

CERN COURIER

International Journal of High Energy Physics



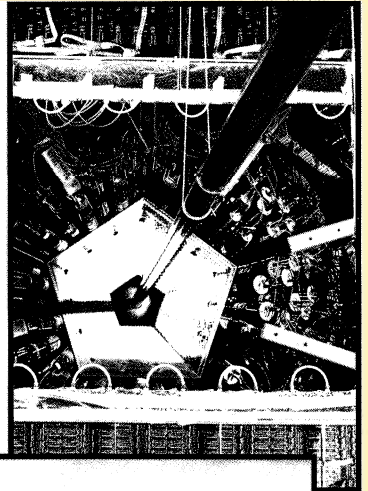
VOLUME 29

2

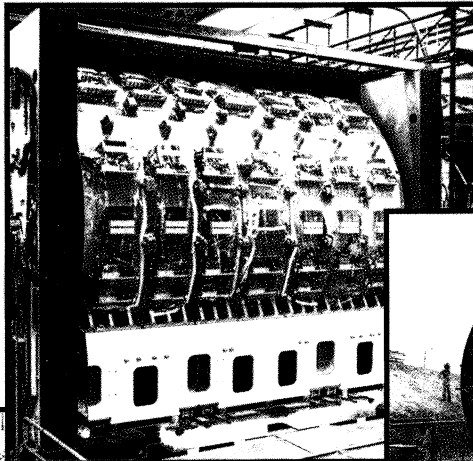
MARCH 1989

The World's Most Demanding Detectors...

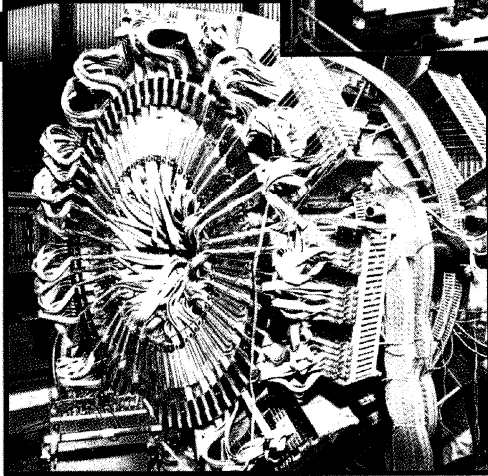
Plastic Ball, WA80 CERN, Europe



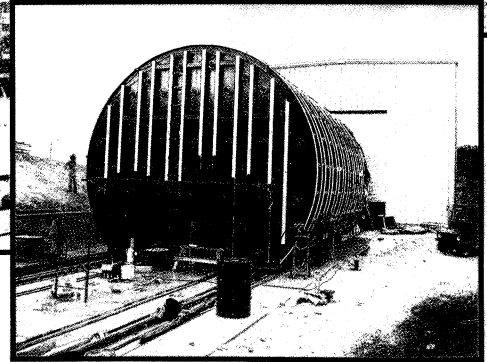
Venus, KEK, Japan



Fly's Eye, Utah, USA

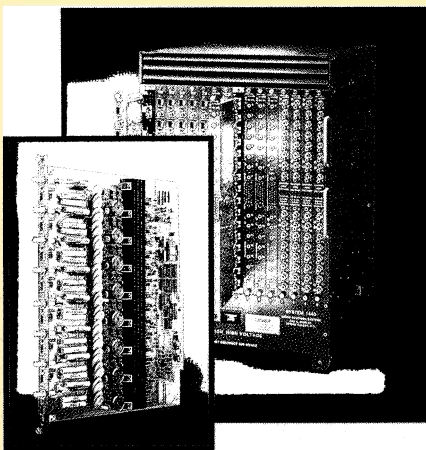


Sindrum, PSI, Europe



Neutrino Oscillation, LAMPF, USA

...Use The Most Dependable High Voltage



The NEW Model 1444 plug-in and 1449 Mainframe with various High Voltage plug-ins

The System 1440 is LeCroy's highest density, ultra reliable high voltage system. The rugged mainframe, available in standard and economy (low power) versions, accommodates up to sixteen 8-channel Wire Chamber or Germanium Detector supplies (0 to 5.6 kV @ 1.0 mA) and/or 16-channel Photomultiplier Tube HV plug-in cards (0 to 2.5 kV @ 2.5 mA).

Control via a local hand held unit; interface via RS232-C or a new high speed parallel port to CAMAC or VME; the System 1440 can power your entire experiment from one complete system.

NEW!

Model 1444 8-channel 5.6 kV HV plug-in card for Wire Chamber or Germanium Detectors features current read back and vital safety features.

Call or write today for a complete High Voltage Product Summary or our 1989 Nuclear Products Catalog.

LeCroy

Innovators in Instrumentation

700 Chestnut Ridge Rd, 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

Covering current developments in high energy physics and related fields worldwide

Editor: Gordon Fraser (COURIER at CERNVM)*
with Brian Southworth (SOUTHW at CERNVM)*
French edition: Henri-Luc Felder
Advertisements: Micheline Falcicola (FAL at CERNVM)*
Advisory Panel: P. Darriulat (Chairman), H. Bøggild,
H. Lengeler, A. Martin

*(Electronic mail address via bitnet CERNVM.CERN.CH)

Laboratory correspondents:

Argonne National Laboratory, USA
M. Derrick
Brookhaven National Laboratory, USA
N. V. Baggett
CEBAF Laboratory, USA
S. Corneliussen
Cornell University, USA
D. G. Cassel
DESY Laboratory, Fed. Rep. of Germany
P. Waloschek
Fermi National Accelerator Laboratory, USA
M. Bodnarczuk
GSI Darmstadt, Fed. Rep. of Germany
G. Siegert
INFN, Italy
A. Pascolini
IHEP, Beijing, China
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
Louise Hall
Saclay Laboratory, France
Elisabeth Locci
IHEP, Serpukhov, USSR
Yu. Ryabov
Stanford Linear Accelerator Center, USA
M. Riordan
Superconducting Super Collider, USA
Rene Donaldson
TRIUMF Laboratory, Canada
M. K. Craddock

General distribution

Monika Wilson (MONIKA at CERNVM)*
CERN, 1211 Geneva 23, Switzerland

In certain countries, 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 (B90904 at FNALVM)
Fermilab, P.O. Box 500, Batavia
Illinois 60510

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

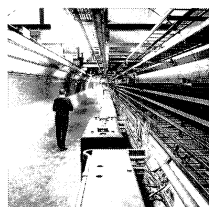
Printed by: Presses Centrales S.A.
1002 Lausanne, Switzerland

Published by:

European Laboratory for Particle Physics
CERN, 1211 Geneva 23, Switzerland
Tel. (022) 83 61 11 (767 61 11 from
22 April), Telex 419 000 CERN CH
[CERN COURIER only
Tel. (022) 83 41 03 (767 41 03 from
22 April), Telefax (022) 82 19 06
(782 19 06 from 22 April)]

USA: Controlled Circulation
Postage paid at Batavia, Illinois

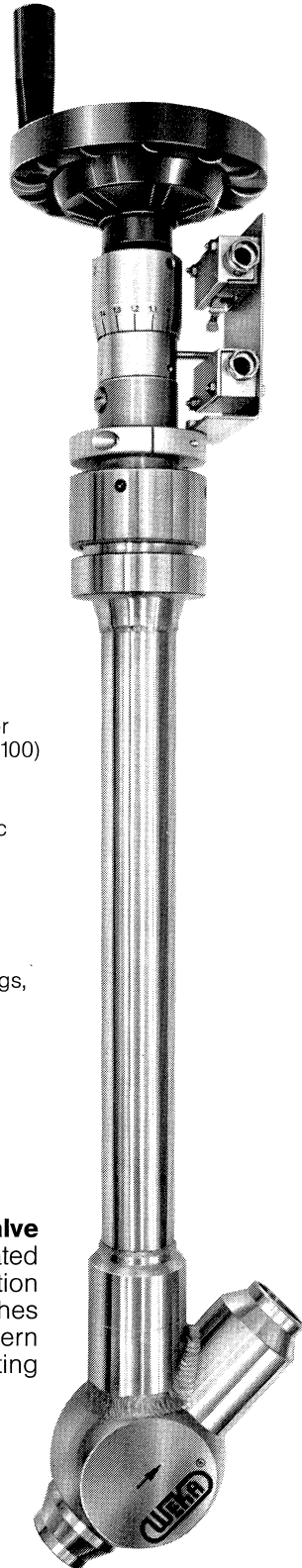
1	Omega-minus plus 25 years <i>Quarter-century on from milestone discovery</i>
4	World science <i>Expanding international collaboration</i>
Around the Laboratories	
8	Crystalline beams <i>Trying to freeze stored ion beams</i>
11	CERN: Low energy frontier <i>Aiming for minimal energy this time</i>
13	STANFORD: Record PEP collision rates <i>Boosting electron positron performance</i>
13	DUBNA/SERPUKHOV: Ultrarelativistic atoms <i>High energy neutral matter</i>
15	FERMILAB: 20 years on <i>Reviewing two decades</i>
21	Lattice 88 <i>Encouraging results from major computation effort</i>
23	DESY: Theory with flavour <i>Annual workshop</i>
26	People and things



Cover photograph:

For CERN, 1989 is LEP year, with the 27-kilometre electron-positron collider's switchon scheduled this summer. Much of the ring is already complete, while in the remaining sectors and the four vast underground experimental halls final installation work pushes ahead (Photo CERN 142.1.89).

Cryogenic Components



Manufacturing Line

- Cryogenic Valves (Vacuum Jacketed and also for Cold Box Mounting, DN 2 - DN 100)
- Special Valves for Cryogenic Applications (Check-Valves, Pilot Cryogenic Valves etc.)
- Bellows Sealed Valves (DN 2 - DN 100, up to PN 300)
- Cryogenic Transferlines and Couplings (Bayonet or Johnston Couplings, Multi-Coaxial Couplings)
- Space Cryogenic Fittings
- Tailor made Cryogenic Components e. g. Cryostats and Ejectors

Cryogenic On Off Valve

manually operated with position indication and limit switches "Y" pattern cold box mounting

for further informations:

WEKA AG

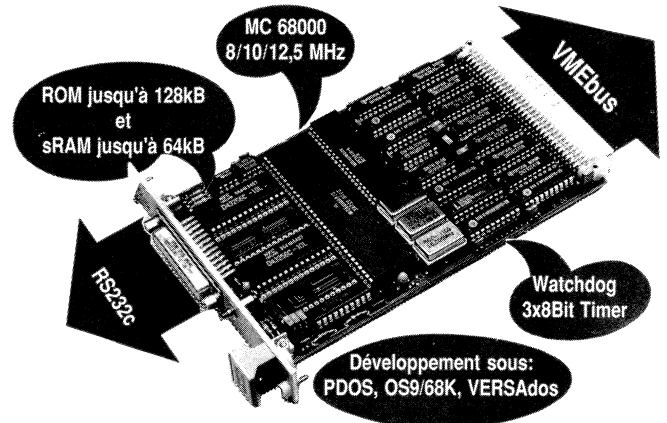
Hofstrasse 8, CH-8620 Wetzikon, Switzerland
Phone (0)1 932 23 02, Telex 875 744, Telefax (0)1 932 43 03

or in USA and Canada:

PROVAC LTD

POB 18411, Greensboro, North Carolina 27419
Phone (919) 282 6618, Telex 510 600 4853, Telefax (919) 288 3375

PEP Modular Computers®



CPU de système CMOS pour des applications avantageuses à bus VME

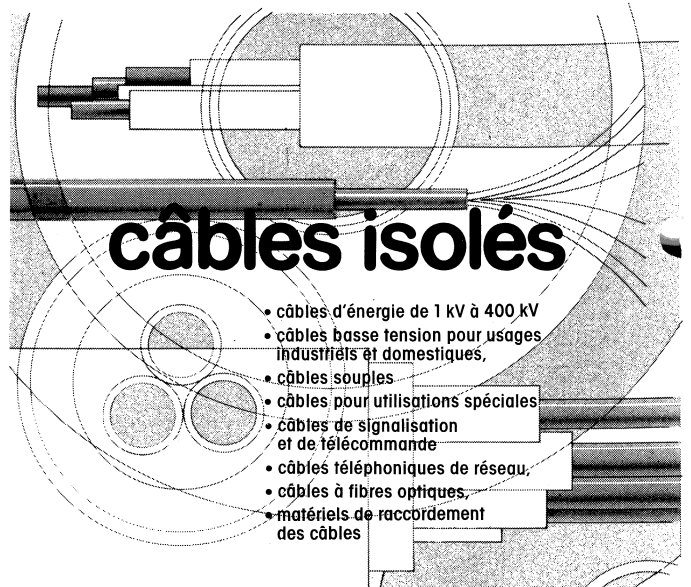
VMPM68KA - 2 (8MHz), Prix: Fr. 890.-

Omni Ray SA, Industriestrasse 31, CH-8305 Dietlikon/Zurich

tél. 01/835 21 11

OmniRay

Tout ce qui a un avenir en technique.



câbles isolés

- câbles d'énergie de 1 kV à 400 kV
- câbles basse tension pour usages industriels et domestiques,
- câbles souples
- câbles pour utilisations spéciales
- câbles de signalisation et de télécommande
- câbles téléphoniques de réseau,
- câbles à fibres optiques,
- matériels de raccordement des câbles



SOCIÉTÉ INDUSTRIELLE DE LIAISONS ÉLECTRIQUES

64 bis, rue de Monceau - 75008 Paris
Tél. : (1) 45.63.14.33. Téléc. : SILEC 280 248 F
Télécopie (1) 45.63.78.40

SOCIÉTÉ ANONYME AU CAPITAL DE 159.176.700 F

DÉPARTEMENT CÂBLES
DÉPARTEMENT SIGNALISATION
USINE A MONTEAUX

Omega-minus plus 25 years

Authors of the 'Eightfold Way' – Murray Gell-Mann (right) and Yuval Ne'eman.

(Photos Kathleen Blumenfeld)

A quarter of a century ago, in February 1964, the world learned that particle physicists had found the omega-minus particle, setting the stage for a new era in our understanding of the components of the atomic nucleus.

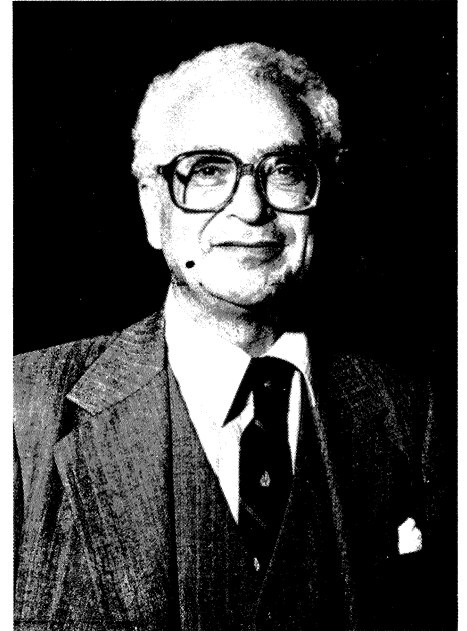
Particle physics had hit the headlines before and has done so many times since, but the dramatic discovery by a Brookhaven bubble chamber team of a particle whose exact properties had been predicted by seemingly simple chalk-and-blackboard arguments was especially romantic.

In the 1920s, physicists had strived to explain all the underlying structure of matter in terms of just two particles, the proton – the heavy constituent of the atomic nucleus – and the light electrons orbiting round the nucleus or given off in beta decay. When the neutron – the electrically neutral component of the nucleus – was discovered by James Chadwick at Cambridge in 1932, understanding took a step backwards.

