CERN COURIER

International Journal of High Energy Physics

VOLUME 28 3 APRIL 1988

Laboratory correspondents:
Argonne National Laboratory, USA
M. Derrick
Brookhaven National Laboratory, USA
N. V. Baggett
Cornell University, USA
D. G. Cassel
Daresbury Laboratory, UK
V. Suller
DESY Laboratory, Fed. Rep. of Germany
P. Waloschek
Fermi National Accelerator Laboratory, USA
M. Bodnarczuk
KfK Karlsruhe, Fed. Rep. of Germany
M. Kuntze
GSI Darmstadt, Fed. Rep. of Germany
G. Siegert
INFN, Italy
A. Pascolini
Institute of High Energy Physics, Beijing, China
Wang Taijie
JINR Dubna, USSR
V. Sandukovsky
KEK National Laboratory, Japan
K. Kikuchi
Lawrence Berkeley Laboratory, USA
W. Carithers
Los Alamos National Laboratory, USA
O. B. van Dyck
Novosibirsk Institute, USSR
V. Balakin
Orsay Laboratory, France
Anne-Marie Lutz
PSI Laboratory, Switzerland
J. F. Crawford
Rutherford Appleton Laboratory, UK
A. D. Rush
Saclay Laboratory, France
Elisabeth Locci
Stanford Linear Accelerator Center, USA
M. Riordan
Superconducting Super Collider, USA
Rene Donaldson
TRIUMF Laboratory, Canada
M. K. Craddock

Copies are available on request from:
China —
Dr. Qian Ke-Qin
Institute of High Energy Physics
P.O. Box 918, Beijing,
People's Republic of China
Federal Republic of Germany —
Gabriela Martens
DESY, Notkestr. 85, 2000 Hamburg 52
Italy —
INFN, Casella Postale 56
00044 Frascati
Roma
United Kingdom —
Su Rooke
Rutherford Appleton Laboratory,
Chilton,
Didcot
Oxfordshire OX11 0QX
USA/Canada —
Margaret Pearson
Fermilab, P.O. Box 500, Batavia
Illinois 60510
General distribution —
Monika Wilson
CERN, 1211 Geneva 23, Switzerland

CERN COURIER is published ten times yearly in English and French editions. The views expressed in the Journal are not necessarily those of the CERN management

Printed by: Presses Centrales S.A.
1002 Lausanne, Switzerland

Published by:
European Laboratory for Particle Physics
CERN, 1211 Geneva 23, Switzerland
Tel. (022) 83 61 11, Telex 419 000
(CERN COURIER only Tel. (022) 83 41 03)
Telefax (022) 82 19 06

USA: Controlled Circulation
Postage paid at Batavia, Illinois

Volume 28
No. 3
April 1988

International Journal of High Energy Physics

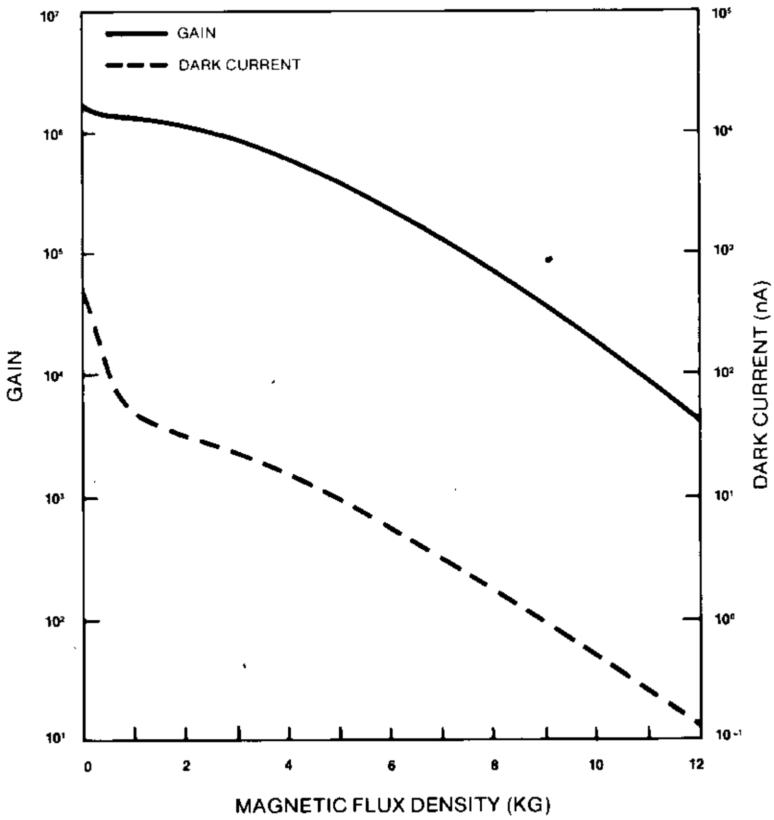
Editors: Gordon Fraser, Brian Southworth, Henri-Luc Felder (French edition) / Advertisements: Micheline Falciola / Advisory Panel: P. Darriulat (Chairman), H. Bøggild, H. Lengeler, A. Martin

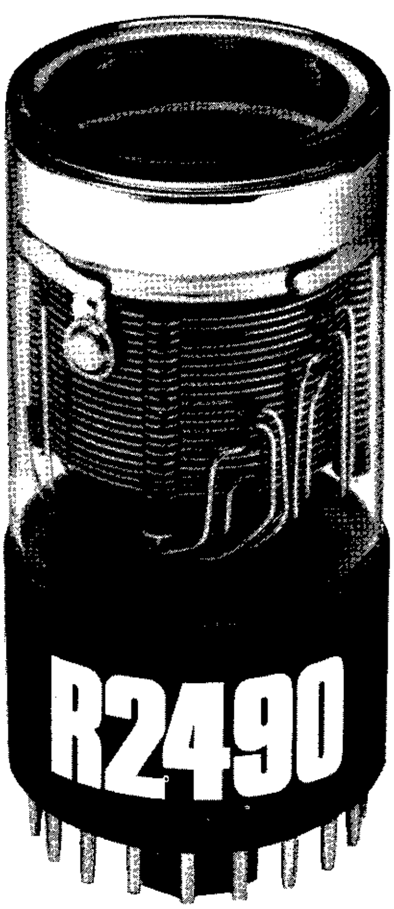
Cover photograph:
Leeds postgraduate student Nigel Smith at the South Pole, scene of a new joint cosmic ray experiment by the Bartol Research Institute, Delaware, US, and Leeds University, UK, see page 3. (Photo J. C. Perret)

2.3 x 10^4 Gain In 10K Gauss Magnetic Fields

This new photomultiplier tube (R2490) has an amplifying structure of fine mesh dynodes which provide excellent performance in high magnetic fields. It is the first high quality detector for High Energy Physics to overcome the gain killing effect of magnetic environments.

Call or write for Data Sheets on the R2490.





Hamamatsu
R2490
Photomultiplier Tube

HAMAMATSU

HAMAMATSU CORPORATION • 360 FOOTHILL ROAD, P. O. BOX 6910, BRIDGEWATER, NJ 08807 • PHONE: 201/231-0960

UNITED KINGDOM: Hakuto International (UK) Ltd. (phone: 0992-769090) • FRANCE: Hamamatsu Photonics France (phone: 46 55 47 58) ITALY: Hesa S. P. A. (phone: (02) 34.92.679) • W. GERMANY: Hamamatsu Photonics Deutschland GmbH (phone: 08152-375-0) SWEDEN, NORWAY, FINLAND, DENMARK: Lambda Electronics AB (phone: 08-620610) • JAPAN: Hamamatsu Photonics K.K.

SF6 HIGH VOLTAGE D.C. GENERATOR *

PERFORMANCE REQUIRED-OBTAINED

1 - Voltage regulation mode

a) Adjustment of output voltage
continuous from 0,2 to 160 kV
– from less than 0,1 to 180 kV
accuracy better than ± 100 V
– better than ± 50 V

b) Response time constant
less than 50 ms for a step
of +16 kV (10%)
– less than 15 ms

c) Line regulation
better than $\pm 2 \times 10^{-4}$ for a
± 10% variation of mains voltage
– better than $\pm 1 \times 10^{-4}$

d) Voltage ripple less than
100 V peak-to-peak at 50% load
– less than 80 V peak-to-peak-

e) Temperature coefficient
less than 1×10^{-4}/°C
– less than 1×10^{-4}/°C

2 - Current regulation mode

a) Continuous adjustment of output
current, in three ranges:
1 - 0 to 0,2 mA, accuracy ± 2 μA
– less than ± 1,5 μA
2 - 0 to 2 mA, accuracy ± 5 μA
– less than ± 3 μA
3 - 0 to 15 mA, accuracy ± 50 μA
– less than ± 20 μA

d) Current stability
Drift less than $\pm 1 \times 10^{-2}$ after 8 h
from 10% to 100% of nominal current
– less than $\pm 0{,}5 \times 10^{-2}$

* 39 UNITS ORDERED BY CERN FOR LEP EXPERIMENT

PASSONI VILLA

IMPULSE GENERATORS • D.C. STATIC GENERATORS
TEST TRANSFORMERS • RESONANT TEST SYSTEMS
STANDARD CAPACITORS • DIVIDERS, SHUNTS AND MEASURING EQUIPMENT
BUSHINGS UP TO 1200 kV • CAPACITIVE VOLTAGE TRANSFORMERS
POWER FACTOR CAPACITORS • GRADING CAPACITORS
CAPACITORS FOR SPECIAL APPLICATIONS

PASSONI & VILLA
EXPERTS IN HIGH VOLTAGE

V.le Suzzani, 229 - 20162 Milano (Italy)
Tel. (02) 6421451 (r.a.) - 6473821 (r.a.)
Telex 330420 PASVIL I - Telefax (02) 6423422 - Telegr. PASVILLA MILANO

Physics in the fast lane

Richard Phillips Feynman 1918-1988

(Photo Cornell)

'What I am really trying to do is to bring birth and clarity, which is really a half-assedly thought-out pictorial semi-vision kind of thing. OK?' Thus Richard Feynman once described his own genius.

A man who changed the way we see the world, his characteristic irreverence both for authority and for dogma made him always seek his own solutions to problems. Nowhere was this to become more evident than in his last major role, serving on the US Presidential Commission to investigate the 1986 Challenger disaster, where his famous ice-water experiment on the behaviour of the rubber seals dramatically demonstrated the inadequacies of technology worth millions of dollars.

His unorthodox brilliance rapidly led to graduate studies at Princeton with J.A. Wheeler. While working on his first assigned problems, he also grappled with the difficulties plaguing the ugly contemporary formulation of quantum electrodynamics. A PhD thesis on the classical problems of the interaction of radiation ensued, and in 1940 at Princeton, he was called to present his work to an audience of 'monster minds' including Einstein, Pauli, Von Neumann and Wigner, among others. The immature Feynman lacked the confidence to be irreverent.

His work on the quantum formulation of the radiation problem was interrupted by a call to join the Los Alamos team, where he became a group leader in Hans Bethe's Theory Division, working on a variety of problems. Here his characteristic irreverence bloomed, with Bethe and Bohr being deemed 'crazy'. However Feynman openly acknowledged his own volatility, expressing admiration for Bethe's disciplined thinking.

Turning down offers from several other universities, he followed Bethe to Cornell after the war. The death of his wife and his father initially stemmed the flow of ideas, although Bethe remarked at the time 'Feynman depressed is a little more cheerful than any other person when exuberant'.

The famous series of conferences at Shelter Island, Pocono and Oldstone helped provide the necessary stimulation during the years 1947-49, and in 1949 his classic papers provided a fresh new template for quantum electrodynamics, now one of the most precise theories ever formulated. Feynman diagrams - his typical way of visualizing the intricate mechanisms of sub-atomic physics – were born. For this work he received the Nobel Physics Prize, with Julian Schwinger and Sin-itiro Tomonaga, in 1965. As Schwinger remarked later, 'just like today's silicon chip, Feynman diagrams brought calculations to the masses'.

Twenty years after his landmark contributions to quantum electrodynamics, his ideas on 'partons' helped form our present picture of the deep interior of protons and neutrons.

