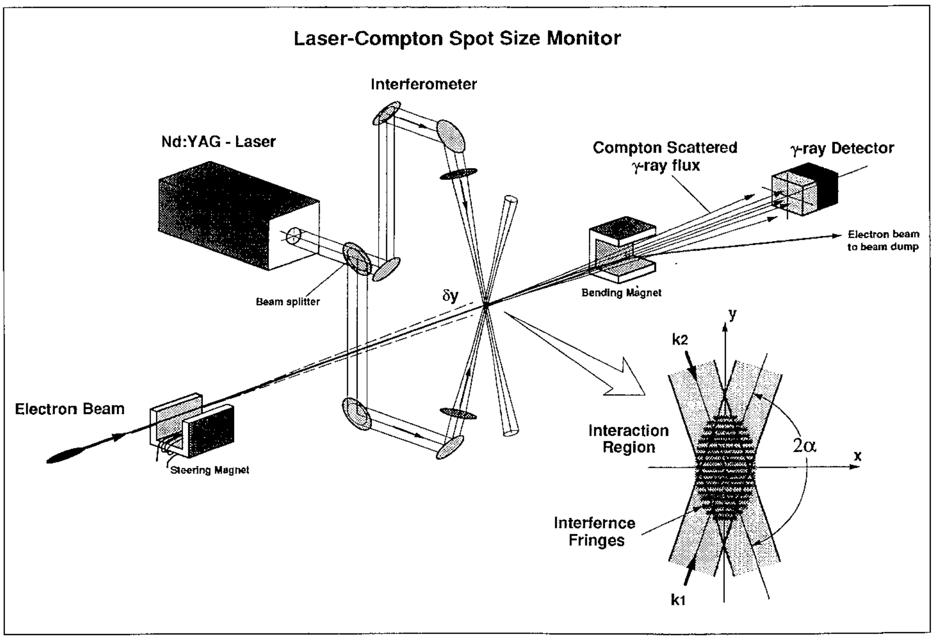


Schematic of the laser-Compton spot size monitor developed at the Japanese KEK Laboratory for measuring tiny electron beam spots.

effort to secure international funding for KAON, as well as generally pushing to make KAON a reality.

Ottowa also confirmed that the Federal Government will provide an additional $6.4 million this year for the continued operation of the TRIUMF research facility. This is in addition to the $24.9 million provided annually by the National Research Council to TRIUMF for ongoing operations.

It was in response to the leadership shown by Stan Hagen and the B.C. government that the Government of Canada made an offer last fall of $608 million toward the construction and operating costs of KAON.

Using the existing TRIUMF 500 MeV cyclotron as injector, the KAON project calls for a series of five rings to provide a high intensity, continuous beam of 30 GeV protons, and thereafter a wide range of secondary beams. It figures prominently in US thinking for future physics facilities (June, page 3).

KEK
Measuring tiny beams

With the next generation of electron-positron linear colliders aiming to focus beams into spots measured in nanometres, one problem (among many others) is how to measure them.

At the Japanese KEK Laboratory, where plans for the Japanese Linear Collider (JLC) electron-positron linear collider are being pushed, specialists are busy on a full range of research and development work. Following an idea by T. Shintake, a beam spot measurement scheme has been developed using the interference of two split beams from a YAG laser at a small crossing angle.

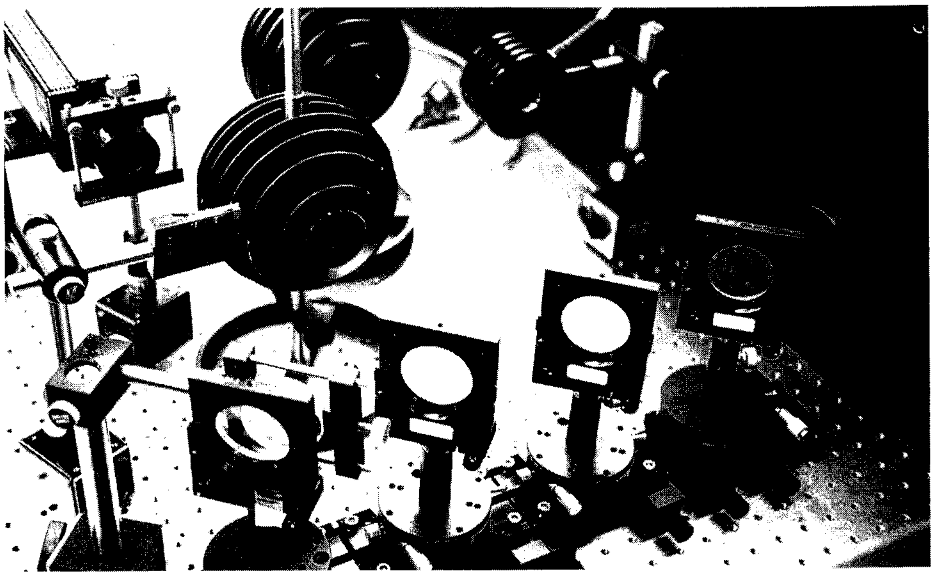
Split laser beams are focused and meet at an interaction point, generating an interference pattern of finely spaced parallel fringes. With the arrival of a bunch of high intensity electrons, some of the particles collide with the patterned laser photons and produce high energy gamma-rays (by inverse Compton scattering).

Sweeping the electron beam over a few fringes of target photons should modulate the intensity of the gamma rays. If the beam spot is much larger than the fringe pitch, the gamma-ray intensity modulation will disappear. On the other hand if a significant modulation is seen, then one knows that the beam spot is as small as or smaller than the fringe pitch.

In this way, the modulation depth of the scattered gamma rays will benchmark the electron beam size. The fringe pitch is 200 microns. In a real setup, it will be reduced to 0.5 microns by reducing the crossing angle of the laser beams, allowing spot measurement down to 40 nanometres. The 4th harmonic radiation from a Nd:YAG laser will probe down 5 nanometres.

KEK is actively involved in the international efforts toward the Final Focus Test Beam (FFTB) Project at SLAC, Stanford (November 1990,

The experimental setup for the KEK beam spot size monitor. A laser beam coming in from the right passes through an initial group of mirrors that act as beam samplers for power monitoring. The beam is finally reflected by 90 degrees by a pair of half mirrors, spaced by 2 mm, sending two beams of equal intensity towards a CCD photo-sensor surface in a TV camera.



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page 11). This project aims to develop the hardware and techniques necessary to produce and monitor very small beam spots. A specific goal is to focus a high intensity 50 GeV electron beam bunch to a spot 60 nanometres by one micron.

A prototype will be constructed this year for installation into the focus point of the SLAC FFTB beamline next Spring. A similar monitor is also needed for the Accelerator Test Facility under preparation at KEK for the Japanese Linear Collider project.

On 23 June, Brookhaven signed a $42.7 million contract with Grumman Aerospace Corporation's Electronic Systems Division for the supply of 373 superconducting dipole magnets to guide the beams in the twin 3.8 kilometre rings of the RHIC heavy ion collider.

BROOKHAVEN
Getting a boost

Some recent scenarios for the future of US high energy physics have glossed over the ongoing high energy physics role of Brookhaven's Alternating Gradient Synchrotron (AGS), seeing it being relegated essentially to a service function as the injector for the RHIC heavy ion collider (June, page 3). However this view is not shared by Brookhaven, now enjoying the benefits of a Booster to inject into the AGS.

The first joint AGS/RHIC Users meeting at Brookhaven on June 5-6, with over 100 users in attendance, was an ideal opportunity to rally the troops. After a brief introduction by Brookhaven Director Nick Samios, Associate Director for High Energy and Nuclear Physics Mel Schwartz gave his view of the future. He discounted the Witherell report's proposed phasing out of high energy physics at the AGS in 1997. Instead, exciting new results from the present round of experiments and new proposals with clear discovery potential would show the considerable physics potential of the boosted AGS. Schwartz expects the next few years will be an exciting time as the benefits of the Booster become apparent.

Bill Weng and Phil Pile discussed the present AGS operation and programme. After dramatic initial success with the gold heavy ion run, proton operation with the new Booster has had some teething problems, especially when transfers are concurrent with the experimental programme. However the results should be worth it. New low- and medium-energy separated beams, using third-order optical corrections, will deliver kaons with exceptional intensity and purity, promising some good physics in a field long regarded as ripe for exploitation.

Meanwhile on 23 June, Brookhaven signed a $42.7 million contract with Grumman Aerospace Corporation's Electronic Systems Division for the supply of 373 superconducting dipole magnets to guide the beams in RHIC's twin 3.8 kilometre rings.