Then Werner Heisenberg pointed out that the proton and the neutron, apart from their electric charge, were otherwise quite similar – both lived inside nuclei and both weighed about 900 MeV.

Perhaps, suggested Heisenberg, they were the two possible quantum states of a single entity – the nucleon – inhabiting some abstract two-dimensional 'isospace'. A new quantity – 'isospin' – was introduced to describe quantum symmetries in this space, analogous to spin, the label that emerged from quantum physics in ordinary space and time.

The nucleon is an isospin doublet, while the pion, with three electrical charge options (positive, negative and neutral), is classified as an isospin triplet.



The underlying mathematical ideas were further developed in the mid-50s by C.N. Yang and R. Mills (and independently by R. Shaw) who explored how the formalism of abstract isospaces depended also on space and time (gauge theory).

At around this time, it was becoming clear that the subnuclear world had many other denizens – particles created in high energy collisions but which did not normally live inside the nucleus. Why were there so many particles? To make some order out of the chaos, Murray Gell-Mann and Kazuhiko Nishijima proposed a new quantum number – 'strangeness'. Some of the particles with approximately equal masses appeared to fall into neat multiplets. These could be grouped in turn into larger families, hinting at some deeper symmetry hidden underneath.

Many attempts were made. In the late 50s Shoichi Sakata toyed with the idea of explaining the rash of particles in terms of just three –

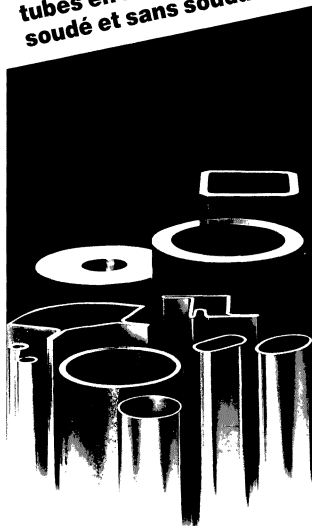
the proton, the neutron and the strange lambda. No real physics followed, but the seeds of an idea had been sown.

In 1961 Murray Gell-Mann at Caltech and Yuval Ne'eman at London's Imperial College realized that many particles could be grouped into octets – 'the eightfold way' – characteristic of a special form of symmetry under three-dimensional rotations (SU3). The symmetry also had other multiplets but at the time these could not be filled up with particles.

The usefulness of the SU3 octet pattern had been noticed before in attempts to find write down the algebra of carrier particles transmitting the nuclear forces, but Gell-Mann and Ne'eman saw that the neat octets fitted other particles too.

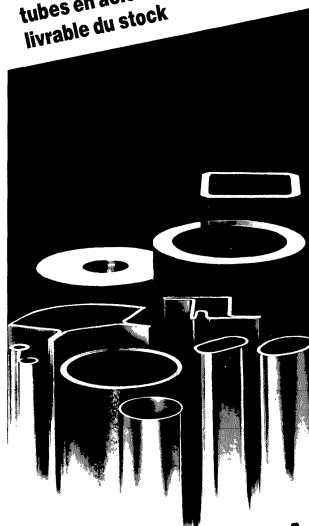
(By this time Gell-Mann was well known in the field, having developed with Nishijima the idea of strangeness, and with Richard Feynman some important links in our understanding of the weak

nouveau:
tubes en acier inoxydable
soudé et sans soudure



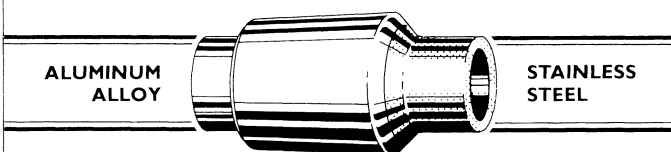
Toggenburgerstrasse 120, Postfach, 9500 Wil SG
Telefon 073-251111, Telefax 073-234343, Telex 883200

nouveau:
tubes en acier inoxydable «ARFA»
livrable du stock



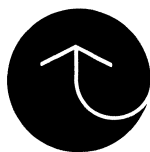
Toggenburgerstrasse 120, Postfach, 9500 Wil SG
Telefon 073-251111, Telefax 073-234343, Telex 883200

T H E V E N E T C L E R J O U N I E
TRANSITION JUNCTIONS C E A SYSTEM
FOR CRYOGENIC, VACUUM, NUCLEAR AND SPACE APPLICATIONS



**THEY HAVE THE
SAME MECHANICAL
CHARACTERISTICS
AS THE ALUMINUM
TUBE AND CAN ALSO
BE FABRICATED
TO ANY MATERIAL
SPECIFICATIONS**

TOTALLY RELIABLE BIMETALIC
TRANSITION JUNCTIONS
FOR TUBULAR ASSEMBLIES
UP TO Ø 600 MM (24")
10⁻⁹ atm. cm³. S⁻¹
10 MPa
0 to 573 K
UNDER RADIATION



* COMMISSARIAT A L'ENERGIE ATOMIQUE

CALL OR WRITE FOR DOCUMENTATION

**THEVENET CLERJOUNIE ■ DEPARTEMENT JONCTIONS TC
CONTACT: M. ARMAND PINET, CONSULTING ENGINEER
22, AVENUE FRANKLIN-ROOSEVELT ■ 69517 VAULX-EN-VELIN
CEDEX FRANCE ■ TELEPHONE: (7) 849.54.64 ■ TELEX 380544F**

**Partout où l'œil ne peut accéder –
Inspection optique sans
destruction:**



TeKZ vidéo-endoscope 2000

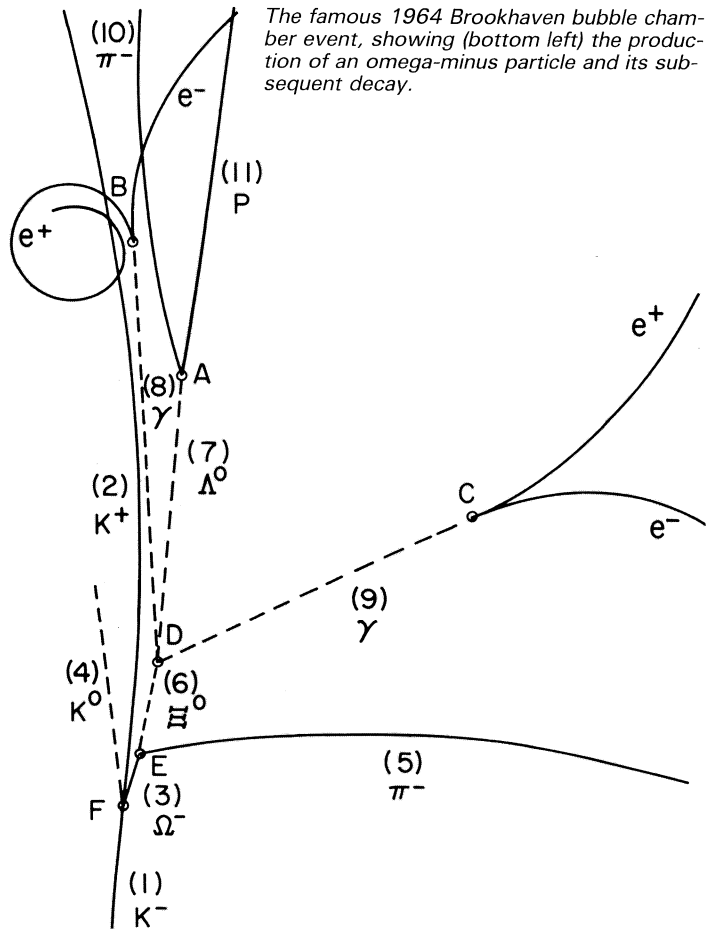
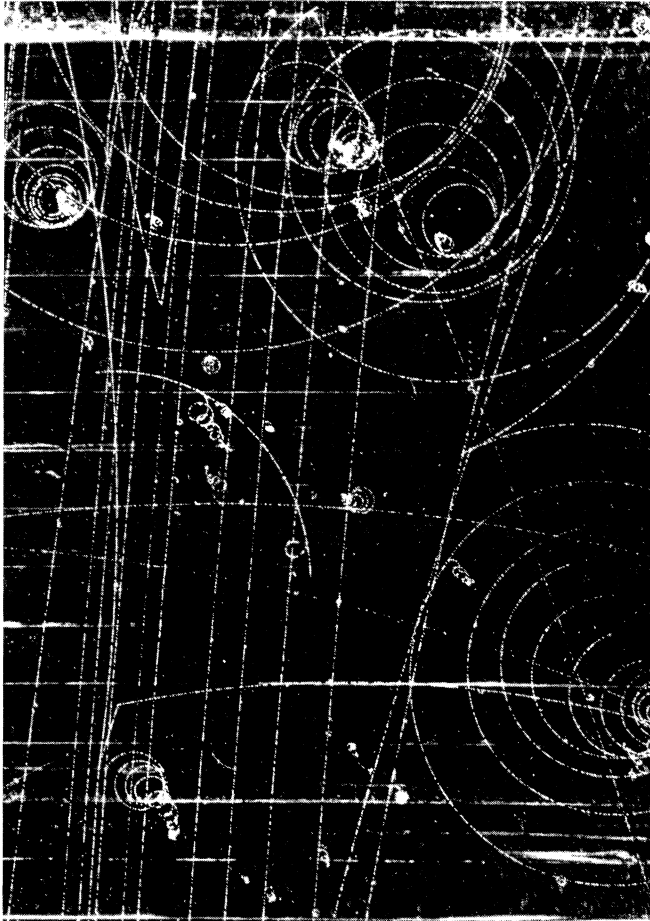
*Reproduction
brillante,
pouvoir
de dissolution
élevé.*

Caméra micro-chip



TECHNOKONTROLL AG

8049 Zürich, Imbisbühlstr. 144, Tel. 01 341 56 33



The famous 1964 Brookhaven bubble chamber event, showing (bottom left) the production of an omega-minus particle and its subsequent decay.

nuclear force. Ne'eman, a prominent Israeli army officer, had come to London in a diplomatic role, and put his multifarious talents to additional use in Abdus Salam's school, where Salam, with J.C. Ward, was working on particle classification schemes.)

At an international conference at CERN in 1962, Bernard Gregory of France's Ecole Polytechnique and George Snow of Maryland summarized the status of the physics of the new strange particles. After Snow's talk, Murray Gell-Mann went to the blackboard and pointed out the appealing regularities inside a then hypothetical decuplet of heavier cousins of the nucleon.

The decuplet was in the form of a triangle drawn in a grid of isospin and strangeness quantum numbers. Nine of the grid points could be filled by known particles – a quartet at the base, with a triplet and a doublet above, but the apex of the triangle was empty. Gell-Mann predicted a new negatively-charged particle carrying three units of strangeness, and even gave it a name, the omega-minus. Extrapolating from the mass patterns in the

triangle, he wrote down its mass, heavier than any particle ever seen before.

At Brookhaven, a new 80-inch bubble chamber was being readied at the Alternating Gradient Synchrotron (AGS). This was the highest energy accelerator in the world at the time and Leon Lederman, Jack Steinberger and Mel Schwartz had just used it to provide the world's first beam of neutrinos. However when it came to finding new particles, the physicists using Luis Alvarez' bubble chambers at Berkeley were still the acknowledged experts.

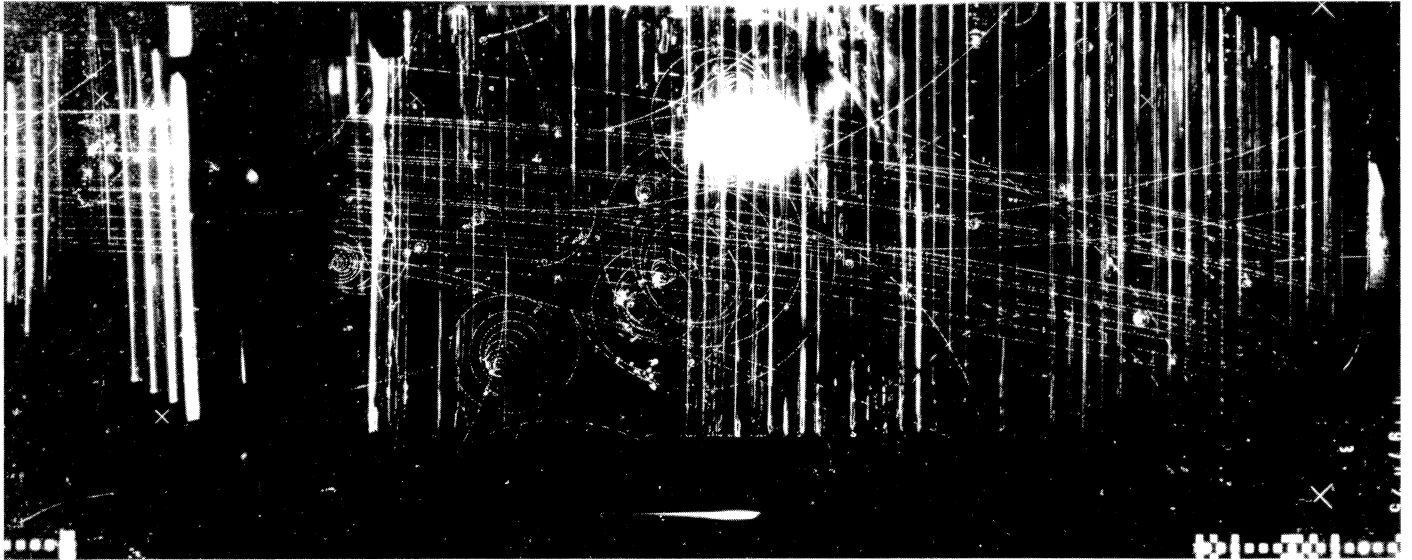
In December 1963, Brookhaven's new bubble chamber came into action, and a team of more than thirty physicists took up Gell-Mann's challenge. In January 1964, after looking at 50,000 photographs, they stumbled on a shot showing a pion carrying a lot of transverse momentum, with a strange particle produced some distance away from the primary collision. Looking closer, they spotted the spirals of not one, but two of the characteristic electron-positron pairs of a high energy gamma ray (photon). Moreover these two

gammas pointed back to a common origin. By careful measurement and calculation, the team unravelled the complex series of decays, finally backtracking to a particle carrying minus three units of strangeness, and with a mass of 1686 MeV, almost right on top of Gell-Mann's blackboard prediction!

The commissioning of the bubble chamber had not been plain sailing. As it had only one window, special reflectors had to be used so that the tracks could be both illuminated and photographed from the same side. Early in the run, some of these reflective 'coat hangers' had come adrift and fallen on the window. As well as obscuring some of the field of view, these could have damaged the window, and with 1,000 explosive litres of liquid hydrogen inside, the future of the experiment hung in the balance. After gingerly testing the chamber with a few expansions, team leader Ralph Shutt decided to continue.

The omega-minus showed that SU3 symmetry was behind the neat particle families. But why SU3? What parentage was behind such large families of eight and ten? Even before the omega-minus

The complete Brookhaven 1964 bubble chamber picture. About a quarter of the chamber was invisible due to an illumination problem.



appeared, Gell-Mann, and independently George Zweig, working at CERN, showed how the eights and tens followed naturally from triplets of more basic entities – termed ‘quarks’ by Gell-Mann.

In the same way that the Periodic Table of elements paved the way for our present picture of the atom, so Gell-Mann and Ne’eman’s octets had hinted that subnuclear particles had some internal me-

chanism, at least on paper.