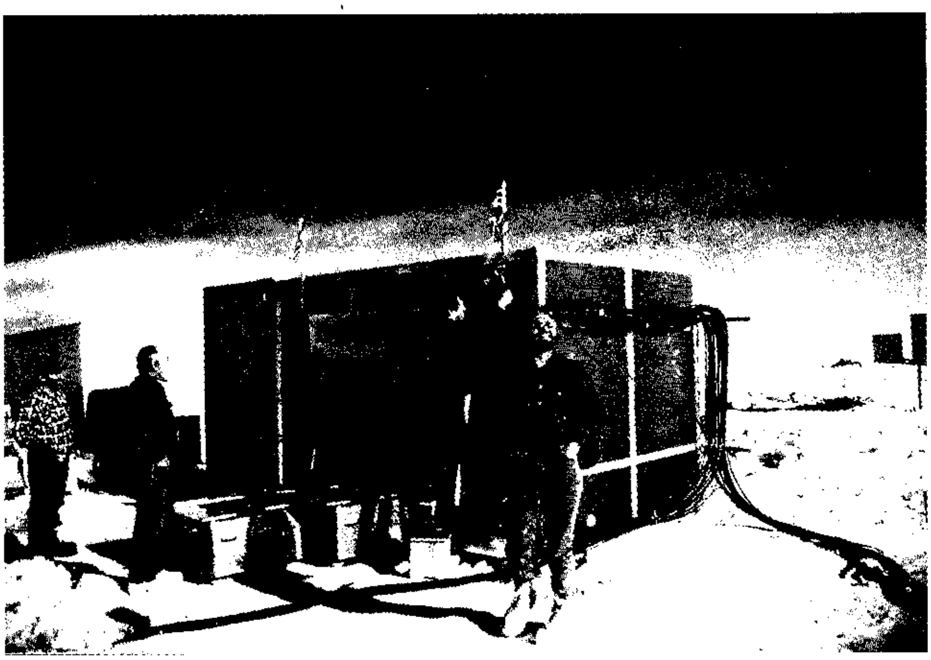
His Caltech lectures were an inspiration to students, and in book form 'The Feynman Lectures on Physics' stimulated many generations of physicists. His anecdotal autobiography 'Surely You're Joking, Mr. Feynman,' was a best seller when it appeared in the US in 1985.

His ideas remain as a monument to one of the world's greatest intellects, but the physics stage is poorer without his flamboyance.

Particle detection at the end of the earth

Setting up for science at the South Pole.

(Photos J.C. Perret)



During the Antarctic summer, a team of five, led by Martin Pomerantz and Alan Watson, has been installing an array of particle detectors at the Amundsen-Scott base at the South Pole. These form the South Polar Air Shower Experiment (SPASE), a joint project between the Bartol Research Institute, Delaware, US and Leeds University, UK.

The experiment will monitor extensive air showers from ultra high energy (100TeV) gamma rays for information on sources of such gamma-rays in the southern sky. Of particular interest are the supernova SN1987a and the X-ray binaries Vela X-1, LMC X-4 and SMC X-1.

Because the experiment is on the earth's rotational axis, candidate source objects which are above the horizon can be seen at the same zenith angle 24 hours per day, particularly suitable for studying transient emission. Additionally, the high altitude (2400m) means that the particle cascade in the atmosphere is closer to its maximum than is the case at sea-level.

The apparatus consists of 16 plastic scintillator detectors, each of one square metre, arranged on a grid with a spacing of 30m. Fast timing between the signals from different detectors determines the arrival direction of the shower to within one degree.

When the team arrived at the Pole in November 1987, the temperature was -45C, rising to a sweltering -20C at the height of the Antarctic summer! Installation went according to plan and the array recorded its first events on 22 December. It will be maintained through the forthcoming Antarctic winter by hardy Leeds postgraduate student Nigel Smith, enduring temperatures down to -80C.

Apart from one mid-winter mail drop, communication is restricted to a link through NASA's SPAN computer network. Some sample data will be sent out over this link throughout the winter. The complete dataset from the first six weeks of exposure has been brought back on tape and is currently being analysed. No further tapes can be returned to the collaborating institutes until the first plane after the Antarctic winter in November 1988.

From John McMillan

Recreating the aftermath of the Big Bang

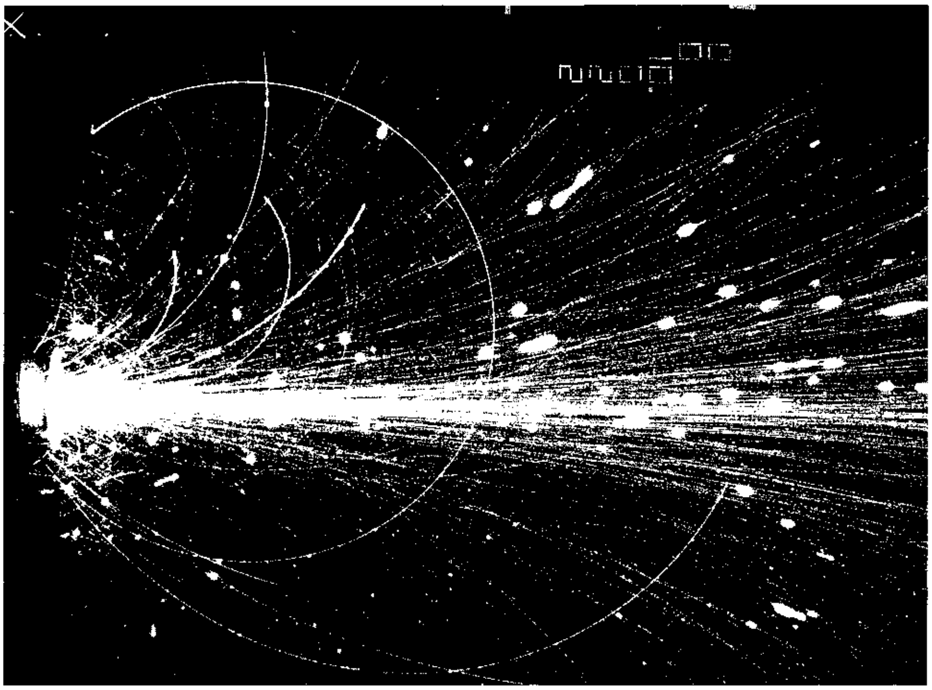
A few microseconds after the Big Bang, the Universe was most likely a fiery soup of quarks and gluons – the quark-gluon plasma, or 'quagma' – with the gluons carrying the inter-quark 'colour' force. As this cooled, quarks froze into 'colourless' bricks of nuclear matter – protons, neutrons and other strongly interacting particles – and have remained this way ever since.

However in the past few years, Brookhaven and CERN began supplying experiments with high energy beams of heavy nuclei. When such heavy projectiles slam into nuclear targets, the component quarks might be squeezed together and heated, breaking loose and recreating, fleetingly, something approaching quark-gluon plasma.

Results from these experiments were reviewed last year at the Quark Matter Conference at Schloss Nordkirchen, near Dortmund, West Germany (see November 1987 issue, page 5), but since then progress has been made, particularly at CERN, in ongoing analysis and where experiments have also profited from a run with sulphur 32 ions at 200 GeV per nucleon, supplying a record beam energy of 6400 GeV (see December 1987 issue, page 13).

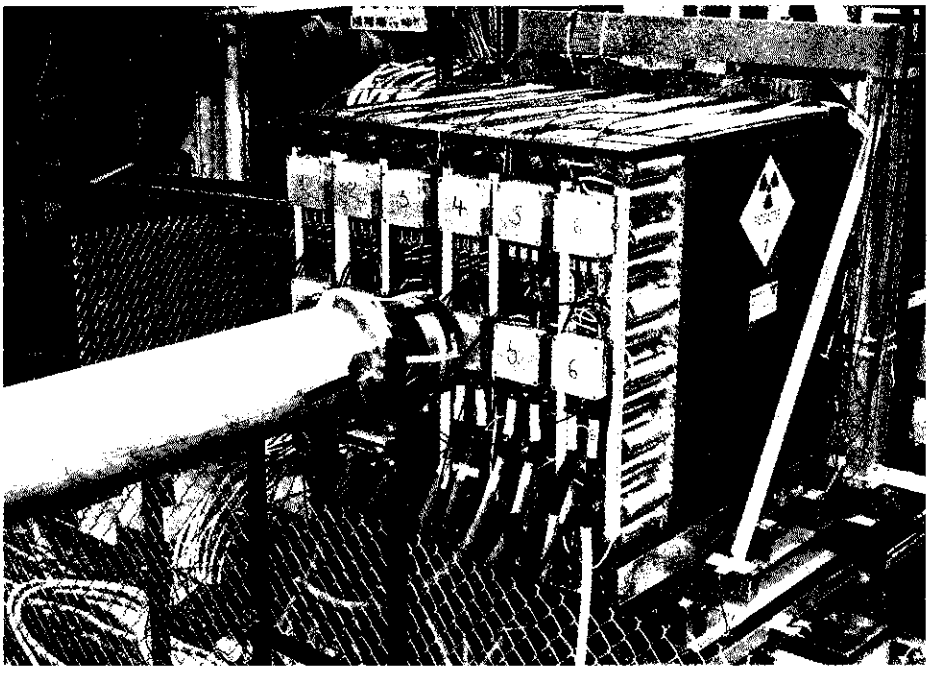
From 8-12 February, an International Conference on Physics and Astrophysics of Quark-Gluon Plasma at the Tata Institute of Fundamental Research, Bombay, India, took another look at the results from these experiments, hoping in particular that the increased energy densities from the sulphur run would have improved the chances of seeing quark-gluon plasma effects.

Although recreating conditions similar to those of the dawn of the Universe, microscopic amounts of



▲ *Experiments at CERN with high energy beams of heavy ions are playing a leading role in the search for new kinds of matter.*

▼ *The sodium iodide array backed by uranium calorimetry of Experiment 814 at the Brookhaven Alternating Gradient Synchrotron should provide interesting information about what happens to projectile nuclei after nuclear collisions, complementing what is learnt from other experiments about the target nuclei.*



M.G.K. Menon, Scientific Adviser to the Indian Prime Minister, inaugurates the International Conference on Physics and Astrophysics of Quark-Gluon Plasma at the Tata Institute for Fundamental Research, Bombay. Seated, left to right, are Conference Convenor Bikash Sinha, Organizing Committee Chairman B.V. Sreekantan, Tata Institute Director Virendra Singh and Organizing Committee Secretary Santanu Pal.

quark-gluon plasma do not jump out at the eagerly waiting experimenters. Instead, the signals are subtle, requiring careful interpretation.

Summarizing the experimental situation, Hans Gutbrod (GSI Darmstadt and CERN) sketched how the Brookhaven and CERN experiments had taken over where earlier studies at the Berkeley Bevalac had stopped, and gave a foretaste of the findings to be covered in detail in later sessions.

E.V. Shuryak of Novosibirsk recalled that only ten years had passed since physicists had first imagined the existence of a quark-gluon plasma, and paid tribute to the experimentalists and accelerator specialists who had been able to respond so quickly, creating a lively community of some 400 physicists.

At the outset, the experimental programme had been haunted by the uncertainty of the nuclear stopping power at these unexplored higher energies. Would a high energy beam lose a lot of its energy in the target, or would most of it shine through unperturbed? Shuryak and subsequent speakers averred that the stopping power was good, supplying enough concentration of energy to make interesting physics.

Shuryak drew attention to the change of slope seen in the low transverse momentum spectrum of the NA35 streamer chamber experiment at CERN, an effect also singled out by conference summarizer Leon Van Hove of CERN, pointing out that nothing of the kind is seen with proton beams.

Helmut Satz of Bielefeld and Brookhaven described how quarks can break loose in dense matter, drawing an analogy with electromagnetic screening effects, and indicated how computations, using an imaginary lattice to overcome calculational problems, had given insights into the temperature dependence of inter-quark forces.

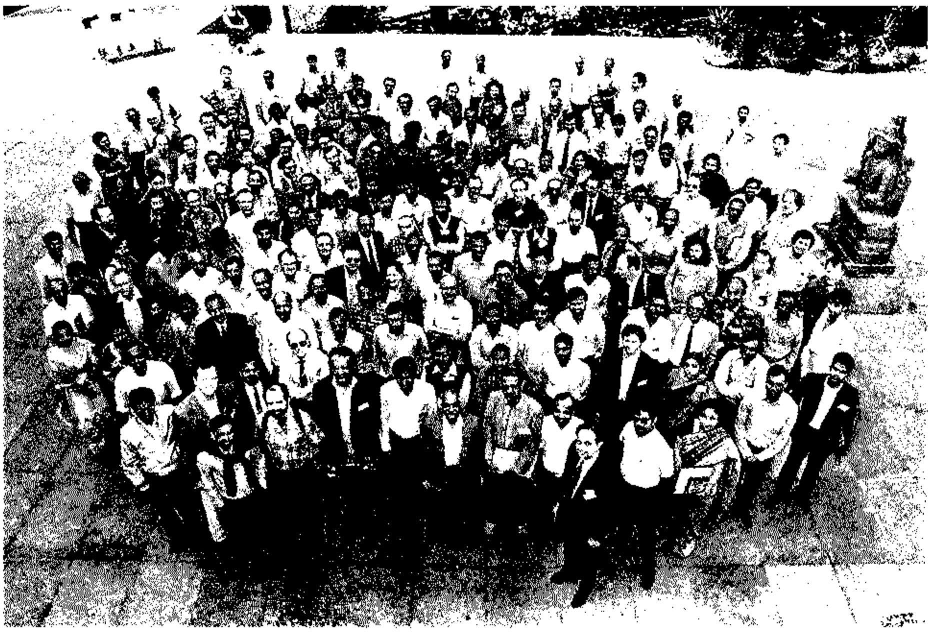
With the inter-quark forces looking very different inside plasma, light quark bound states break up, while heavier quarks may still be able to cling together for a while.