The Grumman magnets will use niobium-titanium superconductor supplied by Oxford Superconducting Technology. The magnet contract requires all manufacturing to be complete by December 1995. RHIC would then be complete in 1997, Brookhaven's 50th anniversary year.

PSI
Upgrading

The accelerator complex at the Paul Scherrer Institute in Villigen near Zurich (PSI - formed in 1988 by combining the Federal Institute for Reactor Research and the Swiss Institute for Nuclear Research) is in the throes of a major and lengthy upgrade.

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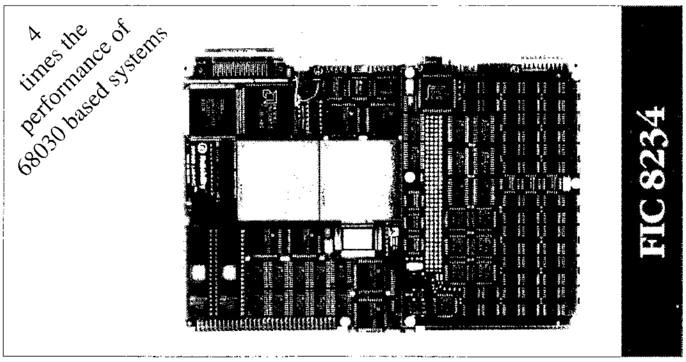
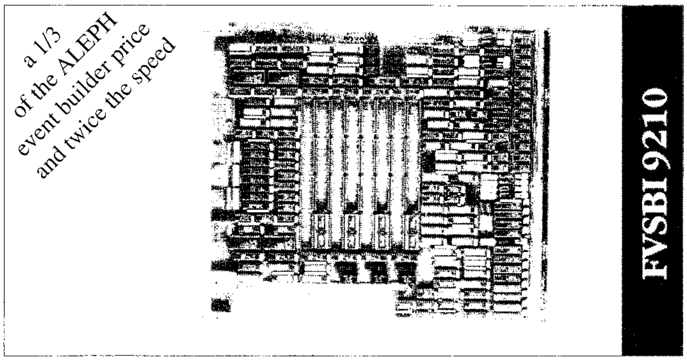


The FVSBI 9210 / FADAP 9211: FASTBUS master / slave interface, offering more than 6 Mbytes/s when coupled with the FIC 8234 on a long distance VSB cable.



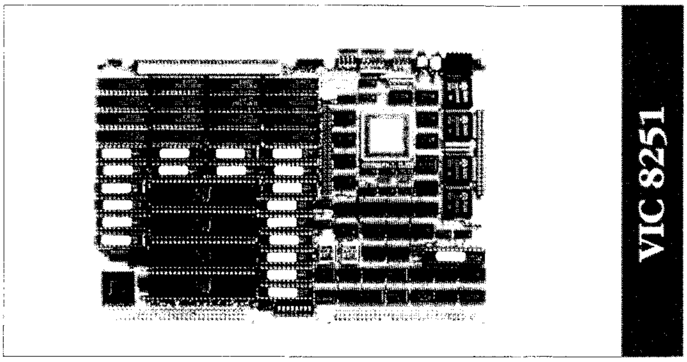
A unique complete OS-9 system package has been designed by CES to make the user unaware of the twin engine architecture as one processor runs OS-9 in the same environment as in the FIC 8232 based workstations.

In case of the FIC 8234B/25/1, the two processors are running in parallel, one performing the front-end task, typically handling the block mover operations, while the other one distributes the reduced data to other elements through the VIC bus, Ethernet or SCSI.

Application software

A complete set of libraries supporting the different elements of the system is already available.

Contact Person: Dr. A. LOUNIS lounis@lancy.ces.ch



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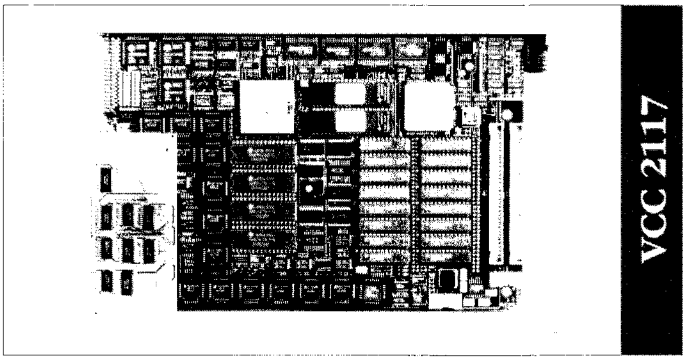

The transparent VME to CAMAC interface: the VCC 2117. It features an embedded CAMAC list processor with simple memory mapped VIC addressing. It includes a combination of 3 units into 1 (CCA2 back-end, FIC 8232 on-board processor (optional), VIC 8250 front-end).

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- After more than 10 years of activity as a hardware design company, CES is evolving to a system company with a full blown software design team whose products will be incorporated in our complete solutions.
- A Turbo-Channel to VIC bus interface will be added to the VIC family. This is a joint development with KFA Julich.
- A special firmware enables the VCC 2117 to be driven directly under TPC-IP for long distance connections between CAMAC and workstations.
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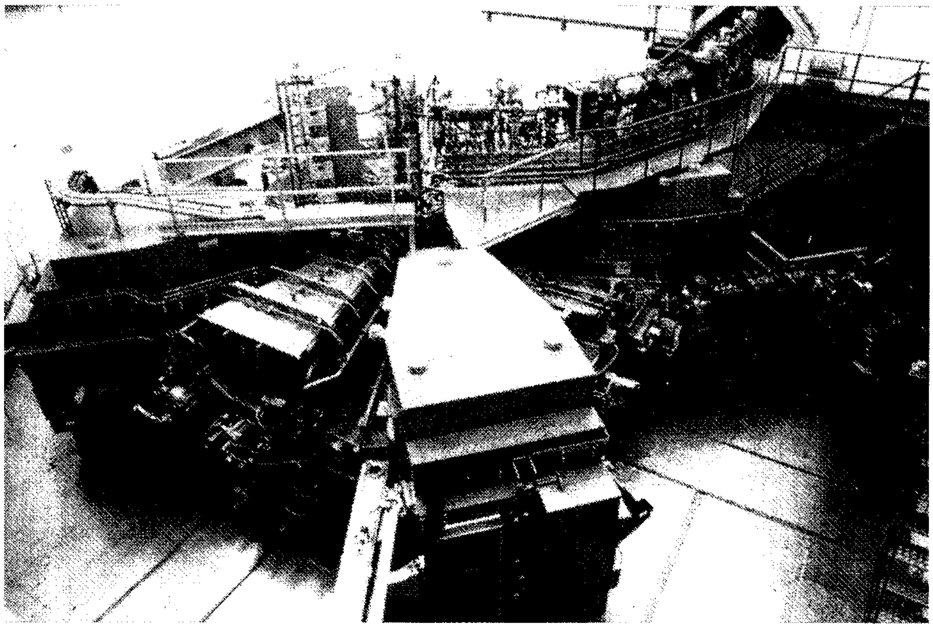
The Injector 2 cyclotron at the Paul Scherrer Institute (PSI) in Villigen near Zurich. 870 keV protons from the Cockcroft-Walton preaccelerator enter the cyclotron from the top, then are guided by four large sector magnets and accelerated to 72 MeV by two aluminium resonators. The beamline on the right takes the extracted protons towards the 590 MeV Main Ring accelerator.