(As often happens in physics, ideas born in one context can lead to useful spinoff in another. The gauge theory groundwork developed in parallel with isospin and the eightfold way went on to pay handsome dividends in the formulation of the ‘electroweak’ unification of the 1960s, showing how the weak nuclear force and electromagnetism have a common origin.)

It took another ten years of painstaking work to find the tiny grains of matter hidden deep inside the nucleon and show that they behaved like quarks. However they steadfastly refuse to come out into the open, staying locked inside their nucleon prisons. To see free quarks, physicists probably need to recreate the conditions of the Big Bang which started it all off.

World science

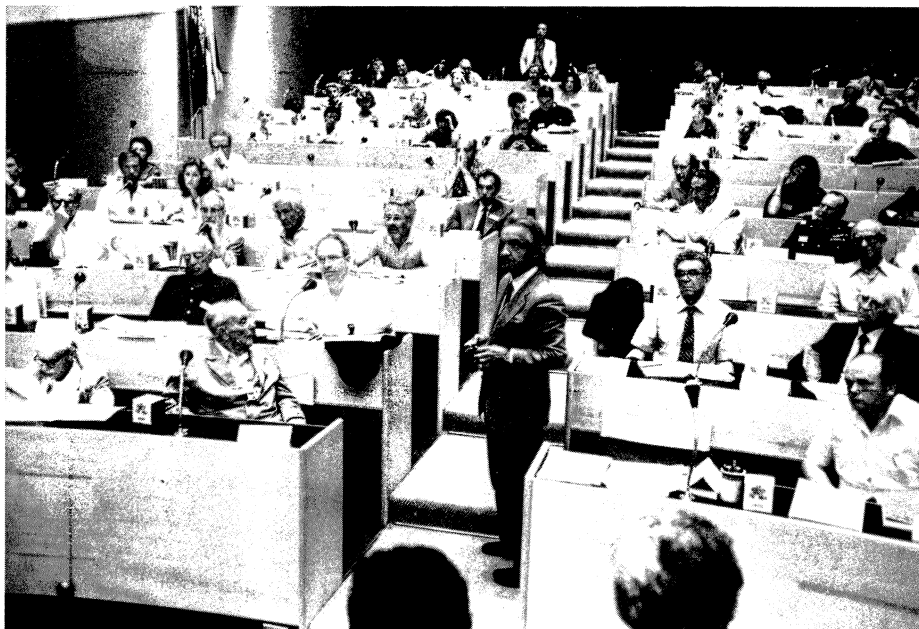
The World Laboratory and the Third World Academy of Sciences are examples of ambitious new global ventures using the established broad base of science and technology in the industrialized nations as a springboard for important projects in and among developing countries.

Established in 1986, the World Laboratory aims to promote truly global, open cooperation in technical and scientific research, with

free circulation of information and researchers. The bottom line is an impressive list of ongoing multidisciplinary projects, with a wide geographical spread.

Under its president Antonino Zichichi, and with its main coordination centre in Geneva and with regional coordination centres in Moscow and Beijing, World Lab’s ongoing programme is grouped into four main areas. The Archimedes programme covers geologi-

cal (seismology, volcanology,) and environmental (climate, pollution,.....) monitoring and modelling, together with computer projects in the education and health areas. The Eloisatron basic physics programme includes the Eloisatron project for a multithousand GeV proton collider, ongoing plans at CERN’s LEP electron-positron collider, and the establishment in China of Advanced Centres for Science and Technology and for



At the second Seminar on Nuclear War held at the Centre for Scientific Culture at Erice, Sicily, in 1982, Paul Dirac and Piotr Kapitza (front row, left) and Antonino Zichichi (standing) drafted the 'Erice statement', a declaration of awareness and intent for scientists to influence ongoing nuclear policy and safeguard the future of the planet. Recipients of the new Erice Prize will be nominated by the signatories of this statement.

Erice Statement

- It is *unprecedented* in human history that mankind has accumulated such a military power to destroy, at once, all centres of civilization in the world and to affect some vital properties of the planet.

The *danger* of a nuclear holocaust is not the unavoidable consequence of the great development of pure science.

In fact, *Science* is the study of the fundamental laws of Nature.

Technology is the study of how the power of mankind can be increased.

Technology can be for peace and for war. The choice between peace and war is not a scientific choice. It is a cultural one: the *culture of love* produces peaceful technology. The *culture of hatred* produces instruments of war. Love and hatred have existed forever. In the bronze and iron ages, notoriously pre-scientific, mankind invented and built tools for peace and instruments of war. In the so called « modern era » it is imperative that *culture of love* wins.

An enormous number of scientists share their time between pure science research and military applications. This is a fundamental source for the arms race.

It is necessary that a *new trend* develops, inside the scientific community and on an international basis.

It is of vital importance to identify the basic factors needed to start an effective process to protect human life and culture from a third and unprecedented catastrophic war. To accomplish this it is necessary to change the peace movement from a unilateral action to a truly international one involving proposals based on mutual and true understanding.

- Here are our proposals:

- Scientists who wish to devote all of their time, fully, to study theoretically or experimentally the basic laws of nature, should in no case suffer for this free choice, to do only pure science.
- All Governments should make every effort to reduce or eliminate restrictions on the free flow of information, ideas and people. Such restrictions add to suspicion and animosity in the world.
- All Governments should make every effort to reduce secrecy in the technology of defense. The practice of secrecy generates hatred and distrust. To start a ban for military secrecy will create greater stability than offered by deterrence alone.
- All Governments should continue their action to prevent the acquisition of nuclear weapons by additional nations or non-national groups.
- All Governments should make every effort to reduce their nuclear weapons stockpiles.
- All Governments should make every effort to reduce the causes of insecurity of non-nuclear powers.
- All Governments should make every effort to ban all types of nuclear tests in war technology.

- Conclusion

Those scientists — in the East and in the West — who agree with this « Erice Statement », engage morally themselves to do everything possible in order to make the *new trend*, outlined in the present document, to become effective all the world over and as soon as possible.

Erice prize

The regional government of Sicily has decided to finance an annual international award recognizing eminent work in scientific culture. Worth a thousand million lire (more than a million Swiss francs), the award will be known as the Erice Prize, underlining the important role played by the Centre for Scientific Culture at Erice, near Trapani on the north-west corner of the island, established by Antonino Zichichi 25 years ago.

Named after the famous Italian theoretical physicist Ettore Majorana, this centre is now home to over seventy regular schools in all branches of science, including the Seminar on Nuclear War, where concerned scientists from all over the world gather to discuss the catastrophic implications of the global nuclear arsenal. At the second of these nuclear war seminars in 1982, Paul Dirac and Piotr Kapitza (both since deceased), together with Zichichi drafted the 'Erice statement', a declaration of awareness and intent for scientists to influence ongoing nuclear policy and safeguard the future of the planet.

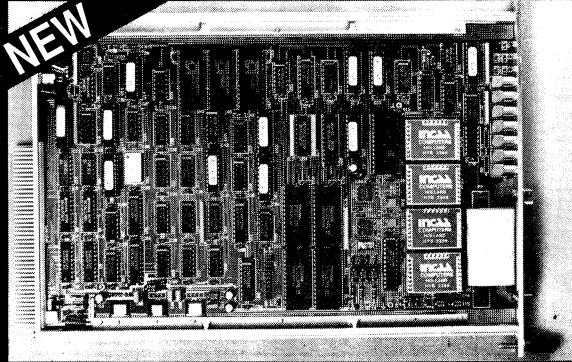
This statement, which now has well over 10,000 signatories, also led to the establishment of the World Laboratory (see accompanying article).

The new prize will be attributed from nominations proposed by the Erice Statement signatories.

CAMAC TRANSIENT DIGITIZER

Single width, 64 ksample memory

NEW



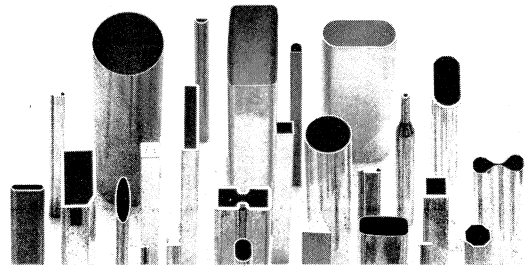
- JET specified
- 16 channel differential input, 12 bit ADC, +/- 10V
- Input impedance: 800 kOhm
- High common-mode range: 200 volt
- Pre/post-trigger recording
- Int./ext. sample clock, up to 10 kHz
- Higher sample rate for less channels
- Simultaneous sampling, modules/crates
- Front panel signals for external sample clock, run, stop and trigger

INCAA
COMPUTERS

INCAA COMPUTERS BV
P.O. Box 722,
7300 AS Apeldoorn, Holland.
Tel: (0)55 - 42.50.01. Tlx: 36340

High precision tubes and profiles

SWISSMADE



Drawn seamless high precision tubes and profiles in stainless steel, copper alloys, nickel alloys, titanium and other special alloys.

Dimension range: $\varnothing 0,2 \pm 0,005$ mm to $40 \pm 0,1$ mm
Wall thickness: $0,02 \pm 0,005$ mm to $2,5 \pm 0,05$ mm

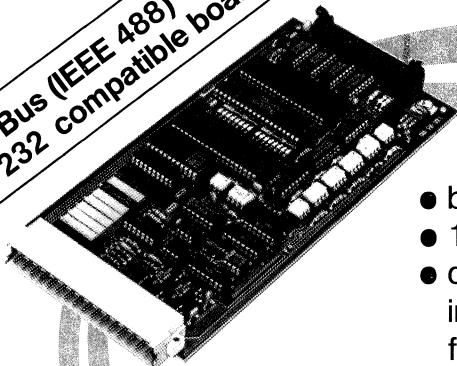
LN INDUSTRIES SA



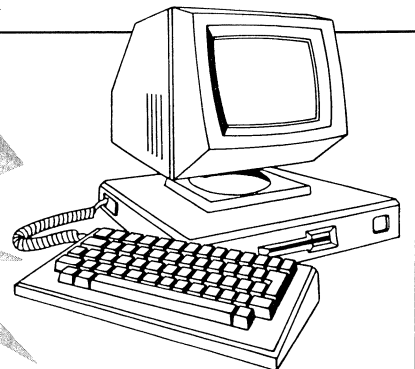
P. O. Box,
CH-1422 Grandson
SWITZERLAND
Telephone (41-24) 71 12 22
Telex 457 102 LNI CH
Telefax (41-24) 71 21 79

**HIGH PRECISION TUBES AND PROFILES
FOR CRITICAL APPLICATIONS**

IEC-Bus (IEEE 488)
RS 232 compatible boards



- bidirectional
- 12 to 16 bits
- direct programming in absolute values for voltage and current
- potential free



ask for the catalog 14

HEINZINGER
electronic GmbH

**Bus-controlled
Power supplies**

Anton Jakob-Str.4
D-8200 Rosenheim
West Germany
Tel. 08031/44040
Fax. 08031/440444
Tlx. 525777



The recently completed China Centre of Advanced Science and Technology (World Laboratory) in Beijing. Second from the left is Ambassador Qian, who represents China at the United Nations in Geneva.

Astrophysics, together with neutrino and cosmic ray studies at the new Italian Gran Sasso underground Laboratory and elsewhere, detector research and development, and basic theory. Under the heading 'Improvement of Modern Life' comes a series of projects aiming for advances in food technology (production, processing and storage), medicine (15 projects), and progress in environmental and ecological sectors; three projects deal with advanced technologies such as coal slurring and new clean energy sources. The final development area is the field of controlled nuclear fusion.

Each of these four areas is grouped into well defined projects, each with its own clearly defined

objectives and one or more directors.

One major success is the establishment of the China Centre for Advanced Science and Technology under T.D. Lee, who has been very influential in getting this project off the ground. The aim is to provide qualified Chinese students with hands-on experience in new technologies, bridging the gap between university education and the modern research environment. The first World Lab building has recently been completed in Beijing.

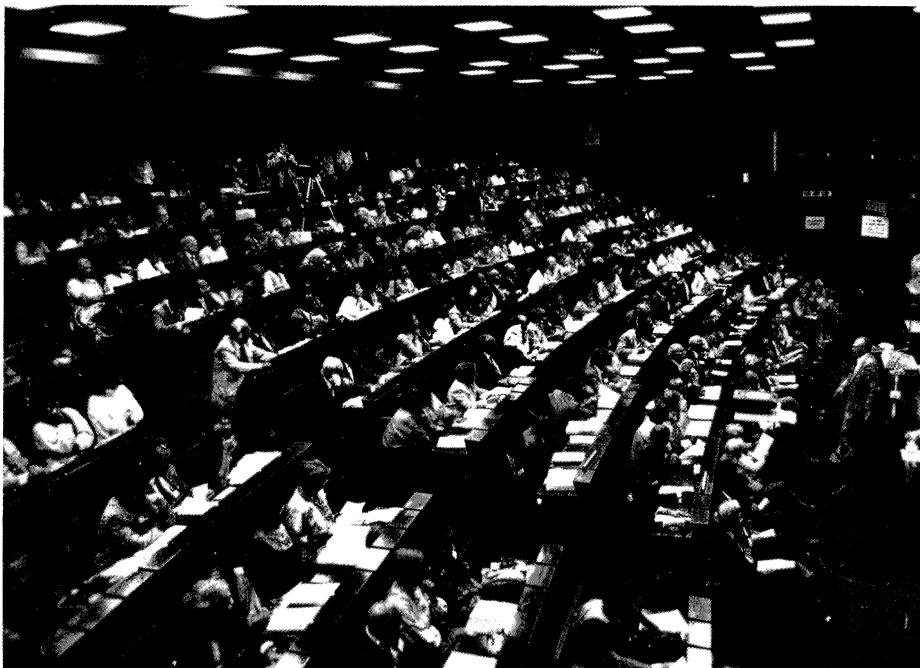
In addition to field work, World Lab progress is regularly reviewed at international meetings and seminars.

The aim of the Third World Network of Scientific Organizations

(TWNISO), established last year with its headquarters in Trieste, Italy, is to promote the role of science and technology in developing countries. TWNSO, under the presidency of Abdus Salam, is an offshoot of the Third World Academy of Sciences, which has pushed the cause of international scientific collaboration since its establishment in 1983.

With support from industrialized nations pledged and with more prospects in the pipeline, TWNSO's membership includes 80 organizations drawn from 60 countries. Aims are to promote the development and application of science and technology both within the Third World and through Third World participation in international schemes. Areas such as space science, controlled thermonuclear fusion, biotechnology and high technology in general are seen as having a potentially strong impact on economic and social development in Third World countries. As well as welcoming with enthusiasm the TWNSO cause, ministers attending the inaugural meeting in Trieste also pledged to produce results in their home countries.

In addition to a strongly regional structure, with Asian, Arab, African and Latin vice-presidents, TWNSO has three project-oriented standing committees dealing with global projects, hazards and programmes.



Cesar Lattes of the Centro Brasileiro de Pesquisas Fisicas, Rio de Janeiro, addresses a meeting of the Third World Academy of Sciences in Trieste.

Around the Laboratories

Participants at the recent workshop on crystalline beams organized by the GSI (Darmstadt) Laboratory and held at Wertheim, West Germany.

WORKSHOP Crystalline beams

Following pioneer work by specialists at the Soviet Novosibirsk Laboratory some ten years ago, interest developed in the possibility of 'freezing' ion beams in storage rings by pushing cooling (to smooth out beam behaviour) to its limits, the final goal being to lock the ions into a neat crystal pattern.

After advances by groups working on laser cooled ions in traps, and with several cooling rings now in operation, a workshop on crystalline ion beams was organized recently by the GSI (Darmstadt) Laboratory and held at Wertheim in Germany.