However even if plasma is formed, it will exist only inside a small region and for a brief interval, so that escaping quarks can still bind together according to the conventional rules. Thus suppression, rather than disappearance, of the J/psi is the clue. Satz singled out the suppression of the J/psi resonance as the most reliable, but not the only indicator of quark-gluon plasma.

The NA38 experiment at CERN benefits from high intensity beams and collects a good sample of J/psis. A. Romana (Ecole Polytechnique) presented the J/psi results seen using oxygen ion beams on both copper and uranium targets, providing the first glimpse of the long-awaited suppression, 'a beautiful result' according to Van Hove.

Hans Gutbrod of GSI Darmstadt and CERN gives an overview of the current experiments using heavy ion beams.

Delegates at the Tata Institute meeting.



Comparison of the copper and uranium results is interesting. While a J/psi spectrum has been compiled from the latest run with sulphur ions, it was unfortunately too early for Romana to make any comment about the increased J/psi suppression expected.

P. Gorodetzky of Strasbourg looked at NA38's muon pair spectra away from the J/psi area, including those from the recent run with sulphur ions, as a probe of pion and kaon production.

Ming Chu of MIT and J.P. Blaizot of Saclay showed how to extract quark-gluon parameters from the NA38 J/psi signals. S. Raha of Calcutta's Saha Institute played the heretic's role, pointing out more mundane explanations. After all, experiments using particle beams on nuclear targets had found that the distributions of quarks and gluons in those heavy targets look different to those of hydrogen or deuterium – the 'EMC Effect'. Why not a 'Hot EMC Effect'? asked Raha.

These difficulties were underlined by Frank Close of Tennessee ('quagma or quagmire?'). Although conceding that NA38 had something interesting, Close shied away from any definitive conclusion.

Van Hove advocated a search for alternative explanations of modified J/psi signals, predicting a flood of papers, with the experimental conditions providing plenty of room to manoeuvre. He also called for careful comparison of the effects observed with different kinds of beams.

The success of these higher energy studies has led to a push for heavier nuclear projectiles at CERN, while Brookhaven is gearing up for a wider range of beams and is hoping for the RHIC relativistic heavy ion collider to bring a new look to the mid 1990s. Helmut Haseroth of CERN sketched the history of ion beams at CERN and the accomplishments of the GSI Darmstadt/Berkeley/CERN collaboration and outlined the options for the future. Tom Ludlam described Brookhaven's plans.

Much of the Bombay meeting was given over to detailed reports from the other major experiments at CERN – the WA80 'Plastic Ball' (F. Plasil of Oak Ridge and H. Gutbrod), the NA34 'Helios' group (D.

Quark-gluon plasma specialist Helmut Satz (left) of Bielefeld and Brookhaven with Conference Convenor Bikash Sinha of Calcutta's Variable Energy Cyclotron Centre.

Rahm of Brookhaven and I. Riccatti of Turin), and the NA35 streamer chamber (K. Pretzl and P. Seyboth of Munich's Max Planck Institute).

Much progress has been made in analysing the complex data gleaned by these studies. Broadly, most of what happens is seen as being due to a sum of individual nucleon interactions, but this is not the whole picture. The effective interaction volume for sulphur 32 is not simply twice that of oxygen 16. As well as the interesting bump in the transverse momentum spectrum, NA35 explores the conditions for pions to interfere. The angular coverage of the Plastic Ball means that it is able to look closely at the pattern of emerging transverse energy, finding that the struck nucleons are 'wounded', 'blown to pieces', or even 'tortured', depending on the emotions of the speaker. WA80 also finds an interesting correlation in the angular distribution of transverse momentum, while NA34 reports a forward/backwards asymmetry in the production of charged particles.

Leaving aside the small-scale production of quark-gluon plasma in the laboratory and turning to astrophysics, Ed Farhi of MIT pointed out that quark matter could be hot enough to contain strange quarks as well as the lighter variants, and looked into its implications for the early Universe and for neutron stars, while Charles Alcock of Livermore took a close look at how the quark-gluon plasma of the early Universe could have frozen (see page 25).

In its exotic setting, the Conference reflected both the vitality of a new field of fundamental physics, and the enthusiasm and ability of Indian researchers to contribute.

Report by Gordon Fraser

India calling

As well as highlighting the latest physics results, the International Conference on Physics and Astrophysics of Quark-Gluon Plasma, held at the Tata Institute for Fundamental Research, Bombay, from 8-12 February, underlined India's enthusiasm for increased collaboration in international physics, building on a long tradition of visual detector studies and currently spearheaded by a Tata Institute team providing equipment for the big L3 experiment being built at CERN for the LEP electron-positron collider.

Inaugurating the conference, M.G.K. Menon, scientific adviser to the Indian Prime Minister and a member of the national Planning Commission, pointed out the relevance of physics with heavy ion beams and of quark matter studies for Indian physicists, and stressed the need for a policy of international collaboration at large accelerator centres.

Tata Institute Director Virendra Singh emphasized the importance of the field because of its ties with so many branches of physics - particle, nuclear, and statistical studies as well as astrophysics and other areas. With the search for quark-gluon plasma well poised, Conference Organizing Committee Chairman B.V. Sreekantan recalled the success of the physics conference organized by Homi Bhaba in Bombay in 1950 – before big international particle physics meetings had a regular schedule, but when the subject was ripe for progress. With names like Blackett, Wentzel, Leprince-Ringuet, Bernardini, Amaldi, Rosenfeld, Moller, Peierls, Perrin, Feather, Fowler and Raman present, this hope had been fulfilled.

After declaring that in his view signals of the quark-gluon plasma were not far off and with world interest mounting, Conference Convenor Bikash Sinha of Calcutta's Variable Energy Cyclotron Centre said that India is 'keenly aware' of these developments. 'It is time that we participate in a meaningful way in this great adventure.'

Important theoretical work has been carried out in India this decade, he pointed out, backed by a distinguished tradition in experimental work. 'It is time to break new ground,' he affirmed, with India taking a 'quantum leap' forward.

The message was also hammered home throughout the week of the conference, with delegates from abroad having the opportunity to inspect Indian facilities to see the progress which has been made. (In parallel, Indian scientists working abroad who wish to return home are invited to contact P.K. Malhotra at the Tata Institute, Bombay.)

Looking for the fifth force

A few years ago, physicists were startled by news of tiny unexplained effects in gravitational measurements, heralded by some as the harbingers of an as yet unseen force in Nature (see April 1986 issue, page 9). This sparked a wave of new measurements, and part of the 1988 Moriond Workshop on New and Exotic Phenomena held in Les Arcs, France, from 23-30 January highlighted progress.

In his fifth force summary at the workshop Bill Fairbank Sr. (Stanford) said 'if this turns out to be true, it is the most important thing now going on in physics'.

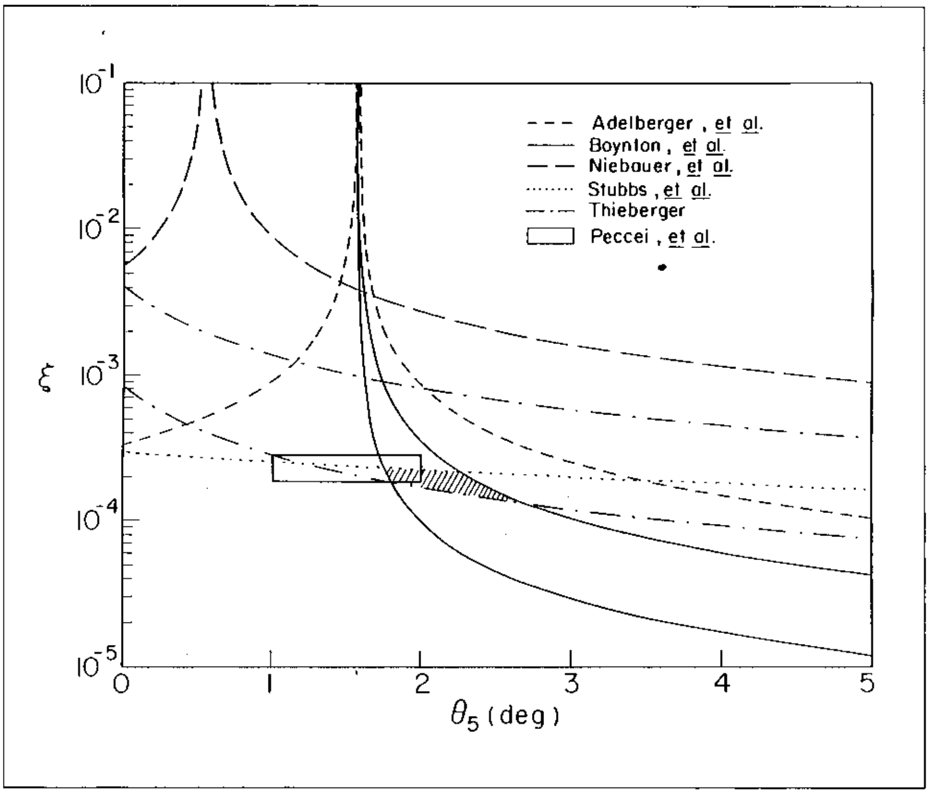
Presentations included status reports on new experiments and unpublished results from ongoing studies.

Paul Boynton (Washington) presented additional evidence for a composition-dependent force, while another Washington group, led by Eric Adelberger, had new negative results. These two experiments are at different sites, the first at the base of a large cliff, the second near a smaller hill on campus.

Boynton's experiment looks at the way the frequency of a torsion pendulum changes with its orientation to the cliff. However the directional effect is not perpendicular to the cliff, and so far this is not understood.

The Adelberger apparatus is a four-mass torsion balance which rotates relative to the hill. Some improvements to lessen the sensitivity to ordinary gravity gradients have been made, and tests were also carried out using 970kg of lead as the source. Both Washington groups plan further improvements and tests, and the Adelberger group is investigating the possibility of moving to the cliff site of

Room for a fifth force. Strength of an additional composition-dependent force (vertical axis) plotted against the mixing angle relating the force charge to neutron and proton numbers. The shaded region is where the experiments are compatible, and the rectangle is the prediction of the Peccei, Solà and Wetterich model.



the Boynton group's tests, or possibly to the cliff site used by Peter Thieberger (Brookhaven). Thieberger, whose floating-ball apparatus produced positive results a year ago, presented new results using the Brookhaven neutrino beam dump as a source. This negative result rules out any force dependent on nuclear composition with a range of less than 200m.

A new floating ball apparatus was described by Pier Giorgio Bizzeti (Florence). He reported no evidence for a composition-dependent force after the first two weeks of running, but emphasized that the results were very preliminary and that a number of checks remained to be carried out.

Preliminary results were also reported by Jim Faller from a new floating Eotvos balance setup; the results are not yet sufficiently precise to impose new constraints on composition-dependent forces.

The Workshop heard and discussed at length the recently announced findings from the tower experiment of Don Eckhardt which finds deviations from Newtonian gravity. Measurements in a 600m television mast are compared with the predictions of an extensive ground survey of gravity extending 200km from the tower base. There is a height-dependent effect of a few parts in ten million, and extensive discussions did not uncover any sources of systematic error that Eckhardt hadn't already accounted for.

New measurements will retest the gravimeter's sensitivity. The results indicate an attractive force, but it is difficult to account for the detailed shape of Eckhardt's data. His best fit suggests a non-Newtonian attraction together with a smaller repulsion, with the former having already been billed in the press as the Sixth Force!

Jim Thomas (Caltech) reported new underground gravity measurements in Nevada, showing discrepancies similar to those originally reported by Frank Stacey (Queensland). However Thomas called for caution because of the uncertainties in determining the so-called free-air gravity gradient.

Clive Speake presented the first results from a new experiment with a flexure-strip common balance. To search for any composition-dependent force, 2.3kg carbon and lead test masses were weighed near a 1000kg mass with the impressive precision of 10ng. Small incremental improvements will enable Speake to put limits on short-range weak forces dependent on nuclear composition.

In his introductory lecture Ephraim Fischbach (Purdue) noted that more than 40 experiments are looking for the Fifth Force. Many are near to being commissioned and taking data. The techniques include torsion balances, free-fall experiments, pumped water experiments, gravity wave antennae, ice boreholes,..........