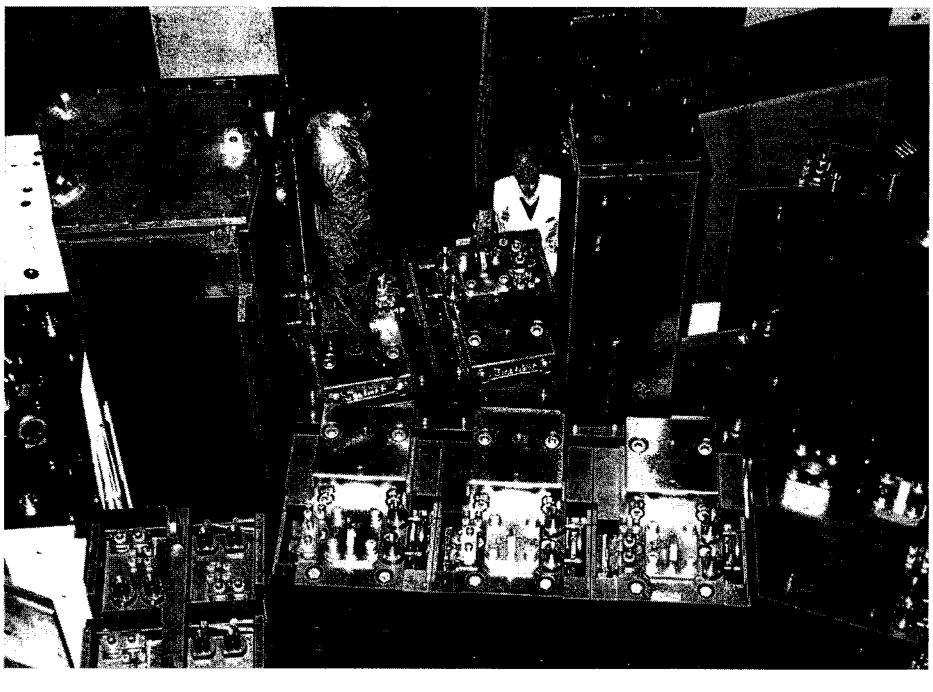
The complex consists of several distinct machines: the 590 MeV Main Ring, fed with 72 MeV protons either by Injector 2 (a special high-current ring cyclotron), fed in turn by the 870 keV Cockcroft-Walton preaccelerator, or by Injector 1, a Philips cyclotron supplying beams of different particles at various energies.

Most of the time, the complex is used as a 'meson factory': several hundred microamperes of 590 MeV protons are sent to two consecutive production targets, supplying intense beams of pions and muons. In special runs, up to 10 microamperes of polarized protons are accelerated to 590 MeV for the production of polarized neutron beams.

The 590 MeV Main Ring consists of eight separate magnets and four 50 MHz acceleration cavities; an additional cavity running at 150 MHz flattens the top of the accelerating voltage. This reduces the energy spread of the internal beam and results in well-separated turns and very low extraction losses.

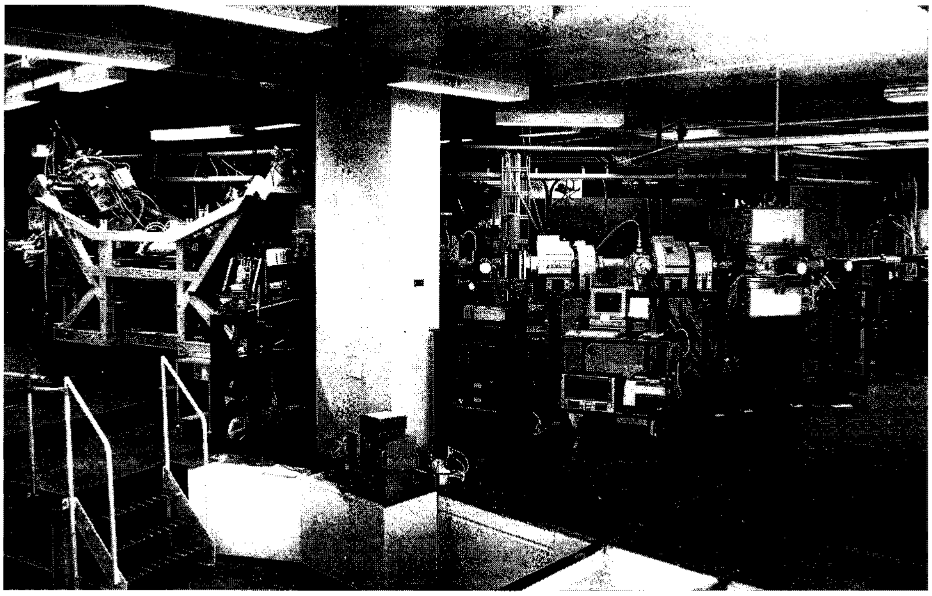
Injector 2 is a ring cyclotron similar to the Main Ring, with four sector magnets, two 50 MHz acceleration cavities, and two 150 MHz flat-top cavities. Its Cockcroft-Walton preaccelerator delivers up to 8 mA (DC) of 870 keV protons bunched to provide up to 40 mA. Due to the high radiofrequency voltage, acceleration to 72 MeV requires only about 100 turns, resulting in a turn separation of 18 millimetres at extraction, and correspondingly low losses; space charge effects are also reduced. In 1991 injector 2 reached its design goal of 1.5 mA (110 kW) extracted beam; extraction losses were 1.3 microamperes.

Following the decision, taken as long ago as the late 70s, to exploit the high current potential, several steps have been realized or initiated: construction of injector 2 (1978-85); reconstruction of the first target in 1985; reconstruction of the second target and the beam dump in 1990-91; upgrade of the 590 MeV ring r.f.



One of the PSI pion production target areas, with local shielding removed. The target itself is at the bottom of the high vacuum box behind the technician on the left, who is standing on the first half-quadrupole magnet of a high-intensity pion channel. In the foreground are three half-quadrupoles and a dipole magnet of a high-intensity muon channel.

The CRYRING ion ring at the Manne Seigbahn Institute in Stockholm. On the left is the electron cooling device which came into action in May.



system (which will be complete in 1994); construction of the SINQ neutron source (to be completed in 1995; see November 1989, page 6).

The dismantling of the old target station 2 and the beam dump after two decades of operation was a very challenging task. Some 500 tons of activated material had to be removed. While 300 tons of this material could be reused, the remainder was enclosed in concrete and reinstalled as shielding. While 12,000 tons of slightly activated concrete and iron shielding were re-arranged, no body contamination was monitored. The highest dose to any person was 30 mSv.

Up to the end of 1989, the accelerator complex was operated at currents up to 250 microamperes at 590 MeV. Towards the end of 1991, 590 MeV beam currents of up to 0.5 mA, representing a world record for cyclotron beam power, were routinely delivered to the two targets. Losses in the Main Ring were of the order of 0.5 microamperes, mainly in the extraction region, still an order of magnitude below the limit set by the requirements of safe operation and maintenance. The 590 MeV beam current is scheduled to increase to about 1.5 mA by the mid 90s.

Experiments using the Main Ring have mainly concentrated on particle properties and decays, hadron-hadron and hadron-nucleus reactions, pionic and muonic atoms, all of which are still active areas of study. Partly because of the higher beam intensity, increased emphasis is now being placed on other applications: solid state physics using muon spin rotation; defect physics and materials testing using 72 MeV protons from Injector 1 or 590 MeV proton beams from the Main Ring; radioisotope production for positron emission tomography experiments in-house and for radiopharmaceutical products; cancer therapy with pions and protons.

In the near future, protons degraded to 200 MeV will be used for the irradiation of large cancers, and 72 MeV protons will be used to produce neutrons for Boron Neutron Capture Therapy. A new low energy beamline at 1 mA proton current will provide over 10^{10} positive pions per second at 120 MeV/c, or over 10^8 surface positive muons per second at 28 MeV/c.

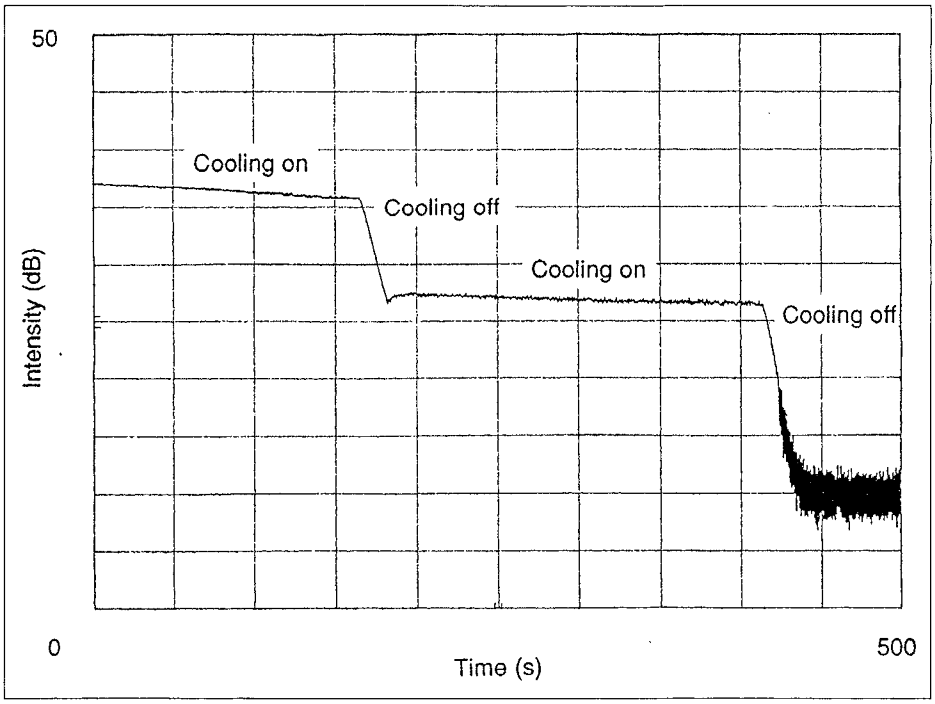
STOCKHOLM CRYRING

The CRYRING accelerator facility for atomic, molecular and nuclear physics at the Manne Siegbahn Institute of Physics in Stockholm is now in full operation, including an electron cooling device for precision beam control.