Some remarkable progress was reported on the understanding of the structure and dynamical behaviour of crystalline beams by molecular dynamics (J.P.Schiffer and R.W.Hasse) and analytical calculations (D.Habs). This work finds no sharp ion energy where ordering should start, the finite width of the beam playing a special role.

Important effects to be taken into account are 'shear' due to the ring radius (particles on the outside tend to be slowed down) and the efficient control of space charge by the focusing force. F.Mills advocated that a ring using modified betatron operation could be better suited to the task than one using alternating gradient focusing.

In the meantime, advances have been made using ion traps with laser cooling. Pioneer studies with Paul and Penning traps (H.Walther, R.Blumel and J.J.Bollinger, W.M.Itano) have succeeded in making crystals containing a up to a hundred ions (Paul trap) or up to 2000 ions in cylindrical layers (Pen-



ning trap – see also following article).

Encouraging from the Paul trap studies is the apparent absence of ordered state heating by the alternating radiofrequency potential. However in a disordered 'cloud' system a Munich group has found strong heating due to chaotic motion.

In the field of cooling techniques, O.Poulsen pointed out the advantage of lasers over electrons in attaining temperatures of a fraction of a degree millikelvin. By coupling longitudinal and transverse optical modes, even three-dimensional cooling is possible. Both methods promise high longitudinal cooling rates, and the challenge is to accelerate transverse cooling and make it equally fast. P.E.Toschek looked at the possibilities of using nonlinear light forces to penetrate the microkelvin degree region.

Recent achievements of cooling rings were surveyed by R.E.Pollock, H.Poth and E.Jaeschke, while D. Moehl of CERN looked at densi-

ty limitations achieved in practice. Conditions are still five to six orders of magnitude away from spatial ordering in three dimensions.

Unfortunately nobody from Novosibirsk was at the meeting to comment on Schottky signal measurements at the NAP ring which hint at longitudinal ordering. Earlier results had suggested that cooling had succeeded in destroying virtually all momentum spread in a proton beam, so that the stored particles look like a string of beads (with a separation of a few microns).

Although immediate prospects are dim, insights can still come from simulation studies of storage ring lattices with discrete quadrupoles and dipoles (I.Hofmann). These calculations show that rings with a low number of superperiods are handicapped (due to coherent resonances), and that a cooling device must follow each dipole, unless a shear-free ring can be designed. However a longitudinal chain of ions looks to be possible

AUBERT & DUVAL

ACIERS D'OUTILLAGE

ACIERS DE CONSTRUCTION À HAUTES CARACTÉRISTIQUES

SUPERALLIAGES

ACIERS INOXYDABLES ET RÉFRACTAIRES

41, r. de Villiers. - 92200 Neuilly-s/Seine
 Tél. : (1) 40.88.20.00. Télex : 620 072 F
 Télécopieur : (1) 47.57.69.39
 ACIÉRIE DES ANCIZES

SCINTILLATORS



We have the expertise and the know-how for high-quality plastic scintillators. High light output, excellent transmission and fast speed are the main features of our plastic scintillators. We manufacture all sizes to customers specifications. Rods, sheets, blocks and light guides with polished or coated surfaces will be manufactured within close tolerances. Lithium-glass-scintillators are available in special shapes and sizes from powders for HPLC and flow cells, discs for neutron measurements etc. Various types from low background to very high efficiency are available.

ZINSSER ANALYTIC (UK) Ltd.
 Howarth Road, Stafferton Way, Maidenhead, Berks. SL6 1AP
 Telephone 06 28/2 45 70 - Telex 849 462
 M & K

DIMENSIONS AHEAD IN SCINTILLATION CRYSTAL TECHNOLOGY

Crystal Materials for your applications.

HILGER Analytical

Hilger Analytical Limited
 Westwood Margate Kent CT9 4JL
 Tel: 0843 225131 Fax: 0843 224402 Telex: 96252

Concepts of Particle Physics Volume II

Kurt Gottfried and Victor F. Weisskopf

This authoritative work enhances the material outlined in the first volume of *Concepts of Particle Physics*, presenting it in far greater detail and with a higher degree of sophistication. The authors, both eminent physicists, provide an in-depth discussion of the electromagnetic interaction, explore the accuracy of the quark model by examining the excited states of baryons and mesons, and consider many other topics.

From reviews of Volume 1:

'... highly readable, and can be warmly recommended to anyone who wishes to penetrate into this field' *Acta Physica Austriaca*

'The book may be recommended to anyone who not only wishes to learn the most important concepts of elementary particle physics, but also wishes to study the intellectual atmosphere which gave rise to the exciting discoveries in this field.' *Physikalische Blätter*

'A splendid review of subnuclear phenomena... Physicists of all stripes have reason to look forward to Volume II with considerable enthusiasm.' *Physics Today*

Volume II
0 19 505393 0, 432 pp., illus., OUP USA, 1986 £40.00

Volume I
0 19 504373 1, 204 pp., illus., paperback, OUP USA, 1986 £9.95

For further details of this and other OUP titles, please contact Miss E. Bone, Academic Publicity Dept., Oxford University Press, Walton Street, Oxford OX2 6DP

OXFORD UNIVERSITY PRESS

E. LOTTI sa Fondation 1908

Réactifs de laboratoire
(Analyse - Synthèse - Biologie etc.)
Produits chimiques industriels

Distributeur agréé de

Fluka Chimie Fine

Société mondialement connue

Gamme très complète de produits inorganiques et organiques de haute qualité.
Prix très compétitifs avec de plus des rabais de quantité.

Spécialités: Dérivés de Silicium - Chélates - Catalyseurs, etc.

Ventron Alfa Products

Research chemicals and Materials

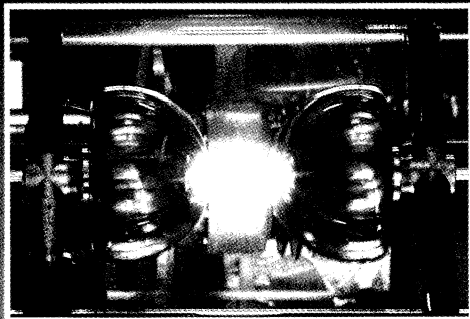
Organics
Inorganics
Organo Metallic
Analytical standards
Pure Metals and Alloys
Research grade gases
Electronic grade chemicals
Materials

B. rue Baylon
Case postale 432
1207 GAROUGE GE SUISSE

E. LOTTI sa

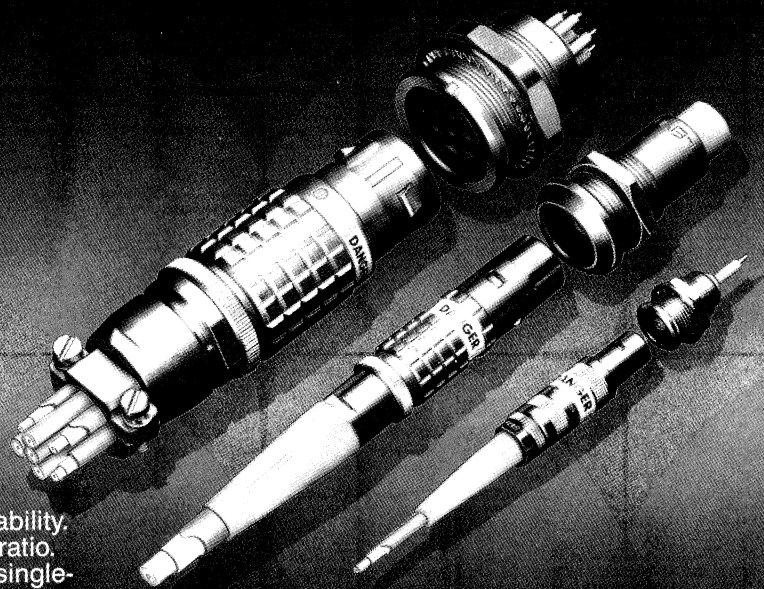
Tel. 022 42 57 65 66
Telex 429 382 Lotti CH
Telegramme LOTICHIM

NEW High Voltage Connectors



LEMO

High quality materials with good radiation stability. Extremely favourable size/operating voltage ratio. Working voltages of 5, 8, 16 and 25 kVdc for single-pole connectors and 8 kVdc for multi-pole connectors (up to 21 contacts). These connectors are available in the following models: straight plug, free socket, fixed socket and vacuum tight fixed socket models.



LEMO - Push-Pull Connecting system,
with safety nut on plugs

LEMO

P.O. Box 194 Ch. des Champs - Courbes 1024 Ecublens Tel. (021) 691 16 16

with existing lattices.

Another problem is how to recognize any onset of crystal beam behaviour once it happens. One promising method is coherent Rayleigh scattering (R. Neumann). Coherent Thomson scattering might work in principle (though technically very difficult), if the cooling electron beam carries a signature of the ion ordering (G. Dodel). The need to continue theoretical work on correlations was also stressed (C. Toepfer). 'Conventional' diagnostics via the Schottky noise spectrum are problematic due to signal distortion and suppression for correlated particles, and it is questionable whether any ordering can be detected this way (S. Baird). New ideas using narrow-band pickups for 1000-3000 GHz working as confocal optical resonators (F. Caspers) placed many wavelengths away from the beam could be useful.

In summary, the meeting showed that ultra high frequency diagnostics and extensive cooling experiments at existing storage rings need to be pushed before longitudinal ordering can be demonstrated. New rings with high symmetry, little shear and lots of cooling are needed to grow crystal-line beams and open up this area of accelerator and condensed matter physics.

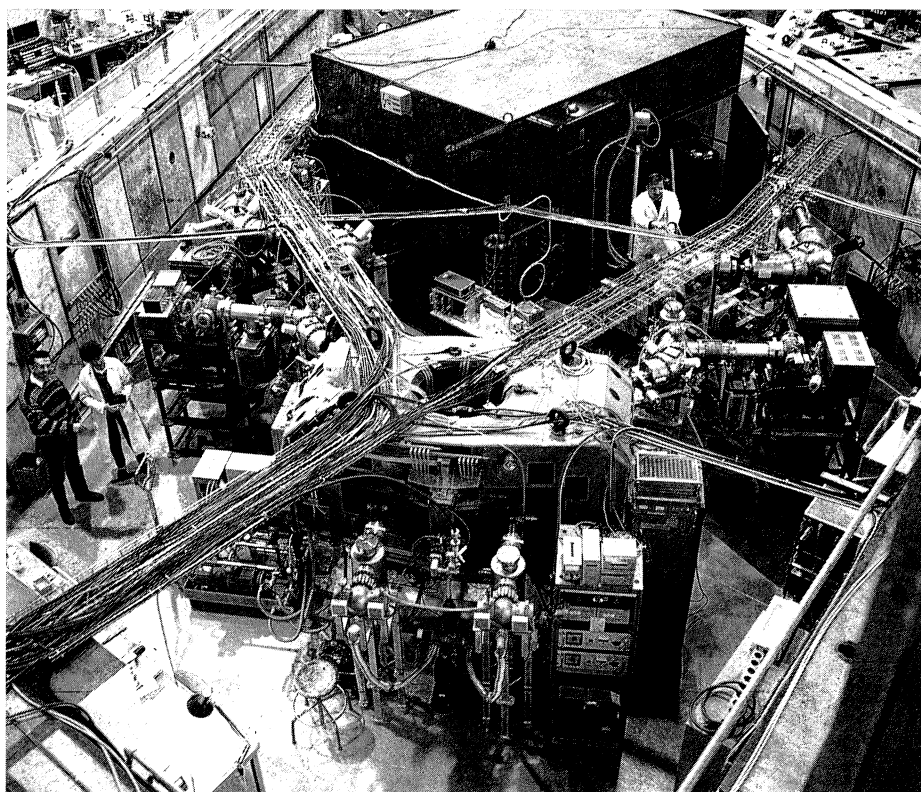
From Ingo Hofmann

CERN Low energy frontier

While CERN and other big particle physics Laboratories look toward higher energies to probe deeper inside the structure of matter (the

Foreground, the spectrometer of the CERN/Orsay experiment at CERN's LEAR low energy antiproton ring preparing to compare the masses of the proton and the antiproton.

(Photo CERN 285.1.89).



TeV – 1000 GeV, or a million million electronvolts is now a commonly used unit), three teams working at CERN's LEAR low energy antiproton ring have another objective – to look at the behaviour of very slow antiprotons, comparing the results with protons to check the basic principles of the laws of physics.

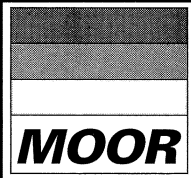
LEAR takes GeV-scale antiprotons down to energies of just a few MeV. A Harvard/Mainz/Washington (PS 196) team uses the electric and magnetic fields of a Penning trap as supplementary particle brakes. Also playing a vital role in this 'cooling' process are electrons, slowed down to a fraction of an electronvolt in the trap. These act in turn on the antiprotons, cooling many of them to below one electronvolt.

At high energies, CERN's antiprotons are regularly held for days

at a time, however the risks of annihilation with atoms of residual gas increase quickly at lower energies. Nevertheless the PS 196 team manages to trap antiprotons for up to several days – much shorter than the ten-month world record for a single electron, but a great advance on the experiment's previous antiproton performance.

Although these energies are miniscule by high energy standards, they are still equivalent to about the temperature of the sun's surface. Initial measurements hope to compare the proton and antiproton masses to one part in a million, improving on the best result so far, eventually going down lower.

Elsewhere (see previous article), other experiments using these techniques have cooled protons down to a fraction of an meV (millielectron volt), equivalent to cryogenic temperatures, while laser



**Elektrotechnik
Elektronik
Datentechnik**

VMETRO



State of the Heart

Real Time Program Analyzer for the 68030, 68020, 68000, 68008

The PMA-030 Program Analyzer from VMETRO is an extremely powerful, compact instrument particularly tailored for real time program debugging and verification, performance analysis and system tuning. The instrument targets the Motorola 68k family of processors, eliminating tedious setup procedures while allowing optimum observability.

The extremely small size of the instrument offers superior portability for on-site trouble shooting. The tiny, low cost detachable processor adapters can be permanently installed on all your processor boards, allowing the PMA-030 instant, plug-in access to your targets without time-consuming system shut-downs.

Two RS-232 serial ports and a transparent mode allows convenient on-site or remote operation of both the PMA-030 and the target system from the same ASCII terminal.

Other features:

33 MHz processor support (max. 25 MHz cache/burst sampling rate.) 2k trace of up to 92 processor signals. BNC contacts for trigger output and user defined external input. 30 user-defined setups stored in non-volatile memory. 60cm flexible flat-cable with plug-in connection to processor adapters. Dimensions: 248x84x219 mm.