Particle physics experiments were covered by Richard Hughes (Los Alamos) and Sam Aronson (Brookhaven). Two CERN experiments, NA31 on neutral kaons and the experiment at the LEAR low energy antiproton ring to look for any proton-antiproton mass difference, will play important roles.

The connection with astrophysical observations (especially of eclipsing binary star systems) was described by Cliff Burgess (McGill) and John Moffat (Toronto).

The conflicting experimental results did not deter theorists from putting forward candidate models. While it is too early to discriminate between different experimental results and candidate theories, one clear consensus emerged from Moriond: the search for subtle new forces is a significant and rapidly growing field of research and will continue to have an impact on physics regardless of the outcome of the present controversy. Thus the fifth force is scheduled for more discussion at next year's Moriond Workshop on New and Exotic Phenomena.

From Sam Aronson and Ephraim Fischbach

Around the Laboratories

STANFORD
Mark-II rolls in

After a three-month shutdown, the commissioning of the Stanford Linear Collider (SLC) began anew in mid-January. The machine had been turned off in early October for the 1800-ton Mark-II detector to be rolled into position at the machine's interaction point.

Meanwhile, many improvements were made to the SLC subsystems. In particular, the magnets in the two arcs bringing the electrons and positrons round to the collision point were adjusted to reduce the sensitivity of both beams to optical mismatches between successive elements (see October 1987 issue, page 23).

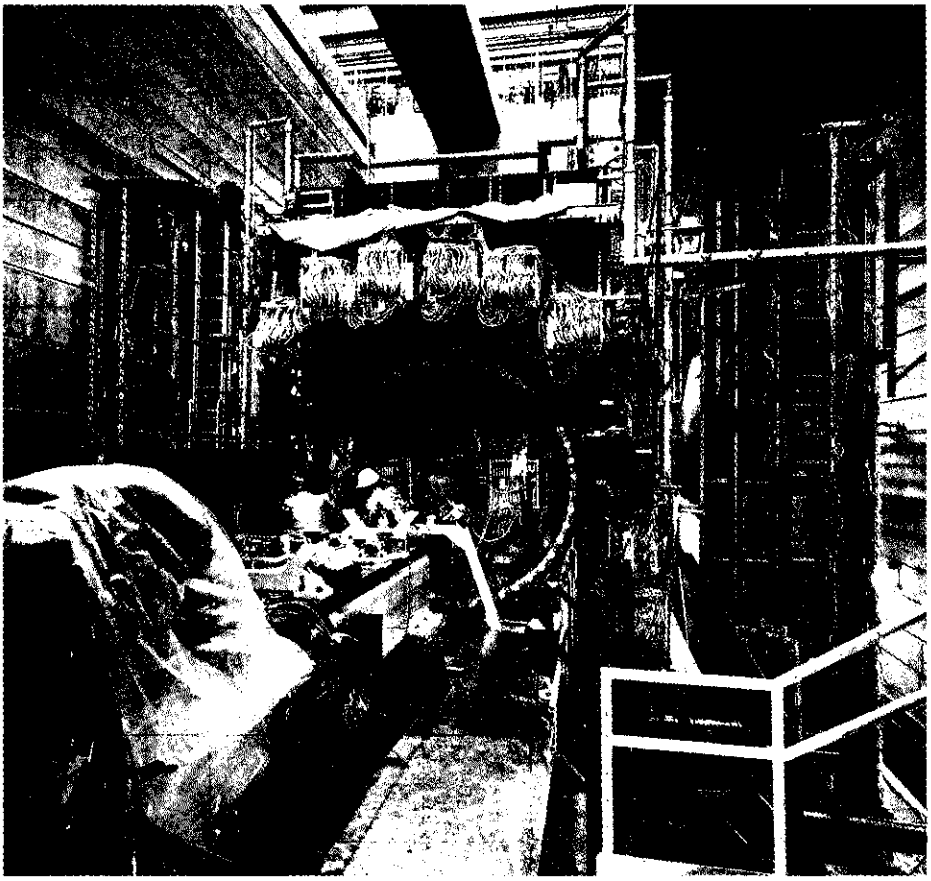
During most of February, the SLC was routinely operated with all three bunches (positrons, electrons and electrons for positron production) in the linac simultaneously. Pulses of 2×10^{10} electrons and 10^{10} positrons have been delivered to the arcs. Both beams have been transported through the arcs to the final focus, validating the improvements made to the arc optics during the shutdown. The electron (but not the positron) beam has been successfully transmitted through the interaction point and into its dump.

Emittance growth of the electron beam has proved a knotty problem. Due to small misalignments and subtle mismatches between machine elements, the tightly packed electron bunches spread out as they zoom down the linac and through the arc. By the time they reach the final focus, the emittance has grown fourfold, and low energy tails of the beam are scraping beam pipes and collimators. Whenever this occurs, a spray of muons hits the drift chamber and calorimeters in the Mark-II. These and other backgrounds have been limiting the currents delivered to the final focus.

At the end of February, a new record spot size was achieved at the interaction point, 3 microns wide by 5 microns high. With a special low-intensity electron beam in the final focus (1% of nominal),

The Mark-II detector in position at the point where electron and positron beams will collide in the SLC Stanford Linear Collider.

(Photo Joe Faust)



the Mark-II detector high voltages were turned on for the first time to begin studying backgrounds.

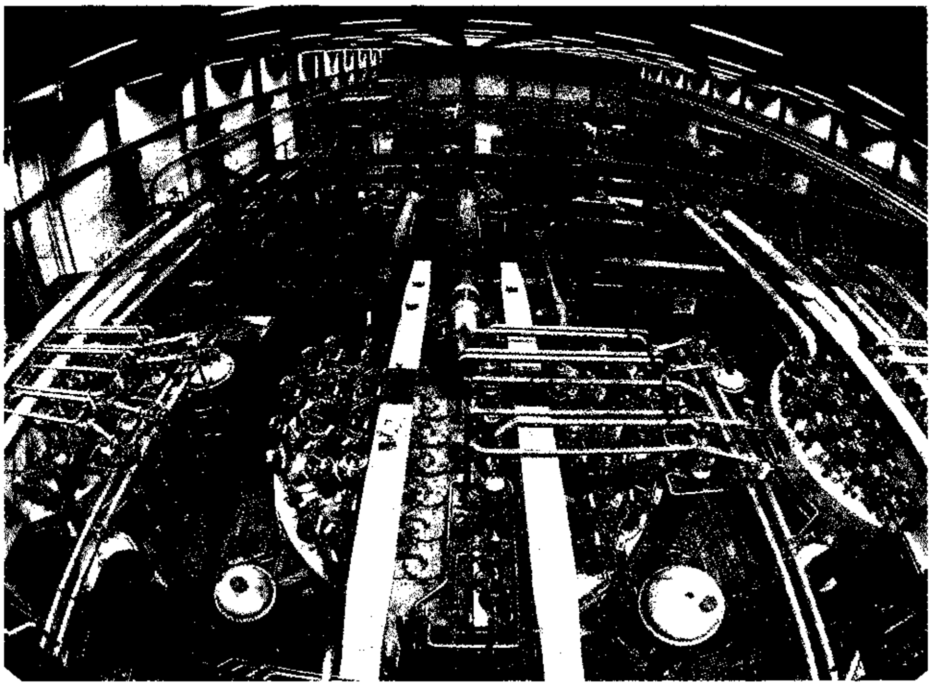
After a short shutdown in early March and installation of the remaining final focus collimators, the SLC commissioning began again. Emphasis is now upon further improvements to the final focus optics and on minimizing emittance growth in the linac and arcs to reduce the Mark-II backgrounds. These upgrades should raise beam intensities and allow data-taking to begin. The present schedule calls for electron-positron collisions inside the detector by Easter.

DESY
Crystal Ball sees light

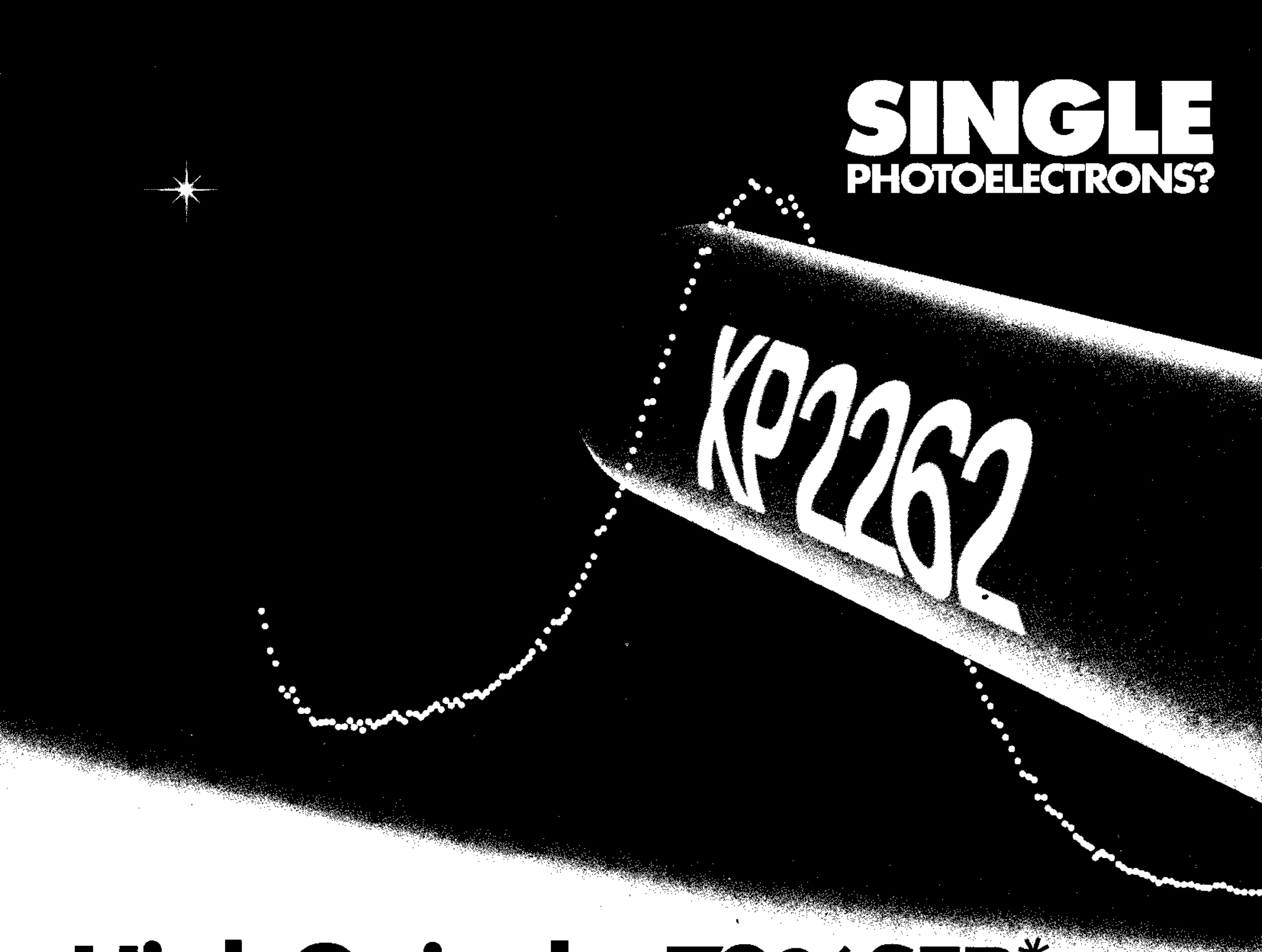
Back in 1960 Francis Low suggested measuring the lifetime of the neutral pion through its production in high energy photon-photon collisions.

Only recently have first results on this interesting 'inverse decay' been reported from the DORIS electron-positron storage ring at the DESY Laboratory in Hamburg by the Crystal Ball team. About 1200 events were collected, running with 5 GeV beams. The neutral pion lifetime, now well known through other experiments, was confirmed.

The two 'nearly real' photons producing the neutral pion come from electrons and positrons suffering very small deflections and exiting through the beam pipe. The



The three units of the helium refrigeration plant for the HERA electron-proton collider at the DESY Laboratory in Hamburg have been successfully put into operation. Under a special agreement, contractor Sulzer has taken over responsibility for the initial running of the complicated plant, the largest of its type in Europe.



High Gain $d_1 \Rightarrow$ 70% SER*

New XP2262 facilitates multiplier noise discrimination

A complete range of fast 2″ PMTs for physics and industry						
PMT	number of stages	t_r (ns)	t_w (ns)	σ_t (ns)	Δt_{ce} (ns)	pulse linearity (mA)
XP2262	12	2,0	3,0	0,50	0,70	250
XP2242B	6	1,6	2,4	–	0,70	350
XP2020	12	1,5	2,4	0,25	0,25	280
XP2230	12	1,6	2,7	0,35	0,60	280
High sensitivity bialkali 44 mm diameter cathode						

t_r = anode pulse rise time for a delta light pulse

t_w = anode pulse duration FWHM for a delta light pulse

σ_t = transit time spread for single electron mode

Δt_{ce} = transit time difference centre-edge

XP2262 replaces XP2232.