Main CRYRING components are an electron-beam ion source (EBIS) for the production of very highly charged ions, an radiofrequency quadrupole (RFQ) linear accelerator and a synchrotron to accelerate, store and cool heavy ions with energies up to 24 MeV per nucleon (charge-to-mass-ratio 0.5).

The EBIS source has been in operation for several years, delivering low-energy beams to atomic physics experiments. It has produced ions such as argon and xenon in charge states up to argon 18+ and xenon 48+. A small plasmatron ion source delivers light ions for accelerator tests. The RFQ accelerates the ions to 300 keV per nucleon for injection into the ring. Since this energy is so low, the injection is made completely electrostatically. The acceleration system - a drift tube connected to a relatively simple high-bandwidth power amplifier - is unconventional in being non-resonant.

A first beam of hydrogen 2^+ ions circulated around the ring in December 1990, and full energy was reached with deuterons in October 1991. The ring's electron cooler came into operation this May, enabling beam lifetimes to be



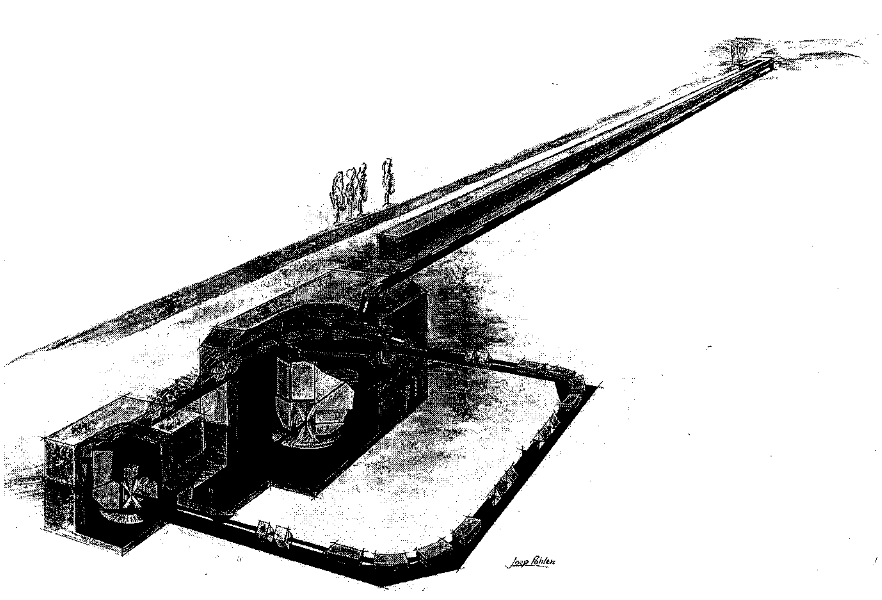
▲ *Typical initial performance of the electron cooling device on the Stockholm CRYRING.*

increased from about 10-20 seconds without cooling to longer than an hour.

Initial experiments include studies of restgas ionization with a beam-profile monitor and dissociative recombination of molecular ions in the electron cooler. Storage rings provide a unique possibility for molecular experiments since it is possible to store the molecules long enough for electronic and vibrational excitations to die away. Thus reaction rates can be measured for processes where the initial state is well defined.

During the autumn, further recombination experiments will use molecular and atomic ions. Then the CRYRING experimental programme will switch to heavy ions.

▼ *The AmPS (Amsterdam Pulse Stretcher) at the NIKHEF-K Laboratory, fed by a 200-metre electron linac, is now operational.*



NIKHEF AmPS of electron beam

Now operational at the Dutch National Institute for Nuclear Physics and High Energy Physics (NIKHEF), Amsterdam, is a new tool for studying the electromagnetic properties of nuclei. Called AmPS - Amsterdam pulse stretcher - this ring provides experiments with a smoother, almost continuous supply of electrons.

The electrons emerge from the 200-metre electron linac with an energy of almost 1 GeV, and the AmPS ring, with a circumference of slightly more than 200 metres, evens out the spiked duty cycle of the linac, opening up experiments looking for particles produced in coincidence.

In addition, polarization experiments could use stored electron beams with

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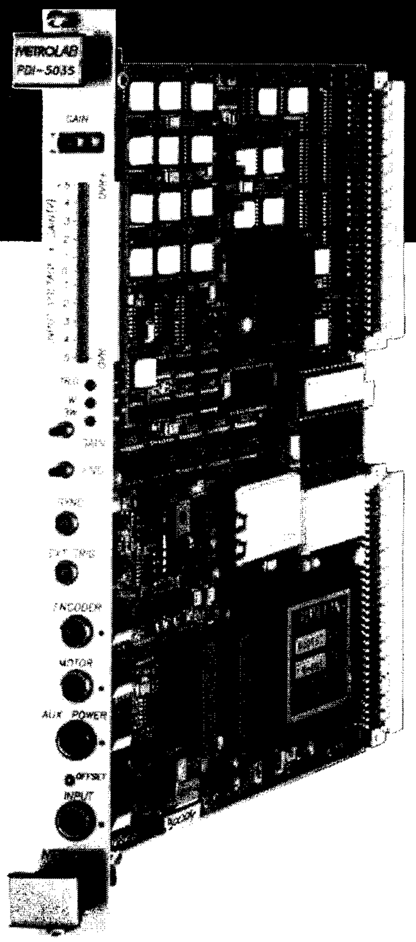

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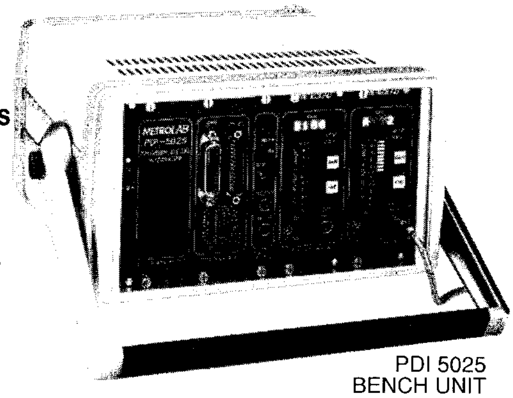

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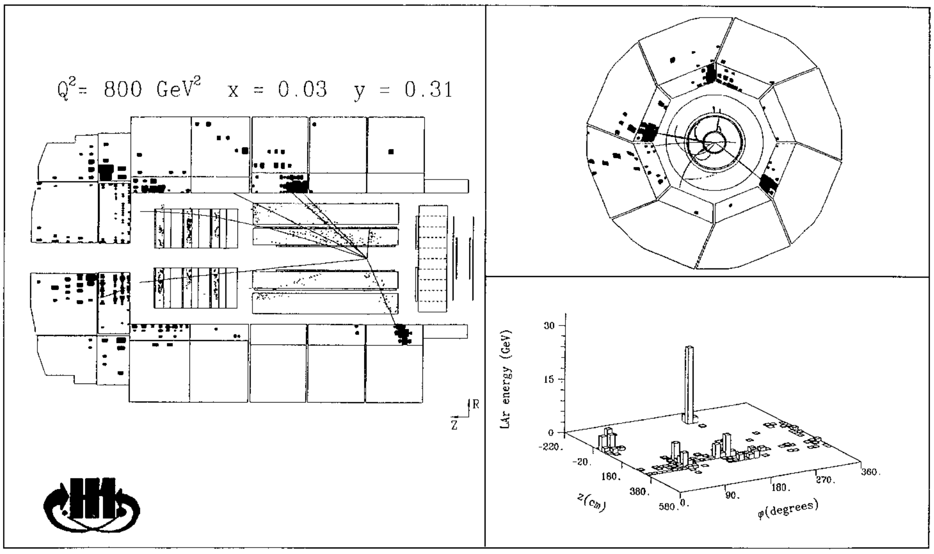


Deep inelastic scattering HERA style. This violent electron-proton collision recorded in the H1 detector shows the new kinematic regime opened up by DESY's newly-commissioned collider. The scattered electron (furthest right track) is absorbed in the first part of the calorimeter, while the proton fragments into three well separated jets. The x-value (fraction of proton momentum carried by the struck quark) is 0.3, while 800 GeV² of mass is exchanged, a hundred times larger than the values achieved in current fixed target experiments.

an internal target, such as a gas jet, mounted inside the AmPS ring.