Ask for MOOR

9032

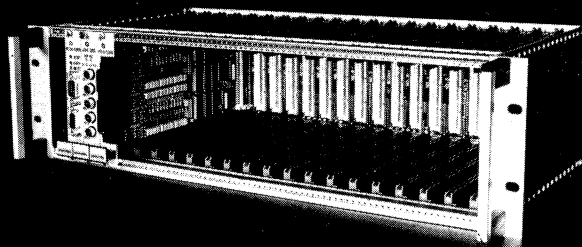
MOOR CIM SYSTEMS AG

8105 Regensdorf
Tel. 01 843 33 11
1026 Denges/Lausanne
Tél. 021 803 09 01

Weitere MOOR Gesellschaften in Bern, Wien, Stuttgart, Paris

NEW

BITBUS™ NODE modular structure



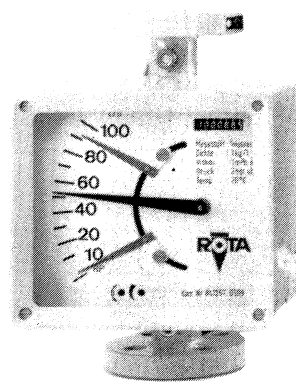
- Each node contains a Control board to interface the external serial BITBUS link and to control up to 8 I/O boards
- Isolated repeater board
- Up to 4 nodes in one powered Eurorack, 19" - 3U
- Interface boards include 16 bit ADC and DAC
- Adapter for nearly all G-64 I/O boards
- Added hardware for "Local diagnostics" and for "Configuration" and "Emergency" management

**INCAA
COMPUTERS**

INCAA COMPUTERS BV
P.O. Box 722,
7300 AS Apeldoorn, Holland.
Tel: (0)55 - 42.50.01. Tlx: 36340

The BITBUS concept allows distributed and intelligent I/O controllers. BITBUS™ is a registered trademark of INTEL corp.

ROTAMETRE-MC



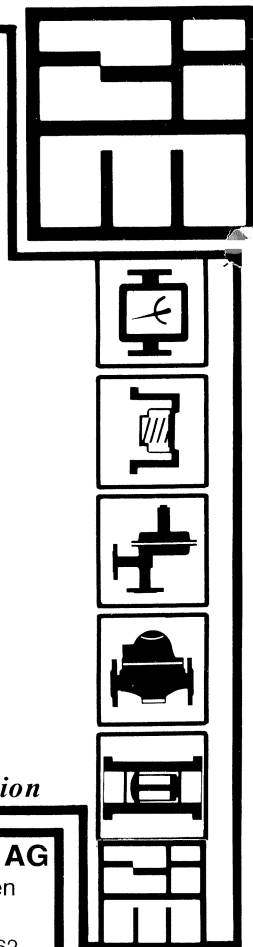
- pour gaz et liquide
- petit encombrement
- exécution inox ou revêtement en PTFE/PVDF/PP
- faible perte de charge

Demandez la documentation

ZIMMERLI MESSTECHNIK AG

Schlossgasse 10 4125 Riehen
f 061 - 67 54 54

Telex 965 135 Telefax 061 / 67 35 62



Stanford Linear Accelerator Centre (SLAC) Director Burt Richter (hard hat No. 60) explains the new SLC Stanford Linear Collider to Texas Senator Lloyd Bentsen (hard hat No. 1, who was last year's Democrat Vice Presidential candidate) and former astronaut Sally Ride.

(Photo Edward W. Souza, Stanford News and Publications Service)

cooling methods have attained particle temperatures of just a few millidegrees above absolute zero.

Also at LEAR, a CERN/Orsay team is preparing to compare proton and antiproton masses down to one part per thousand million using a radiofrequency mass spectrometer and benefiting from lower energy LEAR antiprotons.

A CERN/Italy/US team will look at the effect of gravity on an antiproton beam cooled to thermal levels by a series of traps, to see whether antiprotons 'fall' upwards! This study opens up a new field of study. Gravitation is universally attractive – no example has yet been found of a gravitational repulsion – however the interaction of gravity with antimatter is unexplored territory.

STANFORD Record PEP collision rates

With the new Stanford Linear Collider SLC temporarily on hold (December 1988, page 12) for the past few months, physics at the Stanford Linear Accelerator Center (SLAC) reverted to the PEP and SPEAR electron-positron storage rings.

With only one major experiment (the TPC time projection chamber) running at PEP, the six (three electron, three positron) bunches were colliding at one point only, and the quadrupoles used to squeeze the colliding beams were pushed closer together.

In early December, the peak luminosity (a measure of the particle collision rate) attained $6 \times 10^{31} \text{ cm}^{-2} \text{ s}^{-1}$, a PEP record. For electrons and positrons, only the CESR ring at Cornell has exceeded these



levels. With reliable beams, PEP's accumulated daily collision score reached new heights.

After tests and further installation work, the SLC resumed operation in February, with the goal of supplying the Mark II detector with the first SLC Z particles – the heavy (93 GeV) carriers of the electrically neutral component of the weak nuclear force. Work is also progressing on switching techniques to enable SLC and the storage rings to run in parallel.

DUBNA/SERPUKHOV Ultrarelativistic atoms

The ultrarelativistic region where physics has to be seen in the framework of special relativity is commonplace in particle physics where beams of charged particles are regularly accelerated to velocities approaching that of light.

In other areas of physics, such as the interactions of neutral atoms

De l'original à l'imprimé...

Tout est question de fidélité.

*Les techniques changent. Les hommes aussi. Seul demeure
l'amour du métier et du travail bien fait.*

*Aujourd'hui, les exigences en matière d'impression
n'ont jamais été aussi élevées.*

Les PCL sont là pour vous le prouver.

*Derrière les machines vous attendent des hommes qui ont
déjà choisi d'imprimer avec les moyens de demain.*

PCL

*Presses Centrales Lausanne SA
7, rue de Genève 1002 Lausanne
Tél. 021/20.59.01 Téléfax 021/20.59.50*

La qualité qui communique

(with their full complement of orbital electrons), these conditions can be more difficult to explore.

The importance of relativity is measured by the mass increase (gamma) factor, which approaches infinity as the velocity nears that of light. Theoretical ideas say that the collision rate between atoms would reach a plateau starting from gamma values of about 10, but even this modest level has been difficult to reach with beams of neutral atoms.

One of the simplest atoms is positronium – an artificial concoction of an electron and a positron circling round each other. In an experiment at the 70 GeV proton machine at the Soviet Institute for High Energy Physics at Serpukhov, near Moscow, one neutral pion decay per billion yielded a fast moving positronium atom, with a gamma factor between 800 and 2000.

The interaction rate of these synthetic atoms was measured by passing them through a carbon foil a fraction of a micron thick. Taking all relativistic effects into account (under these conditions any intra-atomic positronium clock runs much slower than the actual flight time through the foil), the reaction cross-section of positronium atoms with carbon is found to be $16(+16-6) \cdot 10^{-19} \text{ cm}^2/\text{atom}$. This does not contradict the theoretically expected value, but also does not rule out ultrarelativistic ionization or excitations which could considerably increase the reaction rate.

Variation of total reaction rate (cross-section) with kinetic energy (expressed in terms of the relativistic gamma factor) for the interaction of positronium atoms with carbon, showing the theoretical expectation (solid line) and the data point from a Dubna/Serpukhov experiment investigating an ultrarelativistic region (shaded). Previous experiments using hydrogen atoms were confined to much lower velocities (arrow).

FERMILAB 20 years on

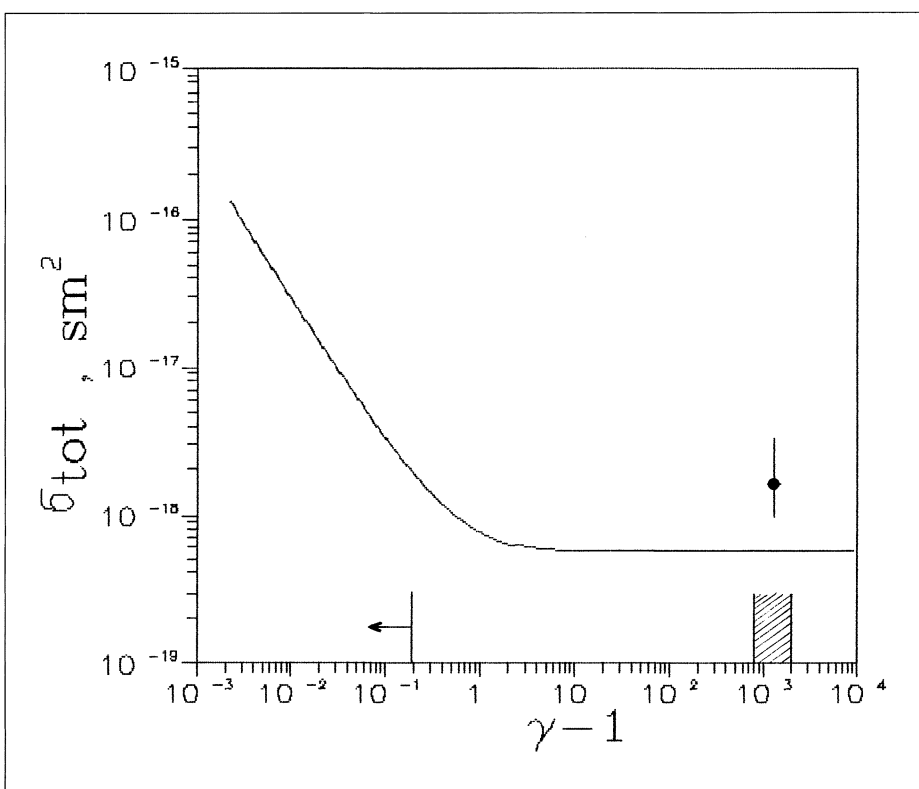
Its twentieth anniversary celebrations last December gave Fermilab an opportunity to look back to its beginnings, look over its accomplishments, and look ahead to the next two decades.

In 1963, the Ramsey Panel had recommended the United States Atomic Energy Commission (AEC) to build a 200 GeV accelerator. These were early days for particle physics (the discovery of the muon neutrino at Brookhaven by Leon Lederman, Jack Steinberger, and Melvin Schwartz was then only one year old) but physicists were becoming aware of the new horizons that higher energies could bring, and US researchers applauded the Ramsey Panel's idea.

Four years later, the National Accelerator Laboratory/AEC Design Study Contract was signed, appointing Robert Wilson as Director of the new Laboratory. With the 1967 selection of the Batavia site near Chicago, and a construction authorization of \$250 million, ground was broken the following year.

Under the able leadership of Robert Wilson, it took just four years to complete the four-mile Main Ring and ramp it to its 200 GeV design energy. With an eye to the future, ambitious R&D work also began on magnets for a possible new superconducting accelerator. After returning \$6.5 million dollars to the United States Government, the Laboratory was dedicated as the Fermi National Accelerator Laboratory, routinely providing 400 GeV beams.

A new laboratory energy scale



Twenty years ago, a pristine shovel for groundbreaking at the future Fermi National Accelerator Laboratory was wielded by (left) Laboratory Director Robert Wilson, and by US Atomic Energy Commission Chairman Glenn Seaborg.

was born when the 1000 GeV 'Tevatron' was formally proposed by Wilson in 1975, but in the environmentalist climate of the time, the name 'Energy Saver' was adopted for the 1977 proposal to the Department of Energy (DOE). That same year, Leon Lederman was named Director following Wilson's dramatic resignation, and the discovery of the upsilon particle by Lederman's Columbia/Fermilab/Stony Brook team showed that quarks come in at least five varieties.

Construction of the Energy Saver began in 1979, and work was well advanced when preparations to exploit the higher energy beams were launched with the Tevatron I scheme in 1981 and Tevatron II the following year.

The new Energy Saver broke the Main Ring's 500 GeV record in 1983 when protons were accelerated to 512 GeV. In the same year, construction of the Antiproton Source began as part of the Tevatron I plan to provide the US with a proton-antiproton collider to rival CERN's, which had begun operations in 1981.

1984 brought Fermilab and the world into a new higher energy domain with protons being accelerated to 800 GeV. Less than a year later, the new Antiproton Source provided antiparticles for the Tevatron to supply 1.6 TeV collisions for the new CDF detector. A comprehensive programme of fixed-target physics with the upgraded Tevatron II facilities and an 800 GeV proton beam rounded out the physics programme.

A prolific amount of fixed target data (May 1988, page 16) and re-



The Wilson Hall high-rise – centrepiece of Fermilab's striking architecture.

La société **C.A.E.N.** (Costruzioni Apparecchiature Elettroniche Nucleari)
et la société **A.E.M.M.** (Atelier d'Electromécanique de Montsouris)
sont heureuses de vous faire part de la naissance de leur filiale commune :



Les besoins des laboratoires français ont rendu indispensable ce partenariat entre **C.A.E.N.**, société italienne dotée de moyens importants d'étude et de recherche, bien connue dans le monde de la physique nucléaire, et **A.E.M.M.**, unité industrielle du groupe VISSAC, à haute notoriété dans le domaine de l'électronique professionnelle.

C.A.E.N. FRANCE
2 chemin latéral - 94290 Villeneuve le Roi
TEL. (1) 45 97 37 10

C.A.E.N. FRANCE

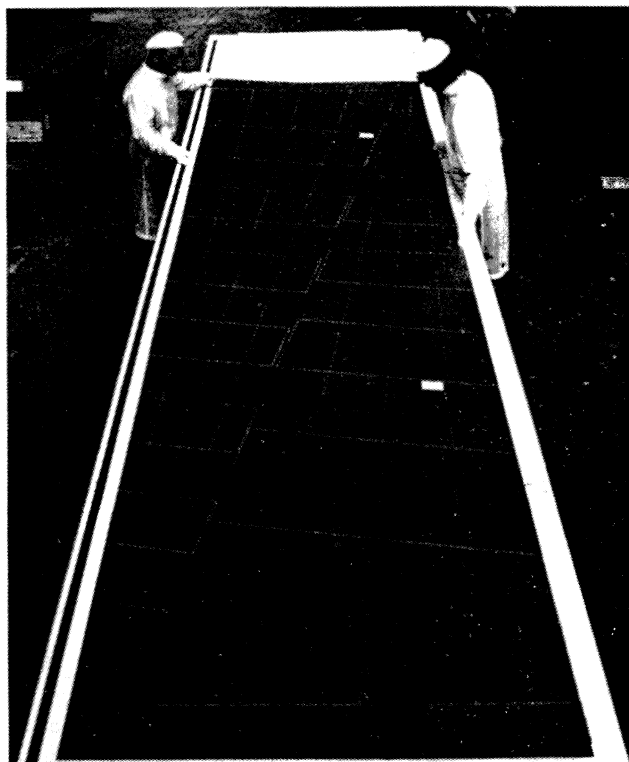
Recherche, dans le cadre de son démarrage, le chargé d'affaires:

- Parlant français,
- Bonne expérience dans les domaines des expériences de H.E.P.,
- Connaissances approfondies de l'électronique analogique et digitale,
- Localisation: Paris Sud,
- Rémunération motivante.

Ce poste offre de très belles perspectives d'avenir au sein d'un groupe jeune et dynamique à fort taux d'expansion.

Prendre contact avec **Pascal VORREUX, Jean-Pierre FARLET**, au
45.97.37.10.

Giant Read-Out Boards?



Epoxy laminates FR-4
1300x4400 mm
produced by

DITRON S.R.L.

have been chosen for the construction of the "Read-Out Board" of the hadron calorimeters of the **ALEPH** and **DELPHI** detectors.