*SER = Single Electron Resolution

Other fast tubes:
3/4″ PM1911 3″ PM2312
1″ PM2982 5″ XP2041

Philips Industries
Electronic Components and
Materials Division
Eindhoven, The Netherlands

We've set the standard for over 20 years

PHILIPS Electronic Components and Materials

PHILIPS

precision two photon data are used to identify the events, separate them from background and finally fix the partial width for neutral pion decay as (7.7 ± 0.5 ± 0.5) eV.

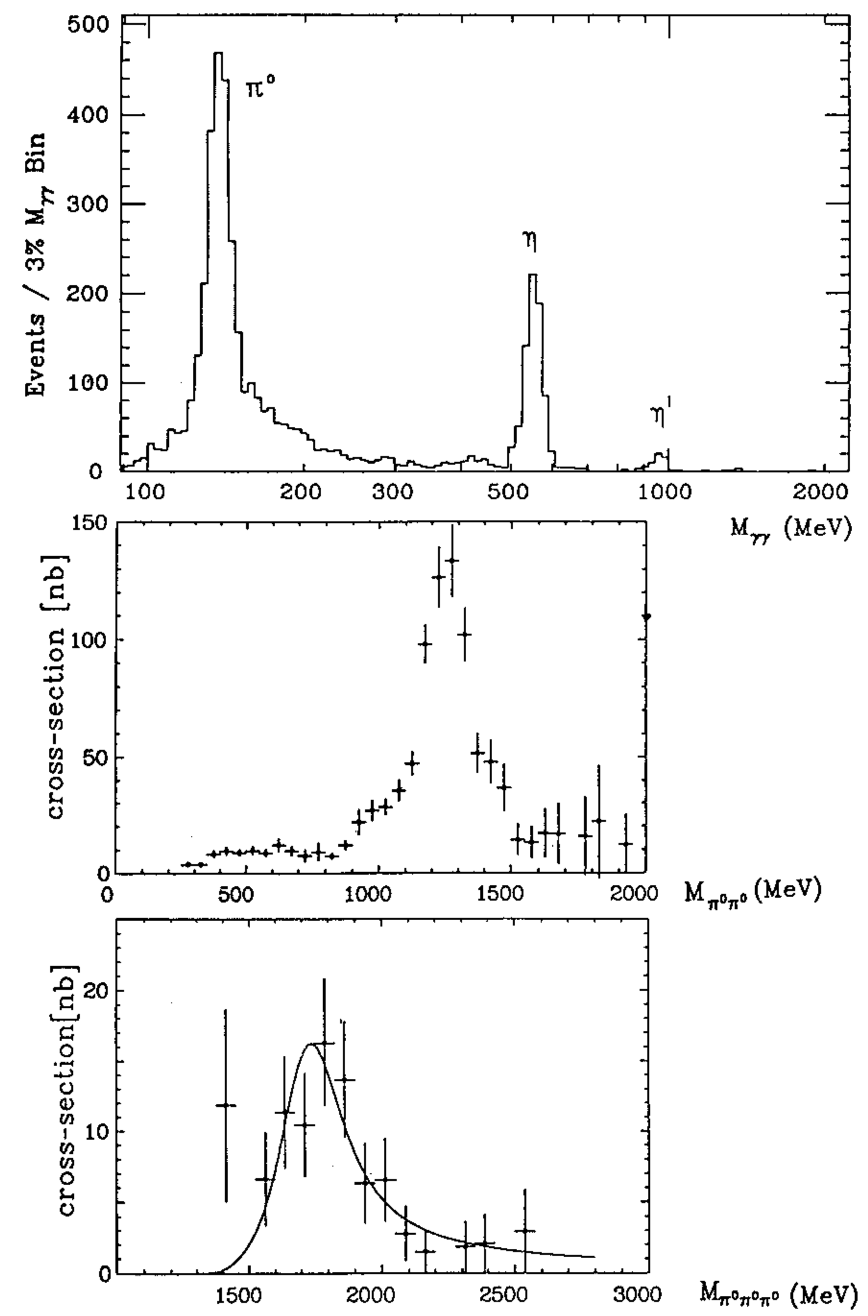
Crystal Ball is well suited for measuring reactions where only photons are detected. About 93% of the solid angle is covered by 812 sodium iodide crystal counters providing an energy resolution of 2.7% at 1 GeV. Recently results on final states containing four and six photons have also been presented.

The four photon system, from decays of two neutral pions or a neutral pion and an eta, was also carefully analysed. The two pion channel shows a dominant peak for the $f_2(1270)$. An enhancement at the mass of the $f_0(975)$ is not statistically significant. (The mass of a single neutral pion is obtained in the Crystal Ball detector with an accuracy of between 7 and 12 MeV, depending on the particle's momentum.)

The mass spectrum of the two pion system was measured for the first time down to the threshold of 270 MeV. At such low energies the identification of two charged pions in photon-photon collisions is very difficult and earlier data did not provide conclusive results.

In the six photon system, events due to three neutral pions show the $\pi_2(1680)$ peak for the first time in photon-photon collisions. The production rate is about one-tenth of that of the $f_2(1270)$. The known decay of the π_2 into an $f_2(1270)$ and a neutral pion was also observed, confirming the assignment of the resonance.

Analysis is being continued following Crystal Ball's return to Stanford last September. Its very successful guest performance at DESY lasted for about five years and was mainly concentrated on beauty quark physics. The detector was run at DESY by a major collaboration including institutions from the US (SLAC, Caltech, Carnegie-Mellon, Harvard, Princeton and Stanford), Germany (DESY, Erlangen, Hamburg and Wuerzburg), Italy (Florence), the Netherlands (Nijmegen) and Poland (Cracow).



Photon systems produced in photon-photon collisions, as seen by the Crystal Ball detector at the DORIS electron-positron collider. The peak in the middle plot corresponds to the $f_2(1270)$ resonance, that in the lower plot to the $\pi_2(1680)$ resonance.

HERA Progress

The first two superconducting quadrupole magnets produced by industry for the HERA electron-proton collider being built at DESY have arrived and are being tested. One is from German manufacturer Noell (Wuerzburg) and the other from French company Alsthom (Belfort). About half of the 246 superconducting HERA quadrupoles are a French contribution and will be built in France. Design and tooling for the industrial production of

ORGANISATION EUROPÉENNE
POUR LA RECHERCHE NUCLÉAIRE

EUROPEAN ORGANIZATION
FOR NUCLEAR RESEARCH

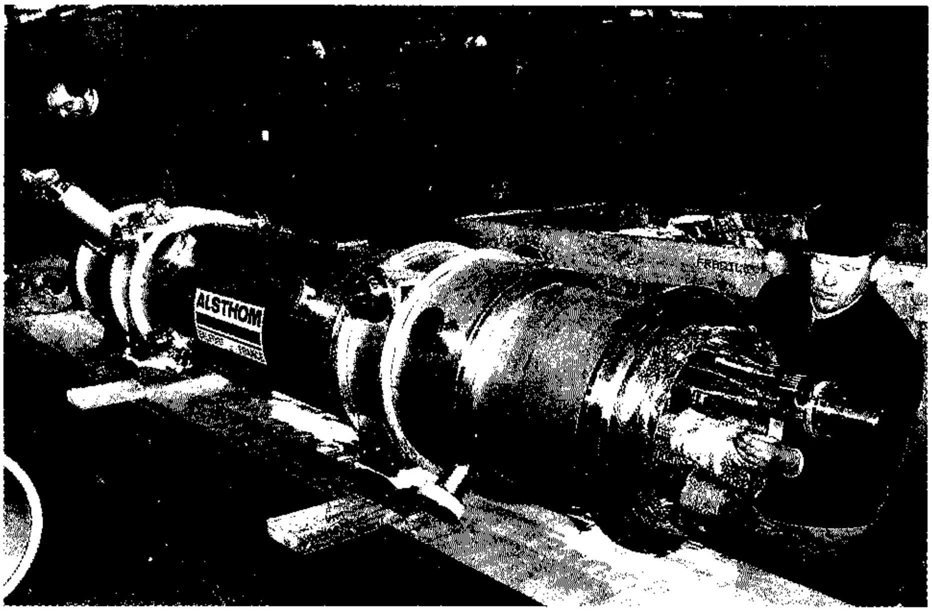
MOVING?

Please remember to let us know in good time. All notices of change of address must be accompanied by old and new addresses. (Include label from magazine wrapper.)

Any enquiries regarding subscriptions should be addressed to:

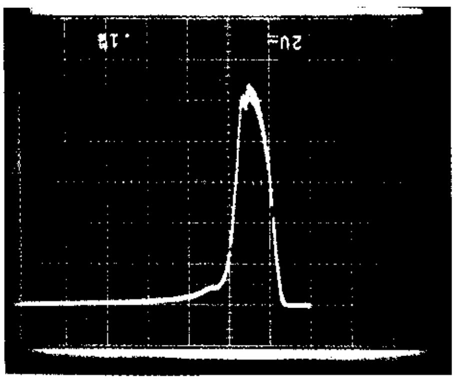
Monika WILSON
CERN COURIER / CERN
1211 Geneva 23 Switzerland

The first French-built superconducting quadrupole arrives for HERA. Half the 246 quadrupoles for the 6.3 km HERA ring are being supplied by French industry.



all these magnets were done at Saclay.

These quadrupoles are of the 'hybrid' HERA type, with the coil supported by metal collars. A mechanically-independent iron yoke surrounds the coil and is also kept at liquid helium temperature. This 'hybrid' design saves cooling power and has several other advantages. It was developed at DESY and is now widely used for superconducting dipoles and quadrupoles.



Beam profile of negatively charged gold ions produced by a new ion source at the Japanese KEK Laboratory.

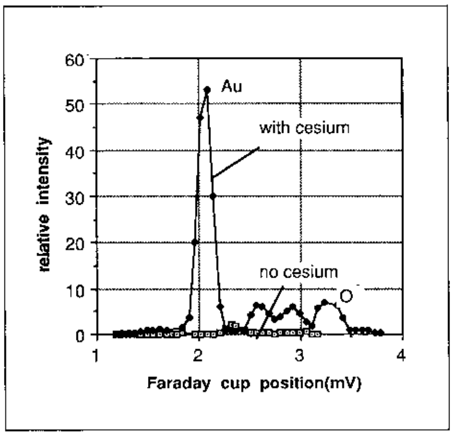
KEK
New ion source

An intense source of negatively charged heavy ions has been developed at the Japanese KEK National Laboratory for High Energy Physics, having produced negative ions of gold, copper and nickel with beam currents of 10, 8.2 and 5.5 mA respectively, almost a hundred times higher than currents obtained with conventional sputtered sources of such ions.

The ion source development group at KEK led by Yoshiharu Mori has been pushing towards an intense negative heavy ion source in collaboration with Gerald D. Alton from the US Oak Ridge Laboratory. The source is similar to the negative hydrogen ion source currently used to supply particles for the KEK 12 GeV proton synchrotron, using hydrogen atoms absorbed on a negatively biased metal surface in a hydrogen plasma discharge confined by a cusp magnetic field. Putting caesium in the plasma boosts the negative ion intensity.

Reflecting its pedigree, the source is called BLAKE (Berkeley – Los Alamos – KEK). To produce heavy ions, the hydrogen plasma was replaced with xenon, and an appropriate metal surface was used.

The KEK Laboratory has plans for a new facility providing both protons and heavy ions (see July/August 1987 issue, page 5).