AmPS construction began in July 1989 and was completed this April, within budget and well on time. Commissioning began almost immediately, with first beam injected on 12 May. First beam was extracted to an experimental area on 5 June.

Attention then turned to storing the beam in the ring. Without radiofrequency power, synchrotron radiation losses could be exploited to stretch the injected beam pulses, giving initial duty factors of about 5%, compared with the 0.02% figure of the linac itself, enough for an initial physics experiment.

The NIKHEF-K project team headed by Guy Luijckx has now shown that the new machine is well and truly operational. Future work will concentrate on improving the duty factor and increasing beam energy and intensity.

DUBNA Heisenberg-Landau programme

The Joint Institute for Nuclear Research (JINR), Dubna, near Moscow, one of the most important centres of fundamental research in the former Eastern Bloc, is naturally looking to new horizons in international collaboration.

In 1991, informal discussions between representatives of JINR's Laboratory for Theoretical Physics and their counterparts from German universities (Berlin, Bonn, Heidelberg, Munich, Tübingen,....), led to the establishment of a 'Heisenberg-Landau' programme to foster scientific exchange between Dubna and German institutes.

Accelerating in Hamburg

Hardly had Europe's accelerator physicists returned and unpacked their bags from the third biennial European Particle Accelerator Conference held in Berlin at the end of March (June, page 5), than they were making more travel plans for Germany; this time to Hamburg to join colleagues from all over the world for the fifteenth biennial International Conference on High Energy Accelerators (HEACC) from 20-24 July. Germany, and Hamburg in particular, has much to excite the interest of the accelerator world these days as DESY's new star - the HERA electron-proton collider - begins to feed detectors for the first time, and at least two long term schemes for the application of linear collider technology emerge involving German participants from DESY, Darmstadt, Karlsruhe and Wuppertal.

Pride of place at the Hamburg meeting was rightly given to HERA's latest achievements, with a status report from Ferdinand Willeke.

Just several weeks earlier, a proton beam at the full design energy of 820 GeV had been brought into collision with an electron beam of 26.6 GeV and HERA detectors switched on for the first time in the full energy beams (July, page 1).

In hardly a month's running the HERA team had already chalked up 40 'luminosity' runs averaging five hours apiece. The luminosity for each crossing of the 10 electron and proton bunches was as yet a modest 10% of the design value, but this was due to throttling back the proton injectors to avoid a beam instability which was thought more likely to have its origin in a control loop in the DESY III synchrotron rather than in any effect which was a fundamental limitation to intensity.

The conference was suitably impressed and wished HERA good fortune as it moves out of its starting blocks towards colliding the many more bunches needed when running flat-out for physics. Germany's interest in linear colliders became clearly apparent as, during a whole day devoted to this subject, the many new schemes and tests planned in this field were unfurled. These will be fully covered in the full HEACC report to feature in next month's issue.

E.J.N. Wilson

Participants at a workshop in Dubna in May on QCD at finite temperature, bound states and nuclear dynamics, organized in the context of the new 'Heisenberg-Landau' programme to foster high energy physics, especially theory, collaboration between Dubna in Russia and German research institutes.

In this context an initial workshop on 'Quantum Chromodynamics at finite temperature, bound states and nuclear dynamics' at Dubna in May led to fruitful discussions and plans for closer future collaboration.

The follow-up seminar in the new programme will be in November, organized by Dubna and Rostock. The Heisenberg-Landau scheme also sponsored a student summer school in Dubna in August on particle and nuclear physics.

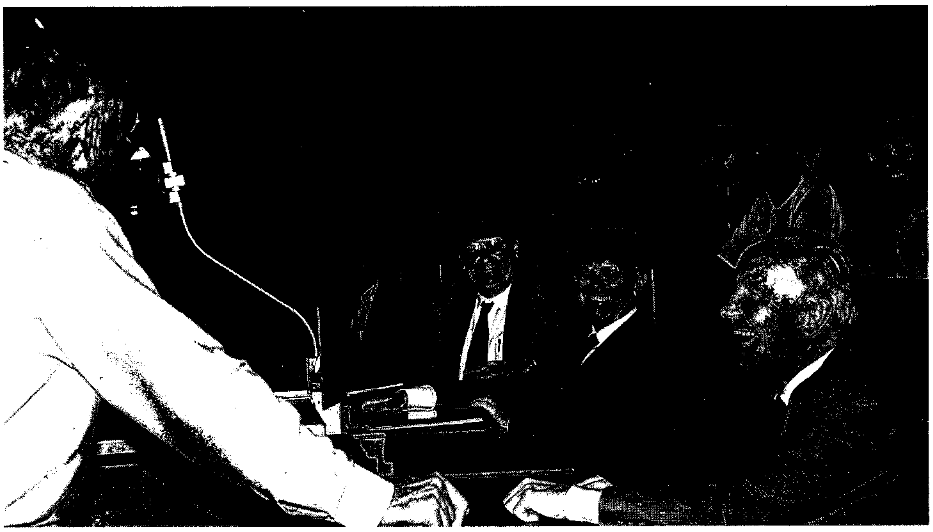
People and things

Hungary becomes CERN's 18th Member State

At the meeting of CERN Council on 26 June, delegates of CERN's existing 17 Member States voted unanimously to admit the Republic of Hungary as the Organization's 18th Member State, with effect from 1 July. Following the dramatic political changes in Central and Eastern Europe over the past few years, CERN is leading the way towards a unified scientific Europe.

Hungary thus joins Austria, Belgium, the Czech and Slovak Federal Republic, Denmark, Finland, France, Germany, Greece, Italy, the Netherlands, Norway, Poland, Portugal, Spain, Sweden, Switzerland, and the United Kingdom. Hungary has a well

A special event at CERN on 9 July marked the 80th birthday of Willibald Jentschke (seated, right), DESY pioneer and CERN's Director General from 1971-75. Speakers paying tribute included Victor Weisskopf (standing, CERN's Director General from 1961-5), and (seated, left to right) CERN's current Director General Carlo Rubbia and Director General from 1981-88 Herwig Schopper. (Photo CERN HI 8.7.92)



An event at CERN on 30 June marked the departure of John Thresher, Research Director since 1986. Among his duties during this time, he kept a fatherly eye on the LEP experiments as they made the change from giant construction projects to prolific physics studies. Here he receives his coveted LEP clock from Steve Myers (background), deputy leader of SPS and LEP Division.
(Photo CERN GE 68.6.92)

established tradition in fundamental physics, with a history of eminent names. The establishment of The Central Research Institute for Physics (CRIP) of the Academy of Sciences in the mid-1950s marked the debut of large scale involvement in modern high energy physics.

Also at the June meeting of CERN Council, Jan Bezemer of the Netherlands was elected as Vice-President of Council, succeeding Pierre Lehmann who died in January. Giorgio Bellettini was elected as a member of CERN's Scientific Policy Committee.