Standard production:

- FR-4, G-10, G-11 rigid laminates for printed circuit boards
- thin laminates and prepreg for multilayer boards

DITRON srl

Via Mulino Vecchio, 85 - 28065 CERANO (NO) ITALY
Tel.: 0321/728294 - 726548 - Telex: 331565 PENCO I
Telefax: 0321/721645

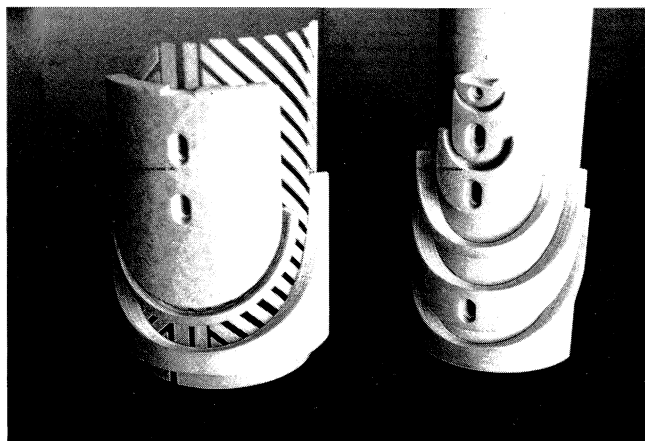
PERMALI COMPOSITES

37, rue de la Liberté - 38602 FONTAINE CEDEX - B. P. 75
☎ 76 26 08 45 - TÉLÉCOPIE 76 27 00 72 - TÉLEX 320855 PERMALI
Siège social: 8, rue A.-Fruchard - 54320 MAXEVILLE

- * Du personnel qualifié
- * Des moyens d'études, d'investigation et d'élaboration modernes et performants:
 - C.F.A.O.
 - Centres d'usage
 - Automates programmables
- * Des matériaux à hautes caractéristiques dont le

PERMAGLAS

nous permettent d'être présents sur les expériences de technologie avancée.



Les pièces isolantes situées au cœur des aimants supraconducteurs du Deutsches Elektronen Synchrotron (DESY) à Hambourg ont été réalisées chez

PERMALI COMPOSITES

Consultez-nous!

cord antiproton production rates (December 1988, page 9) were early dividends from the Tevatron investment.

But Fermilab is more than a world centre for high energy physics. Thanks to the vision of founding director Robert Wilson, its idyllic site and imaginative architecture continually thrill and inspire visitors, whether scientists or the curious public. New buildings like the Muon Laboratory and the Feynman Computing Center have continued the tradition. The unfenced 6,800 acre site is a paradise of natural beauty and a haven of environmental interest, the scene of ambitious projects to restore the Mid-West prairie to its former state, and home to a large herd of buffalo.

The vision behind Fermilab was captured in Director Lederman's testimony before a Congressional Science and Technology Sub-Committee on Energy Development in 1984. 'High energy physics pays back because it enhances our culture, contributes to human dignity, broadens our view of the evolution of the universe and our own position in it. Some will tell you that society profits because we set standards for applied science, we recruit young people into science by the seduction of neutrinos and quarks and black holes. All this is true, but what is also true is that the predecessors of today's high energy physicists changed the world, and there is no reason to believe that what we do now, abstract and remote as it may seem, will not have major effects on the lives of our children's children.'

Apart from particle physics, the Fermilab site boasts other attractions.

Upgrading

With its Tevatron collider and fixed target programmes well into their stride, Fermilab could raise its sights and aim for higher collision rates and more intense fixed target beams.

Initial work is already underway to revamp the linac injector (September 1988, page 16) to provide more protons. To further boost the collision rate, measures include improvements to the antiproton source and beam cooling, stronger quadrupoles to squeeze the colliding beams closer together, more stored bunches, and electrostatic beam separation. In addition, improved Tevatron cryogenics could push operating levels higher and make the machine live up to its name.

To push collider performance still higher calls for more ambitious schemes. A 20 GeV proton superbooster injecting into the existing main ring, and a new antiproton 'depository'

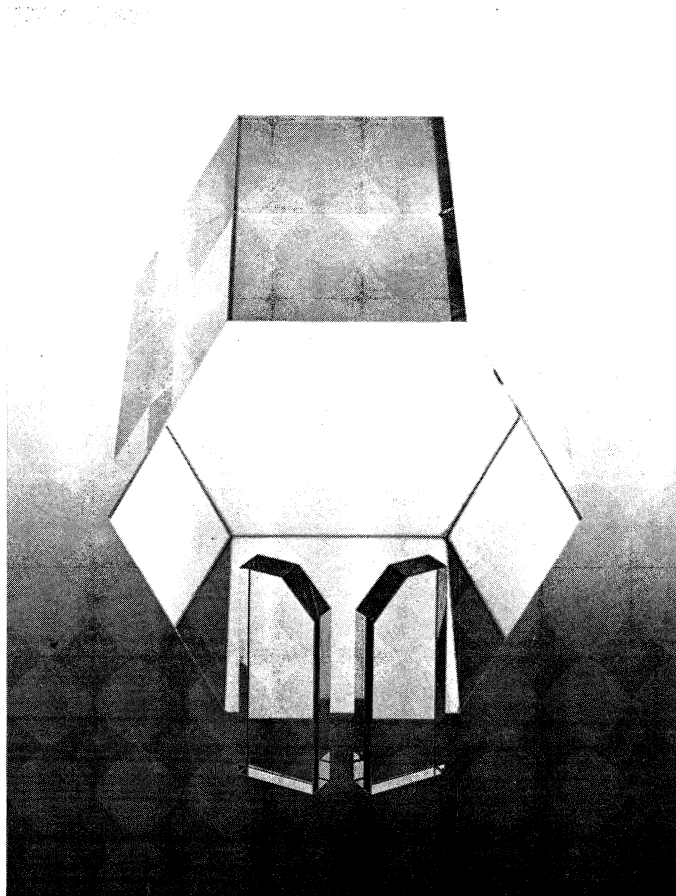
have been looked at in some detail. Even higher energies could be reached by replacing both the existing main ring and the superconducting Tevatron with higher field superconducting magnets, similar to those piling up for the HERA electron-proton collider at the German DESY Laboratory in Hamburg.

The big advantage of a proton-antiproton (or any particle-antiparticle) collider is that the contrarotating beams can be held in the same ring. However proton antimatter is not easy to handle, and in any push for higher collision rates there comes a stage when it is more cost effective to aim instead for a two ring solution providing proton-proton collisions. The original main ring could be replaced by a smaller 150 GeV ring nearby, leaving space above the Tevatron for a second superconducting ring.



High Performance BaF₂ Scintillators

MERCK – the authorized source!



- High quality BaF₂ Scintillators produced under CEA* patents
- MERCK is also a reliable supplier for CsI, NaF, BGO and other materials of interest to you
- MERCK together with CRISMATEC is sole licensee for such BaF₂ Scintillators

For further information please contact E. Merck, Darmstadt

* Commissariat à l'Énergie Atomique, Paris, France

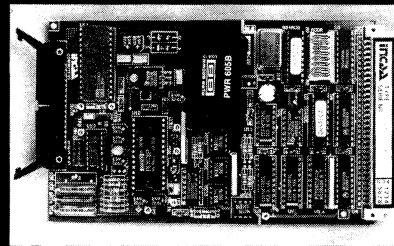
E. Merck
VIC ELO
P. O. Box 4119
D-6100 Darmstadt 1
Phone: (0 61 51) 72 36 86
Fax: (0 61 51) 72 36 30
Telex: 419 328-0 emd

MERCK

NEW

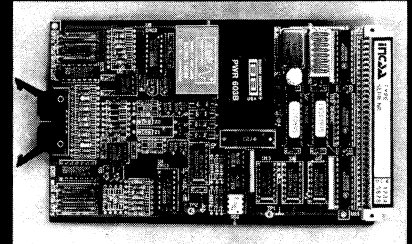
ADC & DAC FOR G-64 16 bit resolution

- Bipolar range: +10V/-10V
- DC power: 5V only
- High speed and high stability
- Full isolation from G-64 bus
- CERN specified
- Interesting price level



ADC-board
8 differential or
16 single-ended
channels

- DAC-board**
- Dual output
- External sense



INCAA
COMPUTERS

INCAA COMPUTERS BV
P.O. Box 722,
7300 AS Apeldoorn, Holland.
Tel: (0)55 - 42.50.01. Tlx: 36340

GIS SYSTEM

Constructeur de ponts-roulants

SPONTA SA

Baconnière 55 Tel.. 038/421.431-(441)-(481)
CH-2017 Boudry (NE) Télex 952.907 sposa ch
Téléfax. 038/421.668

Levage – stockage – Manutention

Pont-roulant HPM-T
Un gain maximum de volume utile

Ponts-roulants suspendus ou posés
Pour des charges jusqu'à 40 tonnes

Hauteur Perdue	
250 kg	225 mm
500	260
1000	370
2000	455
3000	465

Un Record

MEETING Lattice 88

The forty-year dream of understanding the properties of the strongly interacting particles from first principles is now approaching reality. Quantum chromodynamics (QCD – the field theory of the quark and gluon constituents of strongly interacting particles) was initially handicapped by the severe limitations of the conventional (perturbation) approach in this picture, but Ken Wilson's inventions of lattice gauge theory and renormalization group methods opened new doors, making calculations of masses and other particle properties possible.

Lattice gauge theory became a major industry around 1980, when Monte Carlo methods were introduced, and the first prototype calculations yielded qualitatively reasonable results. The promising developments over the past year were highlighted at the 1988 Symposium on Lattice Field Theory – Lattice 88 – held at Fermilab.

Peter Hasenfratz of Bern summarized recent lattice work on the mass limits of the so-far unseen Higgs particle (responsible for mass in the standard electroweak model). It has long been known that simple Higgs theory breaks down if the Higgs is heavier than about 1 TeV. Recent lattice work has even brought the limit down to about 600 – 700 GeV and made it more general. According to these calculations, no Higgs below this level means some new physics beyond the standard model.

Julius Kuti of San Diego outlined further lattice applications in the electroweak sector, including bounds on the mass of the missing sixth

('top') quark. Ideas of a new strongly coupled phase of quantum electrodynamics were aired by John Kogut of Illinois.

The calculation of particle masses is one of the main lattice theory goals, the contribution of itinerant 'sea' quarks being the most difficult to include. A 'quenched' approximation with valence quarks only, ignoring sea effects, is not expected to give the right answer, but it is still important to see what happens before embarking on the full calculation.

Progress with the quenched approximation was covered by Enzo Marinari of Rome. High statistics calculations by a special-purpose computer using improved calculational methods say the proton is about 1.4 times heavier than the rho meson, compared to the actual value of 1.22.

New improved algorithms were reviewed by Don Weingarten of IBM, Yorktown Heights, and Stephen Adler of the Institute for Advanced Study, Princeton. Progress has been most spectacular in gauging the effects of sea quarks, with new Monte Carlo algorithms being about 10,000 times faster than their predecessors.

Hardware too has seen comparable improvements. The special purpose machines under construction at various institutions around the world are roughly 10,000 times more powerful than the VAXes used for the original calculations seven years ago. Norman Christ of Columbia described machines existing or under construction at Columbia, IBM, Rome, Fermilab, Caltech, and Tsukuba, and in industry. Some of these borrow ideas from the approach pioneered by the Columbia group and now in widespread use for lattice calculations – fast floating point chips on a mas-

Peter Hasenfratz – mass limits for the long-awaited but still unseen Higgs particle.

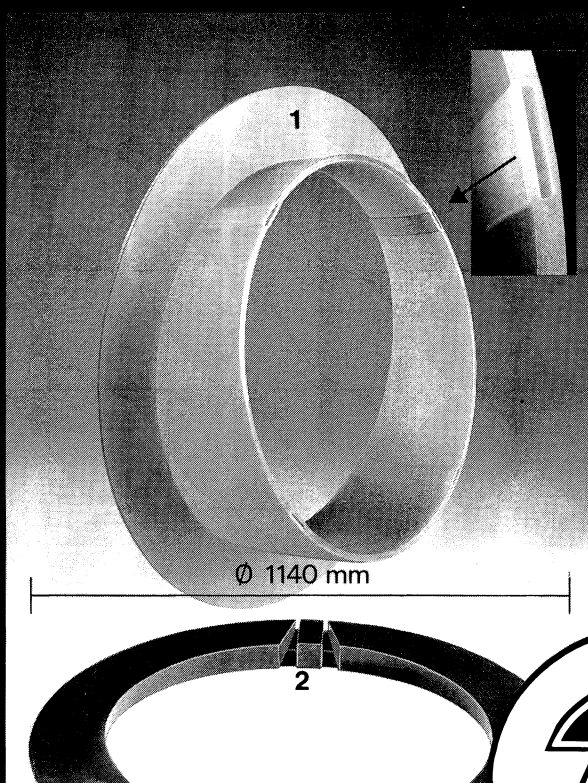


sive parallel array of nodes.

The better understanding of glueballs (particles containing gluons rather than quarks) was pointed out by Andreas Kronfeld of Fermilab. Two years ago, confusion reigned in this area and there was no unanimity even on basic questions. Improved methods of calculating glueball masses have helped to clarify the situation, the consensus being that the spin 2, positive parity glueball is about 1.5 times heavier than its spin zero counterpart.

Pierre van Baal of CERN summarized recent analytic work on the spectrum of a pure glue theory. In addition to being very beautiful, this work has been accurately verified by Monte Carlo methods, so increasing confidence in the numerical approach.

The physics of QCD at high temperatures and densities – interesting for heavy ion physics, astrophysics, and cosmology – has provided the first accurate, reliable simulation result – the transition temperature at which quarks are unlocked from their conventional



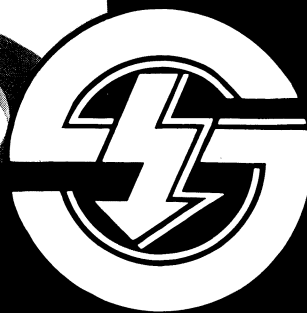
Vacuum-impregnated toroidal components (circular in all three dimensions) made of glass fibre/epoxy for

Tokamak FTU insulation for E.N.E.A. Frascati (and Ansaldo)

- Part 1: For accelerator ring with 4 straight-through ring electrodes.
- Part 2: Coil vee ring manufactured by FW process.

Please request detailed information. Mr H. Mauch will be glad to advise you personally.

We offer a range that is based on 30 years' experience and know how through successful collaboration with field specialists.

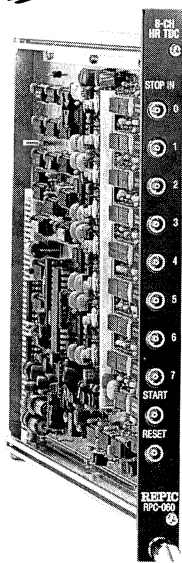


Stesalit AG Kunststoffwerk

We provide easily built-in safety in Know-how.

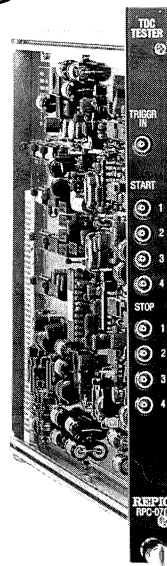
CH - 4234 Zullwill SO Telefax 061/80 06 04
Telephone 061/80 06 01 Telex 963 182

NEW!
CAMAC MODULE



HR TDC MODEL RPC-060

- High Resolution 8ch.
- Common Start Form.
- Full Scale 118 or 236nsec.
- 12bit Dynamic Range.
- Fast Clear.
- Low Temperature.



TDC TESTER MODEL RPC-070

- Programable Time Interval Generator.
- Full Scale Time Range 200n, 500n, 1000n, 2000 nsec.
- 15psec. Time Jitter.
- 13bit Linearity.
- With 4 Output Connectors.

REPIC CORPORATION

林業精器株式会社・国際事業部
28-3, Kita Otsuka 1-Chome, Toshima-ku, TOKYO 170, JAPAN
Tel. 03-918-5326 Telex. 2723523 REPIC J
Fax. 03-918-5712

A.A. Migdal – putting strings on the lattice.



nucleon imprisonment. Masataka Fukagita of Kyoto concluded that this calculation is still in good shape. The phase transition seems to be much weaker than originally thought, and there is some controversy as to its type (weak first order or second order). Preliminary calculations in full QCD hint that the transition temperature may be around 150 MeV (about 10^{12} degrees!). Frithjof Karsch of CERN claimed that the simple picture of the hot QCD plasma as an ideal gas of quarks and gluons interacting through small perturbations looks good so far, though much room remains for nonperturbative effects.