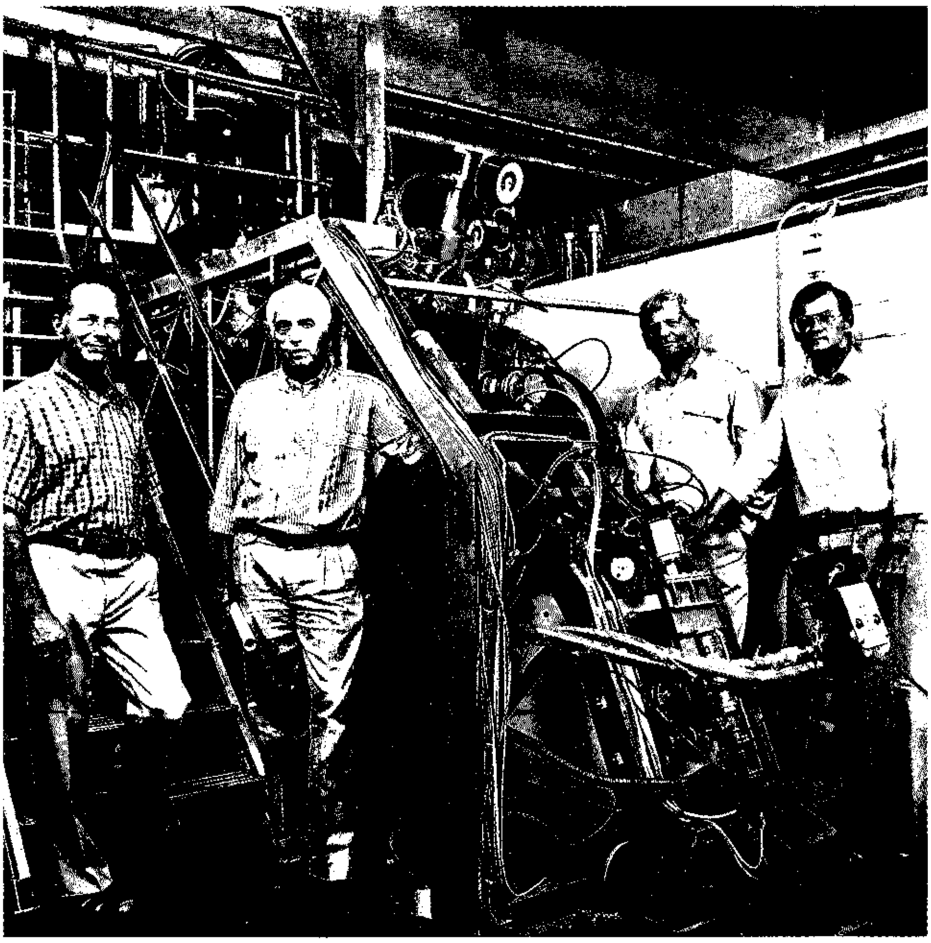
Spectrum of the KEK negative gold ions, showing how the addition of caesium to the plasma dramatically boosts the yield.

JÜLICH
New ion beams

Thanks to its new ion source, the large isochronous cyclotron JULIC of the Institute for Nuclear Physics at the Kernforschungsanlage Jülich (KFA) now provides experiments with a new range of beams.

JULIC was originally designed for the acceleration of light ions up to 45 MeV/A from an internal source. Since 1969 it has delivered these beams for more than 75000 hours for experiments mainly in nuclear physics, but also materials and life sciences.

Left to right, P. Wucherer, H. Beuscher, J. Reich and W. Brautigam with the 14 GHz electron cyclotron resonance ion source for the cyclotron at the Kernforschungsanlage (KFA) Jülich, Germany. With its increased range of beams, the nearly 20-year-old cyclotron is serving additional nuclear physics experiments.



The acceleration of heavier ions was not possible for a long time because JULIC can only accelerate ions with charge to mass ratios larger than 1/3, but the development of electron cyclotron resonance (ECR) sources towards the end of the seventies opened new possibilities. The ISIS (Injektion schwerer Ionen nach EZR-Stripping: injection of heavy ions after ECR-Stripping) project therefore started in 1982.

Its main component is a two-stage superconducting 14 GHz ECR source. A beam forming system transports the beam into the median plane of the cyclotron. For the axial injection, a new radiofrequency centre region has been designed. In the cyclotron itself, the main task was the improvement of the tank vacuum by an order of magnitude to better than 5×10^{-7} mbar by new cryopumps and by differential pumping of the large 3.30 m diameter O-rings. At an early stage a simpler 5 GHz ECR source with normal coils was developed as the light ion source (LIS). This turned out to be a most valuable decision for day by day operation.

The cyclotron was recommissioned for experiments in March 1987 with a 403 MeV 1.4 microamp beam of nitrogen-14(6+). Experiments have also used 0.61 microamps of 344 MeV carbon-12(5+), 0.13 microamps of 560 MeV nitrogen-14(7+), 0.14 microamps of 530 MeV nitrogen-15(7+), 0.1 microamps of 535 MeV oxygen-16(7+) and 0.01 microamps of 1069 MeV sulphur-32(14+). Argon 14+ is the heaviest ion accelerated so far.

ISIS has thus considerably boosted the potential of the almost 20-year-old JULIC cyclotron. With the new beams, interactions between nuclei at the Fermi velocity can be studied. Experiments cover giant resonances in highly excited nuclei, hard photons up to 100 MeV from bremsstrahlung mechanisms, fast nucleon and pion production, fragmentation of light and heavy nuclei, X-ray microstructure of heavy elements and multinucleon transfer.

For the future, site clearing has started at Jülich for the COSY-Jülich 2.5 GeV cooler synchrotron (not to be confused with the COSY compact synchrotron at the BESSY synchrotron radiation Laboratory in Berlin – see January/February issue, page 23). The JULIC machine will act as injector.

FERMILAB
Big new computer

With the new Central Computer Building near completion (see CERN Courier December 1987), one of the most important pieces of Fermilab's Central Computing Upgrade Project is falling into place. A contract was recently signed with Systemhouse, Inc. for delivery of a new large general-purpose computer system to be housed in the new building.

It consists of an Amdahl 5890 600E with four central processors and 192 Mbytes of main storage,

40 Gbytes of disk storage, 16 conventional tape drives, 8 cassette tape drives, 4 impact and 4 laser printers, Decnet and Ethernet gateway links, and connections for 250 terminals. May should see delivery of an initial consignment including two central processors with 96 Mbytes of main storage together with most of the peripherals. Delivery of the remaining equipment will depend on available funds.

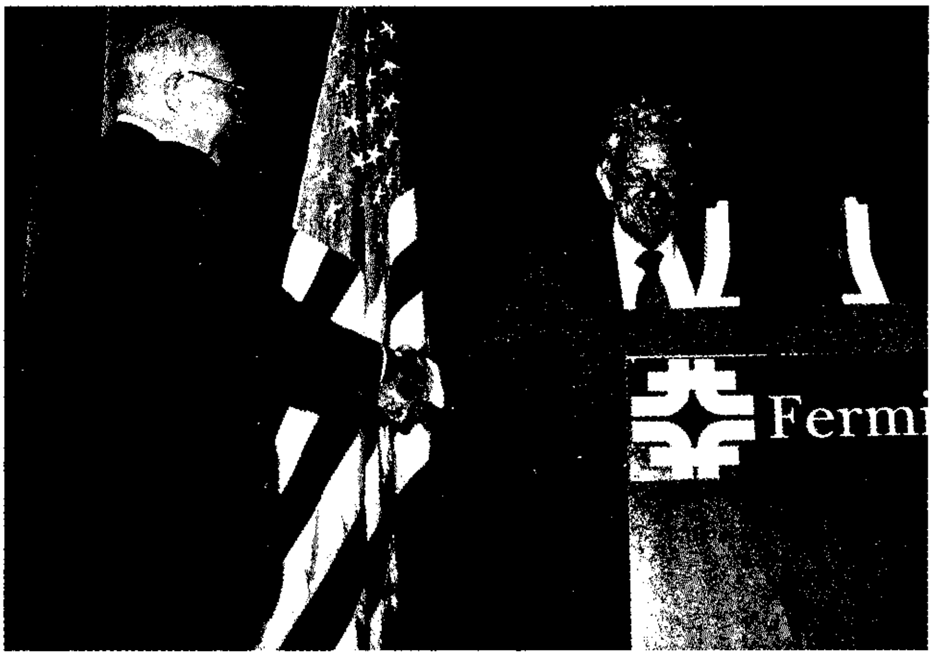
Peter Cooper, previously at Yale, is now Associate Head of Fermilab's Computing Department, with primary responsibility for data acquisition hardware and software. Jack Pfister continues as Associate Head with responsibility for central computing, with Jeff Appel still Head of the Department.

The inner radius of Fermilab's new Computing Centre.

Homage to Bill

A Symposium at Fermilab on 8 January marked William Wallenmeyer's move to the Presidency of Southern Universities Research Association (SURA, the corporate arm of the new CEBAF electron machine being built at Newport News, Virginia) after over twenty years at the United States Department of Energy, most recently as the Director for High Energy Physics, Office of High Energy and Nuclear Physics.

Opening the Symposium, Fermilab Director Leon Lederman recalled the initial phases of the high energy physics advisory panel (HEPAP) chartered by the Division of Research of the US Atomic Energy Commission in 1967, with which Wallenmeyer was directly involved. First HEPAP chairman was Viktor



Leon Lederman welcomes Bill Wallenmeyer to the platform.

How to visit CERN

Comment visiter le CERN

Organized visits take place only on Saturdays, at 9.30 a.m., and/or 2.30 p.m. The visits last about three hours and are free. The minimum age limit is 16 years.

Les visites commentées ont lieu seulement le samedi, à 9 h. 30 et/ou à 14 h. 30. Elles durent environ trois heures et sont gratuites. La limite d'âge minimum imposée est de seize ans.

Please write or call:
Ecrire ou téléphoner:

CERN
Visits Organization / Organisation des Visites
1211 GENEVA 23 Switzerland
Tel. 022/83 40 52 or/ou 83 41 02
Telex 2 36 98

Weisskopf, followed by Sidney Drell, Jack Sandweiss, and currently Francis Low. At the Symposium, each chairman gave his own impressions of the development of high energy physics in general and Wallenmeyer's role in particular.

Their consensus was that Wallenmeyer's assiduousness and commitment had contributed greatly to the success of high energy physics, a view echoed by many others, including Sam Ting and L. Edward Temple.

The end of the Symposium looked to the future, with perceptions from what Lederman, setting baby bottles filled with milk in front of each speaker, called the 'younger generation'. Bruce Winstein, Mike Witherell, Ewan Patterson and Derek Lowenstein gave their impressions of what future accelerators and instruments would need to look like.

HEPAP Chairman Francis Low passed out song-sheets and stepped to the piano to lead the singing of an original song – 'He'll Always Be Our Bill'.

After nearly four hours of praising and pranking, Wallenmeyer was allowed a few minutes to respond.

COSMOLOGY
Baryonic bubbles

Astrophysical measurements show that the Universe is still flying apart (the Hubble expansion), suggesting that it all started off with a Big Bang. However the gravitational attraction between the exploding pieces is presumably slowing this expansion, which will eventually stop if there is enough matter around for the interattractions to be sufficiently strong.

Einstein, who formulated his theory of general relativity before Hubble's measurements, realized something had to be counteracting gravity to keep the pieces of the Universe apart, and put in his 'cosmological constant' by hand.

With the initial Big Bang now providing the explosive force, this mysterious constant has been put on the back burner. However another dilemma arose. Today's abundances of light elements provide a vital clue to the formation of the Universe, and the explanation of the astronomical measurements is one of the major achievements of the Big Bang idea. However the conventional calculations also show that the amount of nuclear matter formed in the wake of the Big Bang is nowhere near enough to apply the gravitational brakes and halt the Big Bang explosion.

For everything to fit together nicely, most of the Universe has to be invisible - 90 per cent of the sky needs to be full of mysterious 'dark matter' supplying the additional gravitational tug.

Thus other dark matter candidates were sought, both known, like neutrinos, and unknown – weakly interacting massive particles (WIMPs), axions, etc. However new ideas now show that the dilemma could be resolved without recourse to exotic dark matter.

A major milestone in the history of the Universe occurred a few microseconds after the Big Bang when the seething gas of quarks and gluons had cooled down sufficiently for protons and neutrons, built of several quarks, to 'crystallize'.

One of the authors of a new idea, Charles Alcock of Livermore, compares this phase change to a simple experiment possible in a domestic freezer. Take a dilute solution, preferably with a coloured solute, like potassium permanganate, and freeze it. The liquid tries to resist, forming pockets of stronger solution, producing in turn an inhomogeneous solid.

In this picture, the cooling Universe would have produced high density bubbles of protons and neutrons coexisting with the remaining quark-gluon plasma, and with other particles, like electrons and positrons. With such an inherent inhomogeneity, the amount of nuclear matter can now be sufficient to close the Universe, although the measured level of lithium-7 is not easy to fit. Other authors prefer to use nuclear abundances as their yardstick to infer what could have happened after the Big Bang.

In the Dirac tradition

It was Paul Dirac who cast quantum mechanics into the form we now use, and many generations of theoreticians openly acknowledge his influence on their thinking.

When Dirac died in 1984, St. John's College, Cambridge, his base for most of his lifetime, instituted an annual lecture in his memory at Cambridge. The first lecture, in 1986, attracted two heavyweights – Richard Feynman (see page 1) and Steven Weinberg. Far from using the lectures as a platform for their own work, in the Dirac tradition they presented stimulating material on deep underlying questions.

(The lectures – 'Elementary Particles and the Laws of Physics' by Richard P. Feynman and Steven Weinberg – are published by Cambridge University Press.)

The late Richard Feynman – 'a way of looking at things so they appear not so mysterious'.