Willibald Jentschke 80

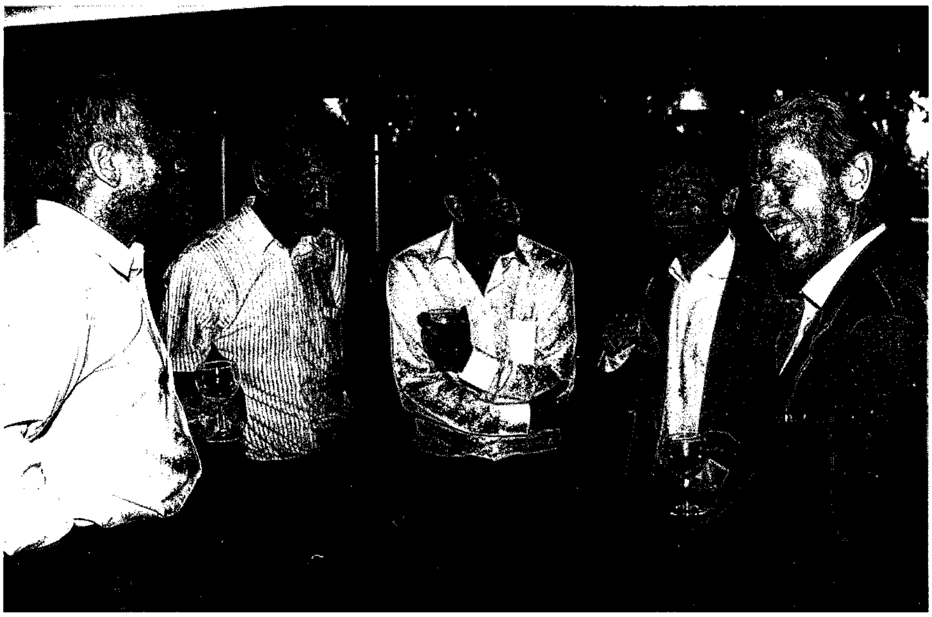
A special symposium at CERN on 9 July marked the 80th birthday of Willibald Jentschke, DESY pioneer and subsequently CERN's Director General from 1971-75. Before the scientific part of the symposium, three CERN Director Generals - present incumbent Carlo Rubbia, fellow Austrian Victor Weisskopf (1961-5), and Herwig Schopper (1981-8) - paid tribute to his contributions to physics, his leadership during an important evolutionary period at CERN, and his driving role in the creation of the DESY Laboratory in Hamburg.

In the mid-1950s Jentschke returned to Europe from the US to become director of the Hamburg Institute of Physics, and was soon nominated to lead a new project to build a world-class electron machine, the future DESY - Deutches Elektronen Synchrotron. As the first director of this new Laboratory, he set its sights high, ensuring that it continues to be a world-class centre to this day. During his period as Director General at CERN, he steered the Laboratory through an era of transition which saw the emergence of much new physics, while the commissioning of big new machines and detectors set the stage for today's style of research.

Several speakers underlined Jentschke's lifelong commitment to internationalism, well matched to a scientific activity which uses the world as its stage.

IHEP Beijing Directorate

The directorate at the Institute of High Energy Physics (IHEP), Beijing, has been changed recently. Former deputy director Zheng Zhipeng becomes the institute's director for the next four years, succeeding Fang Shouxian, appointed in August 1988. Professor Fang continues as director of the National Laboratory of Beijing Electron Positron Collider. The new IHEP deputy directors are: Wang Shuhong, Xu Shaowang, Ma Tongjun and Zhao Weiren.



LEP notables at the John Thresher retirement event at CERN. Left to right, SPS and LEP Division Leader Lyn Evans, Opal experiment spokesman Aldo Michelini, Aleph experiment spokesman Jacques Lefrançois, LEP Experiments Committee Chairman Jacques Haissinski, and Delphi experiment spokesman Ugo Amaldi.
(Photo CERN GE 67.6.92)

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Coinciding with the 13th European Cosmic Ray Symposium, held at CERN from 27-31 July, a special Astroparticle Physics exhibition, organized jointly by CERN's Microcosm unit and the Italian INFN, generated a lot of interest. Seen here at the exhibition's opening are (left to right) INFN President Nicola Cabibbo, co-organizer Alessandro Pascolini (who is also CERN Courier's Italian correspondent) and CERN Director General Carlo Rubbia. Also at the opening ceremony was Italian Ambassador Guilio di Lorenzo Badia.
(Photo CERN HI 70.7.92)

On people

Victor Weisskopf receives the American Institute of Physics Karl Taylor Compton medal for Distinguished Statesmanship in Science. The citation reads 'Victor F. Weisskopf, brilliant physicist and great statesman in science, has led scientists throughout the world in advancing science, promoting peace and seeking solutions to the world's problems. As Director General of CERN he led one of the world's most successful scientific cooperations and as founding father of HEPAP (the US High Energy Physics Advisory Panel) he successfully reconciled the conflicting demands of particle physicists. As a teacher and author he encourages and strengthens the finest traditions and deepest values of science.'

Bruno Zumino of LBL Berkeley and Julius Wess of Munich receive this year's Wigner medal for their development of supersymmetry, work which began when they were both in CERN's Theory Division. The Wigner medal is awarded bienially to recognize outstanding contributions to the understanding of physics through group theory.

Joachim Heintze of Heidelberg receives the Max Born Prize awarded jointly by the Deutsche Physikalische Gesellschaft and the UK Institute of Physics in recognition of his experimental contributions to particle physics. As well as investigating the structure of weak interactions, he has also played a pioneer role in the development of drift chamber detectors and the subsequent jet chamber for the JADE experiment at PETRA, DESY. He worked at CERN from 1959-64.

Frederick Reines of Irvine received the US Franklin Medal for 'the experimental discovery of the neutrino and the subsequent detailed study of its properties and interactions, including the first detection of neutrinos from a supernova'. At the same ceremony, the Franklin Institute awarded its John Price Wetherill Medal to Gerald Brown of Stony Brook for his contributions to theoretical physics and astrophysics, covering quantum electrodynamics, nuclear physics, and supernovas.

From 25-27 May an important joint European Physical Society - American Physical Society meeting took place in Budapest, where the two societies agreed to coordinate their efforts and to collaborate as much as possible to help physics in Central and Eastern Europe and the former Soviet Union. Together at the meeting are (left to right) EPS President Maurice Jacob, APS President Ernest Henley, and EPS Vice President Norbert Kroo.

Louis Michel - formal retirement

C. Conrad Gelbke of Michigan State University has become the Director of the US National Superconducting Laboratory at MSU.

Louis Michel

Louis Michel of the Institut des Hautes Etudes Scientifiques, Bures-sur-Yvette, France, passes a formal retirement milestone this year. His classic work has included the famous rho parameter (the 'Michel parameter') for muon decay, the Bargmann-Michel-Telegdi equation for relativistic spin behaviour in an electromagnetic field, conservation of isotopic parity (later called G-parity) in strong interactions, and the consequences of parity violation in weak interactions. As well as particle physics, Louis Michel is well known for his group theory expertise and for new insights into condensed matter physics. From 2-9 June, a colloquium held in his honour at the Ecole Normale Supérieure de Lyon was attended by many collaborators, colleagues and friends from all over the world.

From A. Martin and R. Stora

Francis Perrin 1901-1992

Distinguished French nuclear physicist Francis Perrin died on 4 July. Son of the famous nuclear pioneer Jean Perrin, who received the Nobel Prize in 1926, he was exposed to top-flight physics from an early age, and recalled with pride that Albert Einstein came to dinner at the Perrin home in Paris in 1912.

His major contributions came in Paris in the 1930s, greatly influenced by the work of Irène and Frédéric Joliot-Curie. With Pierre Auger in 1932 he made some initial suggestions on nuclear composition. At the famous Solvay Conference in 1933, attended by all the great names, the young Perrin proposed the idea of positron emission, but more importantly, helped steer contemporary thinking towards the the modern concept of beta decay. Fermi's first 1934 paper on the subject acknowledges Perrin's suggestion that the neutrino could be massless.

In 1946 he became Professor at the Collège de France, where he remained until his formal retirement in 1972. He was High Commissioner of the French Atomic Energy Commission from 1951 to 1970. In

An event at Tel Aviv University celebrated the 80th birthday of mathematician Naoum Nathanovitch Meiman, who recently emigrated to Israel from Russia. He has made important contributions to mathematical physics, in particular the Pomeranchuk theorem, besides his work in pure mathematics. Speakers at the event also highlighted his commitment to human rights while he lived in Moscow.

The distinguished French physicist Francis Perrin, who died on 4 July, was also an influential figure in early CERN affairs. He is seen here, left, making up with Robert Valeur (centre) the French delegation at the meeting of CERN Council in Geneva in 1954. Right is Danish physicist Jacob Nielson.
(Photo CERN)

1926 he married Colette Auger, sister of Pierre Auger.

At CERN, he was Vice-President of the Council of the provisional Organization in 1952, and his name appears for France on the 1954 document ratifying the establishment of the international Laboratory. He served as France's Council delegate for fifteen years, from 1955 to 1970, and was a member of the Scientific Policy Committee for a similarly lengthy span, from 1960 to 1975.

American Center for Physics

The American Center for Physics, the new headquarters of the American Institute for Physics (AIP), the American Physical Society, and the American Association of Physics Teachers, will be located in suburban Washington DC, where a new building will be complete in the fall of 1993, near the College Park campus of the University of Maryland. Many activities will be transferred to the new premises, although the AIP will retain its publishing centre on Long Island, New York, and its marketing and advertising offices in New York City.