Input from lattice calculations provides a useful complement to new data, giving theorists additional room to manoeuvre. These difficult calculations were described by Claude Bernard of Santa Barbara. The kinematic behaviour of quark content (structure functions) and of particle form factors was one of the earliest successes of perturba-

tive QCD, but prediction of the quantities themselves requires lattice calculations, reviewed by Guido Martinelli of CERN. Chris Sachrajda of Southampton described the painstaking analytic work behind the lattice treatment of the standard model.

The powerful simulation methods of lattice theory are useful in other areas of physics. Jorge Hirsch of San Diego ('What should a lattice gauge theorist be doing in his/her spare time?') reviewed current theoretical ideas on high temperature superconductivity. Sasha Migdal of the Cybernetics Council in Moscow described progress towards a lattice formulation of bosonic string theory, complementing analytic work based on Polyakov's conformal field theory approach. The agreement between analytic and numerical calculations is as important in this field as for QCD.

The past year has been the most active ever for lattice gauge theory, but the vast increase in algorithmic and hardware computing power of the past seven years is not the end of the line. Approximation schemes show promising results, and full calculations will not be far behind. With unrestricted predictive power, a full exploration of the wide open physics territory both in and beyond the standard model will then begin in earnest.

From Paul Mackenzie

DESY Theory with flavour

Last year, the annual Theory Workshop at the German DESY Laboratory in Hamburg had 'Flavour Physics' as its main theme. The sighting by the UA1 experiment at

CERN's proton-antiproton collider and by the ARGUS team at DESY of 'oscillations' in the electrically neutral B mesons carrying the beauty quantum number, and the measurement at CERN of a new parameter in the delicate violation of combined particle-antiparticle and left-right symmetry (CP) in the decays of neutral kaons (July/August 1988, page 7) have made this subject particularly topical.

Setting the tone for the meeting, W. Schmidt-Parzefall (DESY) described the current evidence for neutral B mixing, looking also at the possibilities for a B meson 'factory' at DESY to search for additional signs of CP violation.

In the production, spectroscopy and decay of charm particles (R.J. Morrison – Santa Barbara), significant advances have been made by new high-statistics experiments. B. Stech (Heidelberg) showed how B and charm decay theory was in line with the data. Less conventionally, his explanation of isospin selection rules for weak kaon and hyperon decays based on 'diquarks' provoked some lively discussion.

Mass limits for the so-far unseen sixth ('top') and other heavy quarks (J. Kuehn, MPI Munich) turned the discussion towards an outlook for the future. Kuehn assessed the chances of finding the top up to 80 GeV at the CERN proton-antiproton collider and up to 100 GeV at the Fermilab Tevatron, going on to look at the implications of top physics for the new electron-positron colliders – LEP at CERN and SLC at Stanford.

A. Ali (DESY) examined the physics of heavy quarks at the HERA electron-proton collider being built at DESY and underlined the potential of HERA in the search for top and for a detailed study of B meson oscillations. Open questions

in B physics were also taken up by K.R. Schubert (Karlsruhe), concluding that B factories would be very useful, and in the case of CP violating B decays even necessary, using as an illustration the project proposed at the Swiss Paul Scherrer Institute (PSI – July/August 1987, page 21).

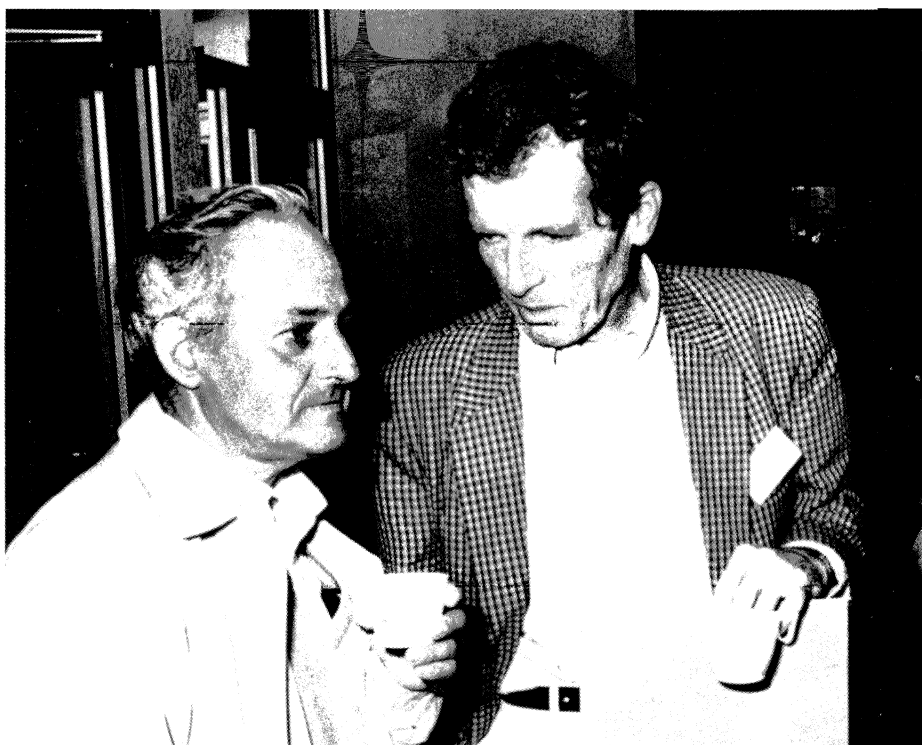
M.P. Schmidt (Yale) imagined the detectors needed to exploit the enormous production rate of B particles in hadron colliders, in particular at the proposed US SSC Superconducting Supercollider.

Looking to the other extreme of the particle mass scale, the meeting turned to the neutrinos. A survey of the numerous delicate experimental studies, particularly in the mass and oscillation sectors by K. Winter (CERN), was followed by the theory viewpoint from R. Mohapatra (Maryland), illustrating the possible connection between neutrino mass and very high energy physics with the help of several models.

In a series of talks on CP violation, quark masses and flavour mixing, M. Holder (Siegen) covered new CP violation parameter measurements of neutral kaons at CERN and Fermilab and looked at future experiments, such as a study at CERN's LEAR low energy antiproton ring. I. Bigi (Notre Dame) turned to CP violation in both B and charm meson decays, estimating the chances of seeing such effects. Finally C. Jarlskog (Stockholm) painted scenarios for CP violation in the electroweak picture using three or four quark families.

Subsequent talks concentrated on calculating the input for a theoretical description of weak decays, mass mixing and CP violation. G. Martinelli (CERN) summarized the status of lattice calculations, while A. J. Buras (Munich) advo-

At the DESY Theory Workshop – top, R. Rueckl (left) with R. Peccei; below, E. Lohrmann (left) with C.A. Heusch.



CERN COURIER

A unique advertising medium for scientific and technical equipment

CERN COURIER is the internationally recognized news magazine of high energy physics. Distributed to all the major Laboratories of the world active in this dynamic field of fundamental research, it is compulsive reading for scientists, engineers, administrators, information media and buyers. Written in simple language and published simultaneously in English and French it has become the natural communication medium for particle physicists in Europe, the USA, the Soviet Union, Japan—everywhere where the fundamental nature of matter is studied.

Published from CERN, Switzerland, it also has correspondents in the Laboratories of Argonne, Berkeley, Brookhaven, Cornell, Fermi, Los Alamos and Stanford in the USA, Darmstadt, DESY and Karlsruhe in Germany, Orsay and Saclay in France, Frascati in Italy, Daresbury and Rutherford in the U.K., SIN in Switzerland, Dubna and Novosibirsk in the USSR, KEK in Japan, TRIUMF in Canada and Peking in China.

The annual expenditure on high energy physics in Europe is about 1000 million Swiss francs. The expenditure in the USA is about \$ 400 million. There is similar expenditure in the Soviet Union.

CERN COURIER is the way into all high energy physics research Laboratories. If you have a market in this field, there is no surer way to make your products known than by advertising in CERN COURIER.

All enquiries to:

Advertising Manager
Micheline Falcia
CERN COURIER
CERN
CH - 1211 GENEVA 23
Tel. (022) 83 41 03
Telex 419 000 CER
Telefax (022) 82 19 06

University of Cambridge
Department of Physics


University Assistant Lecturer in
Experimental Particle Physics

Applications are invited for the post of University Assistant Lecturer in the High Energy Physics Group of the Cavendish Laboratory. The research programme of the group is currently centred upon the OPAL experiment at LEP, the UA2 experiment at the CERN proton-antiproton collider and the development of electronic detectors for particle physics.

It is hoped that the successful candidate will take up appointment by 1st October 1989, or as soon as possible thereafter. The appointment is for three years, with the possibility of reappointment for a further two years. The statutory limit of tenure of a University Assistant Lectureship is five years, but all holders of the office of University Assistant Lecturer are considered for possible appointment to the office of University Lecturer during the course of their tenure.


The pensionable scale of stipends for a University Assistant Lecturer, not ordinarily resident in College, is £10,460, rising by seven annual increments to £14,500.

Further information may be obtained from the Secretary of the Appointments Committee for the Faculty of Physics and Chemistry, Institute of Astronomy, Madingley Road, Cambridge CB3 0HA, England, to whom applications (ten copies), including a curriculum vitae and the names of three referees, should be sent so as to reach him not later than **31st March 1989**.



SERVILEC, SOCIÉTÉ ANONYME
POUR LA RÉPARATION D'INSTRUMENTS DE MESURES
17, ch. du Faubourg-de-Cruseilles
1227 Carouge

**CONFIEZ-NOUS
VOS INSTRUMENTS
DÉFECTUEUX**



**022
43 89 00**

NOUS RÉPARONS ET CALIBRONS :
Oscilloscopes, multimètres, sondes, compteurs, générateurs de fonctions, de fréquences, moniteurs, alimentations, etc...

Dans les marques suivantes :
Tektronix © - **HP** © - **Fluke** © - **Schlumberger** ©
ABB Metrawatt © - **Philips** © - **Gould** ©
© marque déposée

People and things

cated an alternative perturbation expansion approach, and A. Pich (CERN) covered duality and quark field theory sum rules. The isospin 1/2 selection rule was a yardstick for reliability of the different results.

H. Harari (Weizmann Institute) investigated the hierarchy of quark and lepton masses, paying particular attention to the neutrinos and looking at relationships between masses and mixing angles.

The final day of the workshop was given over to speculations beyond the standard model and possible experimental tests. H.K. Walter (PSI) surveyed worldwide efforts to detect rare decays of muons, pions, kaons and heavy particles. A. Masiero (Padua) showed how rare decays of B mesons could be used as a litmus test for a fourth quark family, further Higgs bosons, left-right symmetry and supersymmetry.

Flavour dynamics in the standard model is intimately connected with spontaneous symmetry breaking and the concomitant Higgs bosons, which have so far eluded observation. However renormalization group and lattice studies can give limits for Higgs and other masses, as demonstrated by R. Petronzio (Rome). The results all say that the standard Higgs boson should be lighter than 1 TeV.

R. Peccei (DESY) speculated on an exotic zoo of spin zero particles, including leptoquarks, majorons and cosmons.

Superstrings are a long way from flavour physics, however these ambitious ideas could shine new light on many open questions. The concepts of string theories were introduced by H. Nicolai (Hamburg), while H. P. Nilles (Munich) looked at the possible links between strings and conventional

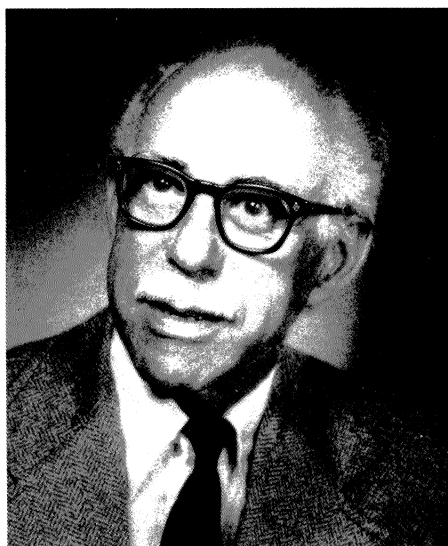
physics.

Summarizing, H. Fritzsch (Munich) singled out the question of particle masses in the standard model, claiming the potential for answering this problem to be a good measure of theoretical physics progress.

(The Workshop organizing committee consisted of J. Bartels of Hamburg, W. Buchmueller of Hannover, J. Koerner of Mainz, R. Rueckl of DESY, B. Stech of Heidelberg, and P. Zerwas of Aachen as chairman.)

From R. Rueckl

The 1988 Enrico Fermi Award of the US Department of Energy goes to Richard B. Setlow of Brookhaven (left) and Viktor Weisskopf (right).

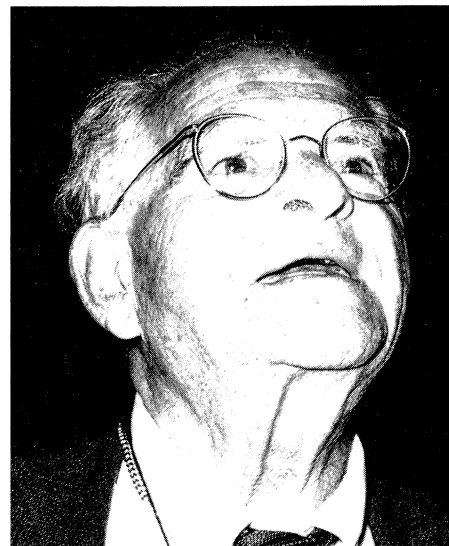


Fermi Award

The 1988 Enrico Fermi Award, the highest scientific award of the US Department of Energy, goes to Viktor Weisskopf, doyen of the particle physics community, and to Richard B. Setlow, a biophysicist at Brookhaven.

The career of Weisskopf, who celebrated his 80th birthday last year (December 1988, page 32), spans the entire history of particle physics, beginning in the golden age of quantum mechanics in Europe in the 1920s. He was Director General of CERN from 1961-5, has been very influential in the development of modern US particle physics policy, and has remained a steadfast proponent of international collaboration.

Richard Setlow is honoured 'for his pioneering and far-reaching contributions to the fields of radiation biophysics and molecular biology, beginning with the discovery and conceptualization of the processes of DNA repair that have had an impact on research in genetics, recombination, mutation and carcinogenesis'.



ACCELERATOR SCIENTISTS AND ENGINEERS

Argonne National Laboratory will be entering the construction phase of its 7-GeV Advanced Photon Source (APS) Project. The APS is a state-of-the-art synchrotron x-ray source optimized to produce insertion-device radiation. APS accelerator facilities comprise a 7-GeV low-emittance positron storage ring 1100 m in circumference, a 7-GeV synchrotron, a 450-MeV positron accumulator ring, a 450-MeV positron linac, and a 200-MeV electron linac. The challenges of building the facility offer great potential for professional growth for scientists and engineers in the following areas:

ACCELERATOR SCIENTISTS

Several positions at various appointment levels are available for candidate with experience and interest in accelerator design, including computer simulation of beam dynamics, calculation of coupling impedance and collective effects, particle tracking simulation, lattice design, vacuum and surface physics, beam diagnostics, and magnetics and magnet design. Appointment level will depend on the candidate's experience. Entry-level or postdoctoral positions will be available.

ELECTRICAL ENGINEERS

Two senior positions are available, requiring an advanced engineering degree and at least ten years' experience in design and construction of large particle accelerators. Work experience in accelerator-type magnets and/or power supplies is highly desirable. We also have several positions requiring BSEE and a minimum of five years' experience in the following areas:

- Design and power electronics
- Multi-kilowatt power supplies
- Low-level fast electronics
- Beam diagnostics.