Richard Feynman

When I was a young man, Dirac was my hero. He made a breakthrough, a new method of doing physics. He had the courage to simply guess at the form of an equation, the equation we now call the Dirac equation, and to try to interpret it afterwards. Maxwell in his day got his equations, but only in an enormous mass of 'gear wheels' and so forth.

I feel very honoured to be here. I had to accept the invitation, after all he was my hero all the time, and it is kind of wonderful to find myself giving a lecture in his honour.

Dirac with his relativistic equation for the electron was the first to, as he put it, wed quantum mechanics and relativity together. At first he thought that the spin, or the intrinsic angular momentum that the equation demanded, was the key, and that spin was the fundamental consequence of relativistic quantum mechanics. However, the puzzle of negative energies that the equation presented, when it was solved, eventually showed that the crucial idea necessary to wed quantum mechanics and relativity together was the existence of antiparticles. Once you have that idea, you can do it for any spin, as Pauli and Weisskopf proved, and therefore I want to start the other way about, and try to explain why there must be antiparticles if you try to put quantum mechanics with relativity.

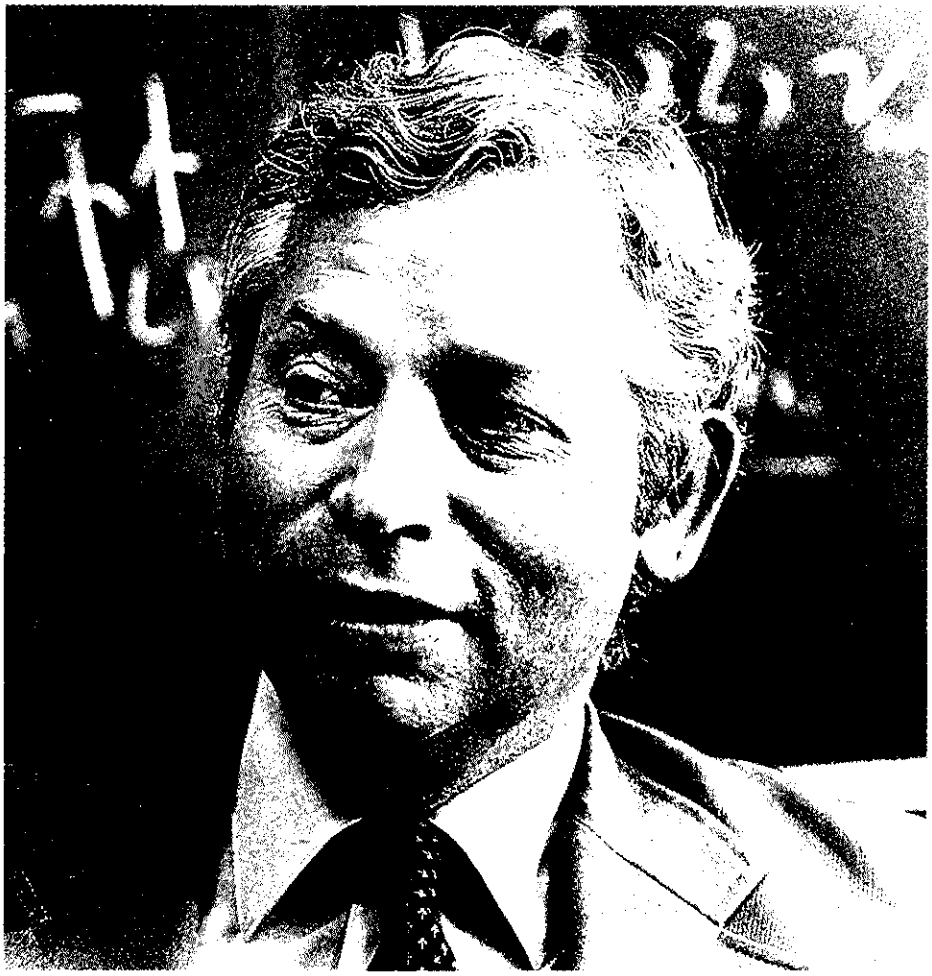
Working along these lines will permit us to explain another of the grand mysteries of the world, namely the Pauli exclusion principle. The Pauli exclusion principle says that if you take the wavefunction for a pair of spin one-half particles and then interchange the two particles, then to get the new wavefunction from the old you must put in a minus sign. It is easy to demonstrate that if Nature was non-relativistic, if things started out that way then it would be that way for all time, and so the problem would be pushed back to Creation itself, and God only knows how that was done. With the existence of antiparticles, though, pair production of a particle with its antiparticle becomes possible, for example with electrons and positrons. The mystery now is, if we pair produce an electron and a positron, why does the new electron that has just been made have to be antisymmetric with respect to the electrons which were already around? That is, why can't it get into the same state as one of the others that were already there? Hence, the existence of par-

ticles and antiparticles permits us to ask a very simple question : if I make two pairs of electrons and positrons and I compare the amplitudes for when they annihilate directly or for when they exchange before they annihilate, why is there a minus sign ?

All these things have been solved long ago, in a beautiful way which is simplest in the spirit of Dirac with lots of symbols and operators. I am going to go further back to Maxwell's 'gear wheels' and try to tell you as best I can a way of looking at these things so that they appear not so mysterious.'

Steven Weinberg

Steven Weinberg – looking for principles with a greater sense of inevitability.



'I am very grateful to St. John's College and to the Cambridge Mathematics Faculty for inviting me here to speak in honour of Paul Dirac. I was much in awe of him when as a student I learned of his great achievements. Later I had the privilege of meeting Dirac a few times, and I still am very much in awe of him. It's really quite a challenge to give a talk in honour of so great a man, and in planning it I felt that it would not be appropriate to speak about anything less than a great subject. I am going to jump over all details, and speak about what is for people working in my own area of physics the greatest question of all : 'What are the final laws of physics ?'

Well, not quite. Much as I would like to honour Dirac by presenting a transparency on which I have written the final laws of physics, in fact I am not going to be able to do that. My real topic must necessarily be more modest. It will have to be 'What clues can we find in today's physics that tell us about the shape of the final underlying theory, that we will discover some day in the future ?'

First of all, let me say what I mean by a final underlying theory. Over the last few hundred years scientists have forged chains of explanation leading downward from the scale of ordinary life to the increasingly microscopic. So many of the old questions – Why is the sky blue ? Why is water wet ? and so on – have been answered in terms of the properties of atoms and of light. In turn, those properties have been explained in terms of the properties of what we call the elementary particles : quarks, leptons, gauge bosons and a few others. At the same time there has been a movement toward greater simplicity. It's not that the mathematics gets easier as time passes, or that the number of supposed elementary particles necessarily decreases every year, but rather that the principles become more logically coherent ; they have a greater sense of inevitability about them. My colleague at Texas, John Wheeler, has predicted that, when we eventually know the final laws of physics, it will surprise us that they weren't obvious from the beginning.

I don't know if we will ever get there ; in fact I am not even sure that there is such a thing as a set of simple, final, underlying laws of physics. Nonetheless I am quite

sure that it is good for us to search for them, in the same way that Spanish explorers, whey they first pushed northward from the central parts of Mexico, were searching for the seven golden cities of Cibola. They didn't find them, but they found other useful things, like Texas.

Let me also say what I don't mean by final, underlying, laws of physics. I don't mean that other branches of physics are in danger of being replaced by some ultimate version of elementary particle physics. I think the example of thermodynamics is helpful here. We know an awful lot about water molecules today. Suppose that at some time in the future we came to know everything there is to know about water molecules, and that we had become so good at computing that we had computers that could follow the trajectory of every molecule in a glass of water. (Neither will probably ever happen, but suppose they had.) Even though we could predict how every molecule in a glass of water would behave, nowhere in the mountain of computer printout would we find the properties of water that really interest us, properties like temperature and entropy. These properties have to be dealt with in their own terms, and for this we have the science of thermodynamics, which deals with heat without at every step reducing it to the properties of molecules or elementary particles.

There is no doubt today that, ultimately, thermodynamics is what it is because of the properties of matter in the very small. But we don't doubt today that thermodynamics is derived in some sense from deeper underlying principles of physics. Yet it continues, and will continue to go on forever, as a science in its own right. The same is true of other sciences that are more lively today and in a greater state of excitement than thermodynamics, sciences like condensed matter physics and the study of chaos. And of course it's even more true for sciences outside the area of physics, especially for sciences like astronomy and biology, for which also an element of history enters.

I'm also not saying that elementary particle physics is more important than other branches of physics. All I'm saying is that, because of its concern with underlying laws, elementary particle physics has a special importance of its own, even though it's not necessarily of great immediate practical value. That is a point that needs to be made from time to time, especially when elementary particle physicists come to the public for funds to continue their experiments.

The realistic hope of finding a small set of simple principles that underlie all of physical reality dates back only sixty years, to the advent of the great revolution in physics which Paul Dirac put in its final form, the revolution known as quantum mechanics.'

People and things

On people

Julius Wess of Karlsruhe and Bruno Zumino of Berkeley receive this year's Dannie Heineman Prize for Mathematical Physics for 'crucial contributions to the discovery and development of supersymmetry, a profound extension of the notion of space-time symmetry, that may underlie unification of the fundamental forces'. The two theorists collaborated on this work in the CERN Theory Division in 1973.

A.H. Wapstra has been appointed Knight of the Order of the Lion of the Netherlands. From 1970 to 1983 he was Director of the Institute for Nuclear Physics Research (IKO), now the Nuclear Physics Division of NIKHEF, as well as being Professor at Delft Technical University.

Quantum theorist John Stewart Bell of CERN receives an honorary D.Sc. from Queen's University, Belfast, Northern Ireland.

Physicist Bill Ash steps down as the CERN Courier's correspondent at the Stanford Linear Accelerator Center, where he took over the slot from Lew Keller in 1984, continuing the West Coast tradition of enlightened but refreshingly informal despatches. He was also the first correspondent to communicate with us via electronic mail. His place is taken by physicist and author Michael Riordan, whose book 'The Hunting of the Quark' was published by Simon and Schuster in the US last year.

A lecture by Denys Wilkinson, a dinner and general festivities at the University of Durham, UK, in February marked the 80th birthday of G.D. Rochester.

During the March meeting of the German Physical Society (DPG) in Karlsruhe the 'Physik Preis 1988' was awarded to Alfred Petersen for his contributions clarifying the 'string effect' predicted by the Lund model for multihadron production in quark-antiquark-gluon formation processes. This work was done for the analysis of three-jet events produced at DESY's PETRA electron positron collider. Petersen was then a member of the JADE collaboration and is now working in industry.

Seth Neddermeyer 1907-1988

Seth Neddermeyer, co-discoverer with Carl Anderson of the muon in cosmic ray studies in 1936, died in January. As Anderson's first research student, Neddermeyer participated in pioneer studies using a sophisticated counter-controlled cloud chamber. Most of his subsequent career was spent at the University of Washington, Seattle.

Colin Fisher

Experimentalist Colin Fisher from the UK Rutherford Appleton Laboratory died tragically in February, aged 51. A classical bubble chamber physicist with a flair for innovation, he helped develop the 1970s' generation of rapid cycling chambers, going on in the early 1980s to hone the technique to a peak of perfection with specially designed small detectors. Subsequently he turned his attention to newer techniques using scintillating fibres and silicon microstrips in the study of short-lived particles containing heavy quarks.

Strengthening scientific and technological cooperation between CERN and the Commission of the European Communities (CEC). CERN Director General Herwig Schopper looks on approvingly as Karl-Heinz Narjes, CEC Vice-President in Brussels and responsible for industrial matters, information technology, science and research and the Centre commun de recherche, signs the visitors' book during his visit to CERN in February together with Herbert Allgeier, Director in the CEC Directorate-General for Science and Technology.

(Photo CERN 0653.2.88)

Books

'How Experiments End' by Peter Galison (University of Chicago Press) traces how the pattern of physics emerges from the laboratory. By way of illustration, a sizeable chapter deals with the fascinating saga of the quest for the neutral current of weak interactions, discovered at CERN in 1973 by the famous neutrino experiment using the Gargamelle bubble chamber.