At the end of May, a Romanian truck transported some five tons of surplus CERN equipment, including a VAX computer and several PDPs, to Bucharest for the University and for the Institute of Atomic Physics. A similar load will shortly be sent to the Albanian Institute of Nuclear Physics in Tirana.
(Photo CERN 23.5.92/5)

Meeting

The First European Workshop on Beam Instrumentation and Diagnostics for Particle Accelerators will be held from 3-5 May 1993 in Montreux, Switzerland. Further information from the Workshop Secretariat: Ch. Parthé, CERN, SL Division, 1211 Geneva Switzerland, fax +41 22 782 2850, e-mail DIPAC@CERNVM. It is intended to hold the workshop every two years, organized in turn by different European accelerator centres.

Seville

CERN's participation at the Seville Expo '92 World Fair included two special events, each highlighting a country relatively new to the CERN family. The first, from 10-12 May, featured Israel, which became a CERN Observer State last year, and the second, on 4-5 June, put the spotlight on Finland, a Member State since 1990. Each event included exhibits of the country's high technology on CERN's stand in the Ambiente '92 hall.

Israel displayed scientific equipment supplied for the OPAL and CERES experiments at CERN, together with industrial communications and computing equipment from Phasecom, RAD and IIS, all firms which have contributed equipment to CERN in the framework of the CERN-Israel cooperation agreement.

For Finland, a special research and technology exhibition was organized together with SEFT, the Finnish national research institute for high energy physics. The major themes were semiconductor detector research and high speed telecommunications.

30 September sees the climax of CERN's Seville season, the special 'CERN Day of Science'.

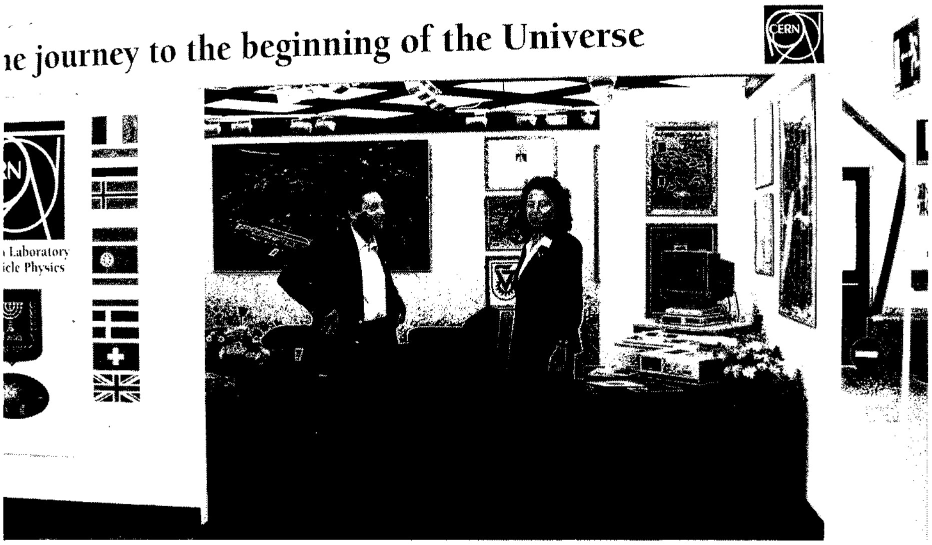
San-qiang Qian (San-tsiang Tsien) 1913-1992

Outstanding Chinese nuclear physicist San-qiang Qian, founder of China's nuclear research, died of a heart attack on June 28 in Beijing at the age of 79. He was a special adviser to the Chinese Academy of Sciences (CAS), a member of the Academic Council of CAS, and the honorary chairman of the Chinese Association for Sciences and Technology.

Born in 1913, he graduated from Qinghua University in 1936. The following year he went to France to do nuclear research at the Curie Laboratory in Paris. After receiving a French doctorate in 1940, he embarked on a successful research career in France and won the Henry De Parville Award for Physics at the French Academy in 1946. Together with his wife Ze-hui He, also a famous nuclear physicist, his investigations of uranium in 1946-47 deepened the understanding of nuclear fission.

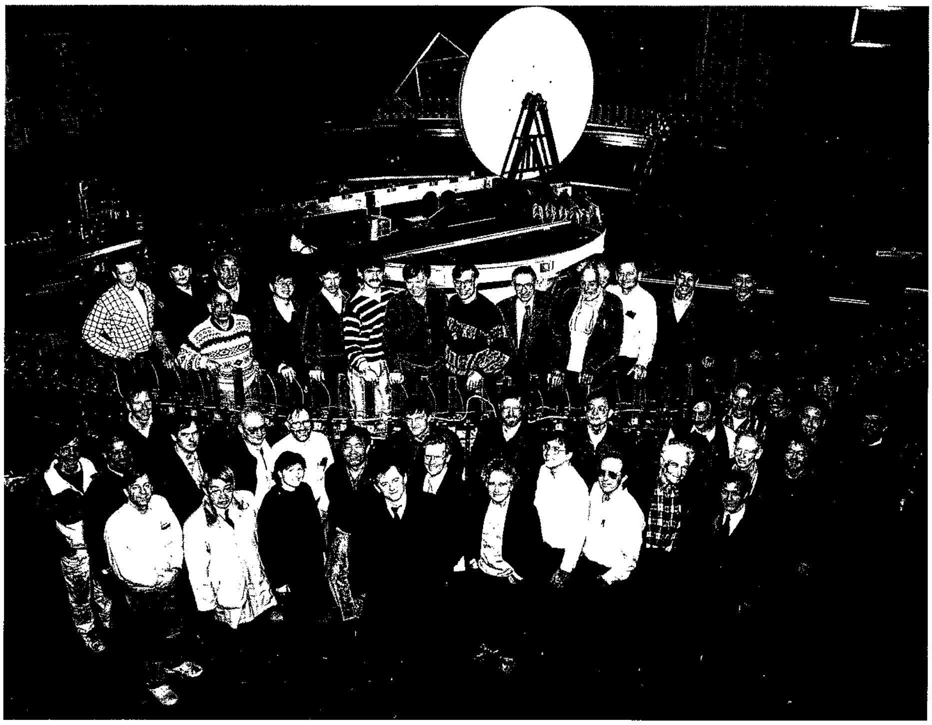
After returning to China in 1948, he actively participated in the organization of the Chinese Academy of Sciences and its Academic Council. He set up the Institute of Modern Physics (to become the Institute of Atomic Energy), the first nuclear research base in China. He served as director of the institute for 28 years and was also appointed as deputy minister of the 2nd Machinery (later the Nuclear Industry) Ministry in 1958. A major contribution was to help develop his country's nuclear research from almost scratch.

In 1978-85 he was elected CAS vice-president, where he worked hard to promote international scientific collaboration, heading CAS delegations to many countries, which resulted in numerous collaboration agreements. After visiting CERN in 1978 and the US in 1980, he helped to develop exchange programmes in high energy physics with Europe and the US. This led to the construction



CERN's participation at the Seville Expo '92 World Fair included two special events, each highlighting a country relatively new to the CERN family. The first, from 10-12 May, featured Israel, which became a CERN Observer State last year. Seen here on the CERN stand in the Ambiente '92 hall are (left) Giora Mikenberg of the Weizmann Institute and the Opal experiment, with Yael Naaman, sales manager of the IIS firm. The second event, on 4-5 June, put the spotlight on Finland, which became a member State in 1990.

Members of a Boston/Brookhaven/Cornell/ Fairfield/Heidelberg/Los Alamos/Novosibirsk/ Tokyo/Riken/Yale collaboration standing in front of a partially completed storage ring coil for an experiment at Brookhaven to measure the anomalous magnetic moment of the muon (g-2) with unprecedented accuracy. The completed apparatus will contain two such 14-metre diameter superconducting coils (September 1991, page 23).



and operation of the Beijing Electron Positron Collider, the first high energy accelerator in China. In 1985 he became Officier of the French Légion d'Honneur. During the1980s he was elected president of Chinese Physical Society and honorary president of Chinese Nuclear Society, among other responsibilities, and kept working until the last moment of his life. Professor Qian had a life-long commitement to educate and train the younger generations, and many of his students now are active in various fields of Chinese scientific research.

From his colleagues

Mass Spectrum

Instrumentation specialists LeCroy Corp are hosting this year's Conference on Instrumentation for Time-of-Flight Mass Spectrometry, to be held 11-12 November at LeCroy headquarters, Chestnut Ridge, New York. Contact George Blanar, LeCroy Corp, 700 Chestnut Ridge Road, Chestnut Ridge, NY 10977-6499, tel (914) 578-6012, fax (914) 578-5984.

UNIVERSITÄT HAMBURG

Im Rahmen eines Kooperationsvertrages zwischen der Universität Hamburg und dem Deutschen Elektronen-Synchrotron DESY suchen wir zum baldigen Eintritt eine(n)

Wissenschaftliche(n) Mitarbeiter(in) promovierte(r) Physiker(in)

Der (die) Bewerber (in) soll an verantwortlicher zentraler Stelle beim Betrieb und Ausbau des H1-Detektors mitwirken und insbesondere die Arbeiten und Beiträge mehrerer externer Institute koordinieren. Er (sie) soll für die Kalibration von Detektoren und deren permanente Überwachung verantwortlich sein.

Wir erwarten eine abgeschlossene Hochschulausbildung, Promotion in Physik und mehrjährige Berufserfahrung auf dem Gebiet der experimentellen Hochenergiephysik, insbesondere Erfahrungen beim Bau von Detektoren. Die Stelle ist unbefristet.

Schwerbehinderte werden bei gleicher Eignung bevorzugt berücksichtigt.
Schriftliche Bewerbungen sind zu richten an

Universität Hamburg
Personalreferat 331.8
Moorweidenstrasse 18
D - 2000 Hamburg 13
Tel. 049 40 4123 4415.

Division Head

Research Division

The Research Division at Fermi National Accelerator Laboratory plays a vital role in planning and implementing the research program at the Laboratory. Currently, an opportunity is available for an individual with scientific and technical management experience to provide leadership to this Division.This is a key senior appointment within the Laboratory organization.

Reporting to the Laboratory Director, this position is responsible for the planning, R&D, construction, operation and maintenance of the collider detectors, fixed target detectors and fixed target beam lines; financial management of the division; human resource programs; reinforcement of university/FNAL relations; contributions to PAC deliberations; and serving on advisory committees. A Ph.D. in High Energy Physics, and a background in experimental physics and/or accelerator program participation are required,as is the ability to make effective verbal and written presentations.

Located in a large, campus-like setting 40 miles west of Chicago, Fermilab will provide an attractive salary and excellent benefits program. For consideration, please send your resume to: **Mr. Ken Stanfield, Chair Search Committee, Fermi National Accelerator Laboratory/ CC992, P.O. Box 500, Batavia, IL 60510-0500.** Equal Opportunity Employer M/F/D.

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ISTITUTO NAZIONALE DI FISICA NUCLEARE (I.N.F.N.)

Post-doctoral fellowships for non Italian citizens in the following research areas : Theoretical Physics (n.8) Experimental Physics (n.14)

Applications are invited for one year fellowships, which will start before November 1993.

Fellowships are intended for young post-graduates (candidates should not be more than 35 years of age at the time of application).

Each fellowship is granted for one year, and may be extended for a second year.

The annual gross salary is lit. 30,000,000, plus travel expenses for a return trip from home Institution to I.N.F.N. Section or Laboratory.

Candidates should submit an application form and a statement of their research interest, including three letters of reference.

Applications should reach I.N.F.N. not later than September 30, 1992.

The successful applicants may carry on their research at any of the following laboratories and sections of I.N.F.N. :

National Laboratories of Frascati (Rome), National Laboratories of Legnaro (Padova), National Southern Laboratories (Catania) and National Gran Sasso Laboratory (L'Aquila).

INFN Sections in the universities of :

Turin, Milan Padua, Genoa, Bologna, Pisa, Rome "La Sapienza", Rome II, Naples, Catania, Trieste, Florence, Bari, Pavia, Perugia, Ferrara, Cagliari, Lecce and National Institute for Health (Rome).

Enquiries, requests for applications forms, and application should be addressed to :

Fellowship Service - Personnel Office,
Istituto Nazionale di Fisica Nucleare (INFN)
Casella Postale 56 - I 00044 FRASCATI (ROMA)

Experimental Physicist (Software)

Physics Research Staff Position

The Continuous Electron Beam Accelerator Facility (CEBAF) is a 4 GeV high intensity (200 micro amp), high duty-factor electron accelerator under construction in Newport News, VA. We invite applications for the position of Software Coordinator for Hall B. Duties will involve coordination and active participation in the development and implementation of the on-line acquisition and analysis software for the CEBAF Large Acceptance Spectrometer (CLAS). This will require working with the Hall B software group, interacting with the hardware groups responsible for building various components of CLAS, and working closely with the CEBAF-wide data acquisition group. The qualified candidate should have a Ph.D. in Experimental Nuclear or Particle Physics plus three years of experience in the design and implementation of on-line software for high data-rate experiments, or an equivalent combination of education, training, and specific experience related to this position. Experience with large acceptance detectors, for example, at a high-energy collider is especially desirable. Demonstrated in-depth experience with real-time development on Unix platforms and the ability to coordinate and participate with a scientific team is required. Salary is commensurate with working experience and educational background and includes a comprehensive benefits package. Interested candidates should send a curriculum vitae and arrange for three letters of recommendation to CEBAF, ATTN: Employment Manager, 1200 Jefferson Avenue, Newport News, VA 23606, USA.
Specify position number PR2119 and job title when applying.
To insure consideration, applications should be received before October 9, 1992.
CEBAF is an Equal Opportunity, Affirmative Action Employer.

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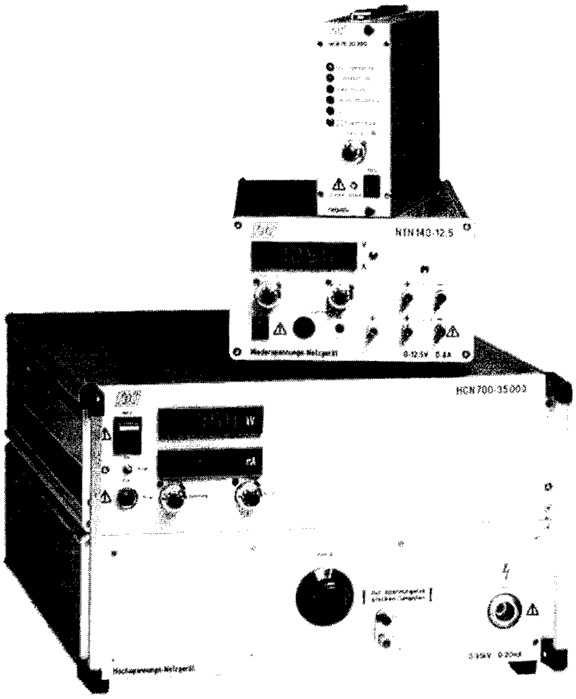
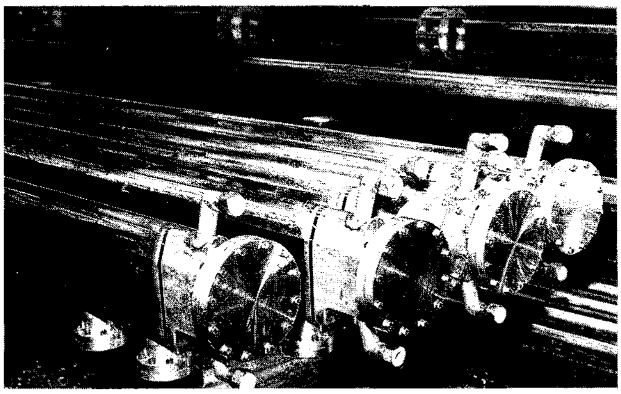
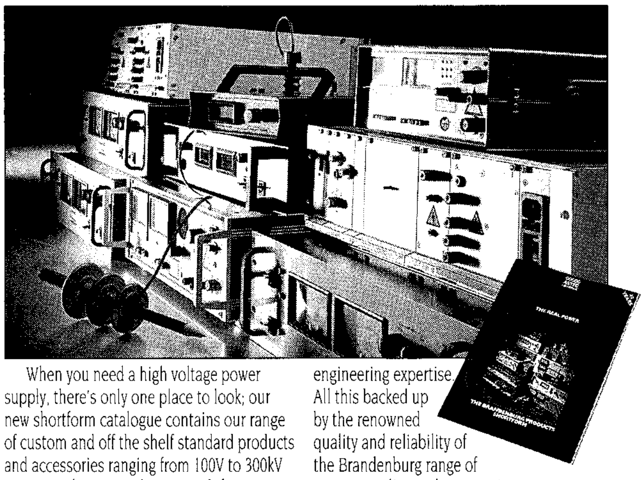




Lead-lined chambers for LEP-ring, CERN



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