Meetings

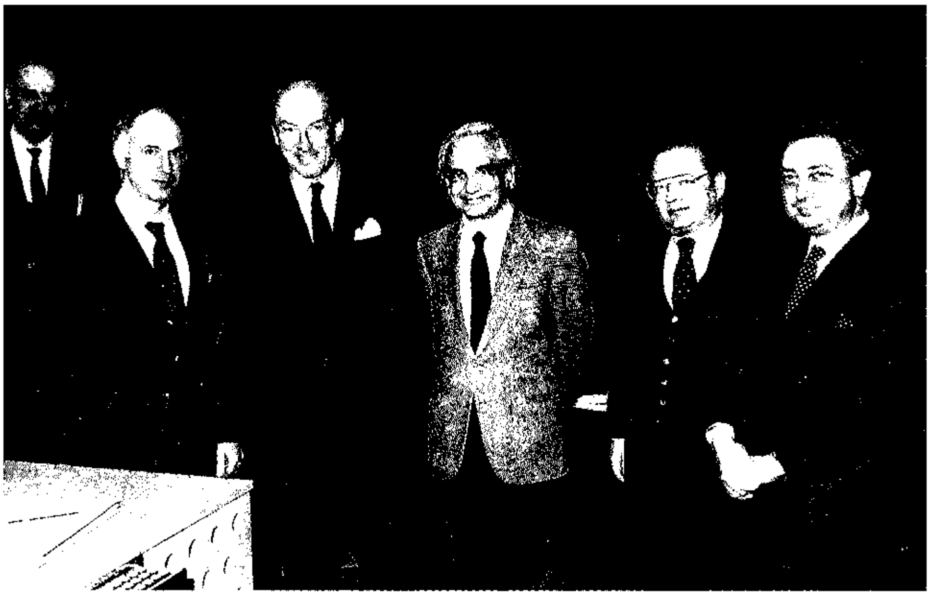
The 5th Workshop on Nonlinear Evolution Equations and Dynamical Systems (NEEDS '89) will be held in Kolymbari, near Chania, Crete, from 2-19 July 1989. Further information from F. Calogero, Dipartimento di Fisica, Universita di Roma 'La Sapienza', p. Aldo Moro, 00185 Rome, Italy.

This year's DESY Theory Workshop ('Flavor Physics') will be held in Hamburg from 28-30 September. Further information from Peter M. Zerwas, Institute for Theoretical Physics, RWTH-Aachen, D-5100 Aaachen, W-Germany, bitnet: ZERWAS at DACTH51

In conjunction with Daresbury Laboratory, the CERN Accelerator School is organizing a course on synchrotron radiation and free electron lasers in Chester, UK, from 6-

Italian high technology was on show at the German DESY Laboratory in Hamburg for one week in February, with one day given over to a symposium 'Scientific collaboration between Germany and Italy' concentrating on basic research and accelerators, organized by DESY and the Italian Institute for Foreign Trade.

At the exhibition, left to right, F. Venturini of the Italian Institute for Culture in Hamburg, DESY Director Volker Soergel, Italian Ambassador in Bonn Raniero Vanni d'Archirafi, Antonino Zichichi, Italian Consul General in Hamburg G. Germano, and organizer M. di Capua from the Italian Institute for Foreign Trade.



12 April 1989. Further information from Mrs. S. Wartburg, CERN Accelerator School, LEP Division, CERN, 1211 Geneva 23, Switzerland.

The topic for this year's SLAC Summer Institute is 'Probing the Weak Interaction: CP Violation and Rare Decays', The dates of the Institute are July 18th – 29th, 1988. The Institute includes a 7-day Summer School and three days of topical conference. Further information from Eileen Brennan, SSI Coordinator, SLAC, Bin 62, PO Box 4349, Stanford, CA 94309

The 1988 Summer Study on High Energy Physics in the 1990s, sponsored by the Division of Particles and Fields of the American Physical Society, the US Department of Energy, the National Science Foundation, and Universities Research Association, will be held in Snowmass, Colorado, from 27 June to 15 July. The aim is to examine and evaluate the opportunities for high energy physics in the 1990s, including the possibilities with existing facilities, the proposed US Superconducting Super Collider (SSC), new accelerator technology, non-accelerator experiments, special purpose facilities, and innovations in instrumentation and detector technology. A sub-meeting on July 5-7 will review progress of detector research and development for future proton-proton colliders. Working Groups cover Astrophysics/Particle Physics (J. Cronin, E. Kolb), Electroweak Symmetry Breaking (A. Seiden, H. Georgi), Strong Interactions, (M. Shapiro, I. Hinchliffe), New Quarks, Leptons and Gauge Bosons (C. Baltay, G. Kane), Weak Decays (M. Witherell, R. Peccei), Accelerator Physics, B Factories (R. Siemann), Large Linear Colliders (R. Ruth), SSC (A. Chao, R. Talman), and K Factories (M. Craddock). Further information from Joanne Day, Argonne National Laboratory, Argonne, IL 60439, US, telephone (312) 972-6181, bitnet JSD at ANLHEP.

Electronic Mail

The CERN Courier editorial desk can be contacted through electronic mail using the EARN/BITNET communications network. The Editor's address is

COURIER@CERNVM

Contributions coming in through electronic mail are edited on the screen, and are now coded for typesetting before being sent to the printer through a telephone modem link, making for increased flexibility.

For subscriptions (free!), changes of address, etc. the contact is

MONIKA@CERNVM

Distribution in the USA, West Germany, Italy, the UK and China is handled from regional centres (see page III).

STAFF PHYSICIST

Relativistic Heavy Ion Physics

The Los Alamos National Laboratory, a worldwide leader in technologies and scientific research, has an immediate opening for a motivated professional in its Medium Energy Physics Group. We are looking for an outstanding candidate with research interests in ultrarelativistic heavy ion collisions. The successful applicant will help define future experimental projects and is expected to contribute to currently approved experiments. The Group provides opportunities to interact with a team of 16 physicists, 4-5 postdoctoral research fellows, and a significant technical support group. Current research activities cover a broad range of experimental nuclear and particle physics at LAMPF, IUCF, FNAL, BNL, and CERN.

The appointment requires a Ph.D. degree in Experimental Physics and extensive experience in nuclear or high energy physics research, as evidenced by publication record, and the demonstrated ability to pursue a vigorous research program. Effective interactions within large international research groups are essential. A knowledge of high energy physics detector and data acquisition technology is desirable.

For additional information contact: Dr. Jules Sunier (MS D456), Los Alamos National Laboratory, Los Alamos, NM 87545. (505) 667-5505.

Los Alamos National Laboratory provides excellent compensation and benefits. To apply, submit detailed resume and publication record plus three letters of reference to: Richard O. Garcia (MS P205), Employment Group 80073-T, Los Alamos National Laboratory, Los Alamos, NM 87545.

Affirmative Action/
Equal Opportunity Employer

University of California

Los Alamos

High Energy Physics Safety Programs, Brookhaven National Laboratory

Position is available in the Alternating Gradient Synchrotron Department for an individual to be responsible for the development and maintenance of Departmental safety programs affecting the accelerator and experimental areas. The position reports directly to the Department Chairman.

Safety responsibilities are broad, including radiation, electrical, and general safety and fire protection.

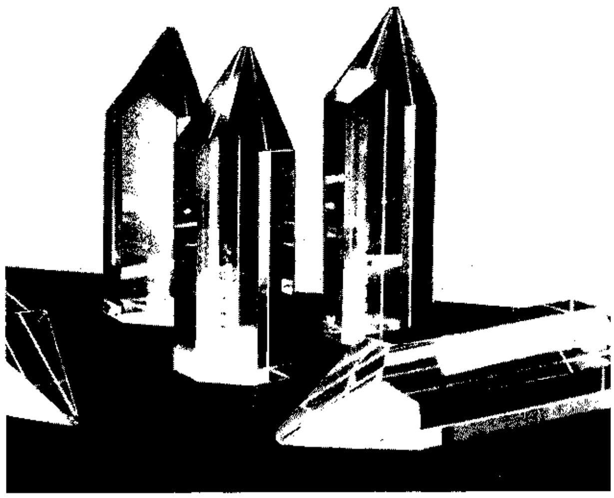
Physics/engineering background is necessary, and prior experience with high energy accelerators is desirable.

Responses should be sent to:

J. Herbert,
AGS Search Committee
Bldg. 911B,
Brookhaven National Laboratory,
Associated Universities, Inc.
Upton, Long Island, New York 11973.

Equal opportunity Employer m/f.

BROOKHAVEN
NATIONAL LABORATORY
ASSOCIATED UNIVERSITIES INC.



CORNING FRANCE

OPTICAL DIVISION DIVISION OPTIQUE

44, avenue de Valvins
77210 AVON - FRANCE
Tel.: 33-1 60 72 50 00
Telex: 690562 CORFOPH
Fax: 33-1 60 72 58 00

The worldwide specialist in glasses for Cerenkov counters.

Le spécialiste mondial des verres pour compteurs Cerenkov.

Yves Goldschmidt-Clermont, pictured here (left) with King Baudouin of Belgium at CERN in 1974, died in a skiing accident in February. He was one of CERN's first staff members, joining in 1953, and retired only last year.

Yves Goldschmidt-Clermont

On 22 February CERN was stunned to hear the news of Yves Goldschmidt-Clermont's death. It saddened everyone, particularly the few who worked with him from the very beginning to set up the Laboratory.

As a graduate of the Université libre, Brussels, Yves started his career at the Collège de France under Joliot. But his real debut can be said to date from his studies in Bristol in that heroic age when the pion was discovered and when he became a faithful disciple, admirer and friend of Beppo Occhialini. Yves was very proud that, under Beppo's leadership, he helped pioneer the measurement of masses by multiple scattering and that the resulting pion/muon mass ratio was much more accurate than that generally accepted at the time.

After a period at the Laboratoire de Bruxelles, he went to MIT in 1950. He was one of the first to switch from cosmic ray physics to accelerators. At the 300 MeV synchrotron, with L. Osborne, he studied neutral pion photoproduction in hydrogen in a pioneer experiment using emulsions in a very ingenious and unconventional way.

In 1953 he joined CERN, then only on a provisional footing and made up of scattered groups. After some time in Zurich, he came to Geneva when, in a hut at the airport, Lew Kowarski was setting up the STS Division to make technical and scientific equipment. This wide-ranging and nebulous task gradually took the shape of building bubble chambers 'with all the trimmings'. It was the latter that interested Yves Goldschmidt-Clermont. He realized that the chambers needed equipment to measure photographs quickly and accurately, and computers for both measuring and analysis, and worked full time on CERN's analysis facilities. Under his influence and guidance the first instruments for measuring photographs were developed; IEP, and finally the HPD invented by Hough and Powell. All this within the DD Division (formerly STS) as Deputy Leader in (almost perfect) tune with his friends and colleagues building bubble chambers. (Yves knew that perfect harmony is a trifle boring and that some discord is often more fruitful.)

In 1963 he changed direction to devote himself to bubble chamber experiments. He concentrated on the systematic study of strange resonances using positive kaon beams at increasingly higher energies in ever bigger chambers. In his last experiment at BEBC he discovered an abnormal production of soft photons. To study this he turned his hand to electronics, and proposed the Sophie experiment at the Omega spectrometer. He was working on the analysis of the results right up to his accident.

He was always active for the general good. For many years he coordinated CERN's collaboration with Soviet laboratories and from 1979 to 1981 was secretary of the Research Board and Deputy Leader of EP Division.

All who knew Yves will always remember his engaging personality. He was above all a good physicist, with the rare distinction of having successfully changed disciplines, fields and technical approaches several times with unflagging energy despite the passing years. His outstanding quality was his enthusiasm for physics, his universal curiosity for other science: he taught astronomy at the Lycée in Ferney and lectured in physics at the Université libre, Brussels. Sensitive and cultured, his passion for music was well-known. In Yves Goldschmidt-Clermont CERN mourns a man of almost naive enthusiasm, shy but courageous, who, while discretion caused him to be reticent at times, was unfailingly friendly, despite the conviction of his opinions, and who in friendship, was generous, honest and steadfast.

From his colleagues

The World's Biggest Calorimeters...

ALEPH LEP/CERN, Europe

CLEO CESR/Cornell, USA

E665 FNAL, USA

AMY KEK, Japan

L3 LEP/CERN, Europe

...Use The World's Best ADC's

New FASTBUS Instruments including the 1885F ADC, 2724 24-input preamp and LIFT™ Software Tools

Large calorimeters need economic, high performance ADC's.

LeCroy has been supplying our Series 1880 FASTBUS ADC's to fixed target and colliding beam experiments for over three years. Many particle physics experiments in Japan, Europe and the United States have instrumented or are installing our cost effective systems. These ADC's are part of LeCroy's evolving family of FASTBUS data acquisition electronics for research.

Call or write today for a complete FASTBUS Product Summary.

The Series 1880F ADC's feature:

- High Density: 96 chan/#1FASTBUS
- Wide Dynamic Range: to 15 bits
- High Sensitivity: 50 fC/count
- Short Conversion Time: 265 μsec
- Model 2724 pre-amp compatible
- Fast Readout: 40 megabytes/sec
- Multiple Event Buffer: 8 events
- On-board Calibration: to ± 1.5%
- Fast Clear: ≤ 600 nsec
- Trigger Outputs: 24 current sums

LeCroy

Innovators in Instrumentation

700 Chestnut Ridge Road, Chestnut Ridge, NY, 10977-6499 USA Tel: (914) 578-6013
Route du Nant-d'Avril 101, 1217 Meyrin 1-Geneva, Switzerland Tel: (022) 82 33 55