MECHANICAL ENGINEERS

A senior-level position is available, requiring an advanced ME degree at least ten years' experience in mechanical engineering aspects, such as ultra-high vacuum and structural design, of the design and construction of large particle accelerators. We also have several openings requiring a BSME and a minimum of five years' experience in the following areas:

- Survey and alignment techniques
- Ultra-high vacuum systems
- Mechanical design of magnets
- Shop fabrication practices.

You will receive a competitive salary and a superior benefits package which includes medical/dental insurance, 9% contribution to your retirement annuity, 24 days paid vacation, and 10 paid holidays each year. Please forward your resume in confidence to:

R.A. JOHNS, Appointment Officer
Box J-APS-88, Employment and Placement
ARGONNE NATIONAL LABORATORY
9700 South Cass Avenue
USA - ARGONNE IL 60 439



Argonne is an equal opportunity/affirmative action employer.

In the
**Max-Planck-Institut
für Physik und Astrophysik
Munich**

a group is pursuing the development of cryogenic detectors for low energy neutrinos and dark matter and is searching for an

Experimental Physicist (Ph. D.)

to take a leading role in the group.

Experience in low temperature physics and/or particle and nuclear physics is requested. Depending on qualification, permanent appointment on a senior level is anticipated.

Applications (including curriculum vitae, list of publications, and names of two referees) should be sent as soon as possible to:

Prof. N. Schmitz
Max-Planck-Institut
für Physik und Astrophysik
Führinger Ring 6
D-8000 München 40,
Fed. Rep. of Germany

UNIVERSITY OF SOUTH CAROLINA

Faculty Positions in HIGH ENERGY PHYSICS

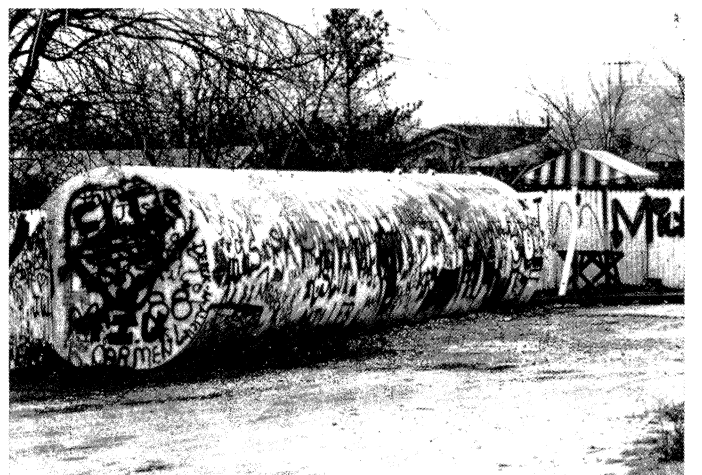
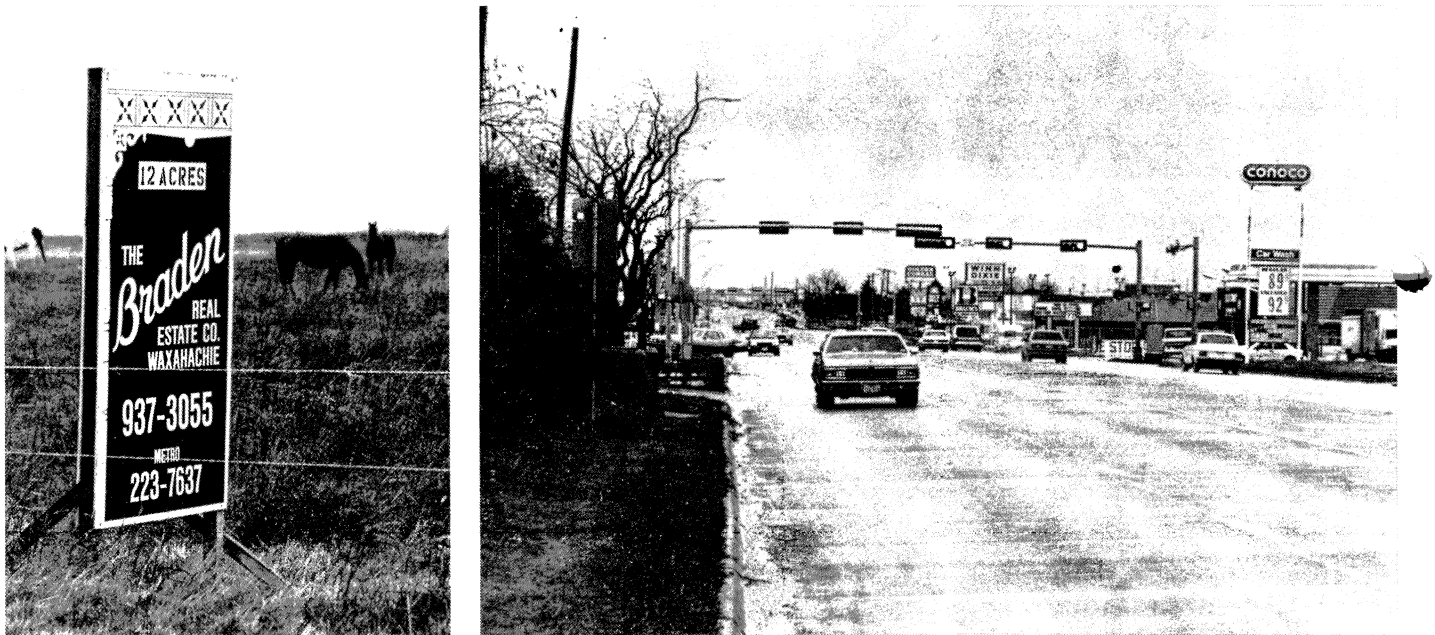
The Department of Physics at the University of South Carolina invites applications for two tenure-track positions in the area of experimental high energy physics. The positions are at the assistant professor level although appointment at a higher level may be considered for an exceptionally qualified candidate. The South Carolina high energy group currently pursues $e^+ e^-$ collider physics at KEK's TRISTAN ring using the AMY detector and an experiment on charmless two-body B^0 decays at Fermilab. The ongoing programs would welcome new members, but candidates with other research interests will also be considered. Applicants should submit a curriculum vitae and publications list, a statement of research interests, and the names of professional references to

Prof. Frank T. Avignone, III,
Chairman,
Department of Physics and
Astronomy
University of South Carolina
Columbia, SC 29208

The University of South Carolina is an Affirmative Action / Equal Opportunity employer and solicits applications especially from qualified women and minorities.

Waxahachie walkabout

On a recent North American trip, CERN's E.J.N. ('Ted') Wilson took his camera to Waxahachie, Texas, preferred site for the proposed 84-kilometre US Superconducting Supercollider ring to collide 20,000 GeV proton beams.



Directors old and new at the Joint Institute for Nuclear Research, Dubna, near Moscow. Left to right, new Vice-Director Alexei Sissakian (USSR), former Director and now Honorary Director N.N. Bogolubov, new Director Dezso Kiss (Hungary) and new Vice-Director Ditmar Ebert (East Germany).



Dubna Directorate changes

Following the recent senior staff reshuffle at the Joint Institute for Nuclear Research (JINR), Dubna, near Moscow (January/February, page 29), the Committee of Plenipotentiaries of the JINR Member States at its January meeting elected a new Directorate.

Academician Dezso Kiss (Hungary) was elected JINR Director for three years from 1 March, with Alexei Sissakian (USSR) and Ditmar Ebert (East Germany) as Vice-Directors for three years from 1 April.

Former Director N.N. Bogolubov was named Honorary Director in recognition of his outstanding role in the development of the Institute, which has eleven Member States.

On people

Francis Cole, well known in the accelerator field and who has played a major role in Fermilab documentation, has left Fermilab to work on the Loma Linda University Medical Center proton therapy accelerator.

W.P. Swanson 1931-1988

William P. Swanson of Berkeley's Occupational Health Division died in December. After twenty years as a particle physicist, he turned his attention to radiation physics and radiological protection. His work at Stanford and Berkeley created a wealth of expertise on the radiation environments of large accelerators, and he was the author of the definitive work 'Radiological Aspects of the Operation of Electron Linear Accelerators'.

Meetings

The new Summer Nuclear Institute at the Canadian TRIUMF Laboratory aims to provide short nuclear physics courses at the first or second year graduate level. This year's Institute will be held from 31 July – 11 August with core courses covering multiple scattering and the optical potential, hypernuclear physics, relativistic nuclear physics, and hadronic symmetries. Short seminars will cover other topics. Further information from Byron Jennings, TRIUMF, 4004 Westbrook Mall, Vancouver BC, Canada V6T 2A3.

Instrumentation technology

The European Committee for Future Accelerators (ECFA) is organizing a study week on the new instrumentation technology needed to exploit the high luminosity hadron colliders – such as the LHC hadron collider in the 27 kilometre LEP ring at CERN – now being proposed for the next generation of particle physics research. The meeting will be held from 14-21 September in Barcelona, Spain.

For the LHC machine itself, R and D partnerships between CERN and European industry are already underway, and the physics community is now eager to stimulate industrial interest in the technology for big new detectors, with possibilities for significant spin-off.

Key technical areas to be covered at the meeting include semiconductor technology, optical fibres, optoelectronics, fast electronics, and computing.

Further information from Oscar Barbalat, Industry and Technology Liaison Office, CERN, 1211 Geneva 23, Switzerland, or Markus Nordberg, University of Helsinki, Otaniemi Science Park, 02150 Espoo, Finland.

CERN's phone number

From 22 April, CERN's general telephone number will change from Geneva 836111 to Geneva 767 6111. For direct dialling, use 767 followed by the four-digit internal number. Thus the CERN Courier's new number will be Geneva 767 4103. (The international dialling code for Geneva ends with 4122.)

The 12th International IUPAP Conference on Few Body Problems in Physics will be held in Vancouver, Canada, from 2-8 July. Topics will cover nuclear, medium energy, particle and atomic physics. Further information from Terry Murphy (local arrangements, bitnet fewbody at triumfcl) or Harold W. Fearing (conference organizer, bitnet fearing at triumfcl), TRIUMF, 4004 Wesbrook Mall, Vancouver, British Columbia, Canada V6T 2A3.

20 years of the Triangle Seminar

Last year saw the 20th anniversary of the 'Triangle Seminar', founded by H. Pietschmann of Vienna to stimulate particle physics contact between the universities of Vienna, Budapest and Bratislava, building on a previous tradition of joint Vienna/Bratislava seminars. From its modest beginnings, it has become an important east-west bridge, attracting physicists also from Prague, Trieste, Crakow and Zagreb.

H. Pietschmann (left) and W. Thirring (right) of Vienna celebrate the 20th anniversary of the Vienna/Budapest/Bratislava 'Triangle Seminar' with organizer R.A. Bertlmann.

(Photo Renate Bertlmann)

ACCU-rate

Following the recommendations of the CERN Review Committee under Anatole Abragam, the role of the Advisory Committee of CERN Users (ACCU), established in 1978, has been redefined, making it more representative and improving its efficiency as a mutual consultation channel between CERN and its user communities.

ACCU's task is to advise CERN on the practical measures and administrative arrangements needed to complement the research facilities, in particular as regards working conditions and technical support for outside researchers working at CERN. Each Member State is represented by one or two users recognized by their appropriate scientific organizations. In addition, there are two representatives each for users from outside the Member States (a growing community at CERN) and for CERN research staff. While contacts between estab-

lished users and CERN are being strengthened in the respective countries, individual users (particularly those from outside the Member States) are encouraged to channel their requirements through their ACCU representative(s):

Austria – W. Bartl;
Belgium – C. Bricman;
Denmark – P. Hansen;
France – A. Roussarie, G. Sauvage;
Germany – M. Holder, H. Siebert;
Greece – G. Theodosiou;
Italy – G. Conforto, P. Laurelli;
Netherlands – D. Toet;
Norway – E. Lillestol (Chairman);
Portugal – P. Bordalo;
Spain – J. Hernandez;
Sweden – P.O. Hulth;
Switzerland – J. Schacher;
United Kingdom – P. Booth, P. Norton;
Non-Member States – I. Galaktionov, S.L. Wu;
CERN – C. Fabjan, P. Jenni.



Staff Scientists

The Advanced Light Source (ALS), a new facility based on a third-generation electron storage ring, is currently under construction at the Lawrence Berkeley Laboratory. The technical components of the source comprise a 50 MeV linac, a 1.5 GeV booster synchrotron and an electron storage ring optimized for operation at 1.5 GeV, but capable of operation between 1.0 and 1.9 GeV. Machine commissioning will start with the injection system (linac and booster) early in 1990.

The Exploratory Studies Group has two job openings for staff scientists to work on high-level applications programming for the commissioning and operational phases of the project beginning October, 1989. The incumbents will be responsible for the development of algorithms to control the behavior of the beam in the accelerators, to interpret the data gathered by the diagnostic system, and to develop fault-finding procedures in the event of abnormal conditions. It is planned that the incumbents move into positions within the accelerator operations group of the ALS.

The successful candidates will have demonstrated experience in computer control applications and a working knowledge of both FORTRAN and PASCAL. (Experience with Modula-2 and C would also be desirable). A basic knowledge of accelerator physics and some experience in an accelerator based laboratory are required. A Ph.D. in Physics or closely related field is preferred.

To apply, send two copies of resume to: Lawrence Berkeley Laboratory, Employment Office, 90-1042, #1 Cyclotron Road, Berkeley, CA 94710. Refer to JOB # A/5076. An equal opportunity employer M/F/H.



LAWRENCE
BERKELEY
LABORATORY

BROOKHAVEN NATIONAL LABORATORY

Senior Mechanical Engineer

Brookhaven National Laboratory, one of the nation's leading R&D facilities, has a challenging opportunity within our Accelerator Development Department's Relativistic Heavy Ion Collider design team. We require a minimum of a MS degree and 10 years' experience, with a background in at least one of the following: ultrahigh vacuum systems, magnet design, fusion devices or cryogenic engineering. Experience with the mechanical construction of particle accelerators is desirable.

Brookhaven offers a superior working environment on a campus-like site on eastern Long Island, New York. We offer an excellent benefits package, including 24 days annual vacation, comprehensive medical, dental and retirement plans and relocation allowances. If you would like to explore this opportunity, please forward your resume, responding to ad #RHIC, including salary history and requirements, to: Nancy L. Sobrito, Brookhaven National Laboratory, Associated Universities, Inc., Personnel, Bldg. 185, Upton, NY 11973. An Equal Opportunity Employer.

 **BROOKHAVEN
NATIONAL LABORATORY**
ASSOCIATED UNIVERSITIES INC.

DEPUTY GROUP LEADER

Los Alamos National Laboratory is continually strengthening its internationally renowned position as a pioneering research center. Situated in the unspoiled scenic beauty of northern New Mexico, our 43 square mile location comprises an ideal R&D environment. With a future that's as wide open as our skies, we can offer you a highly challenging career opportunity along with a superlative lifestyle.

In this position, you will provide leadership for the Accelerator Theory and Simulation Group, as well as assist in the development and exercise of capabilities of Group to provide expertise in analytic and numerical solution of problems related to traditional linear and circular accelerator performance, including accelerator design and nonlinear instability analysis. Develop expertise in advanced acceleration techniques. Assist in preparation of proposals for advanced accelerator R&D. Assume duties of group leader in his absence. Assist in evaluation of performance of staff.

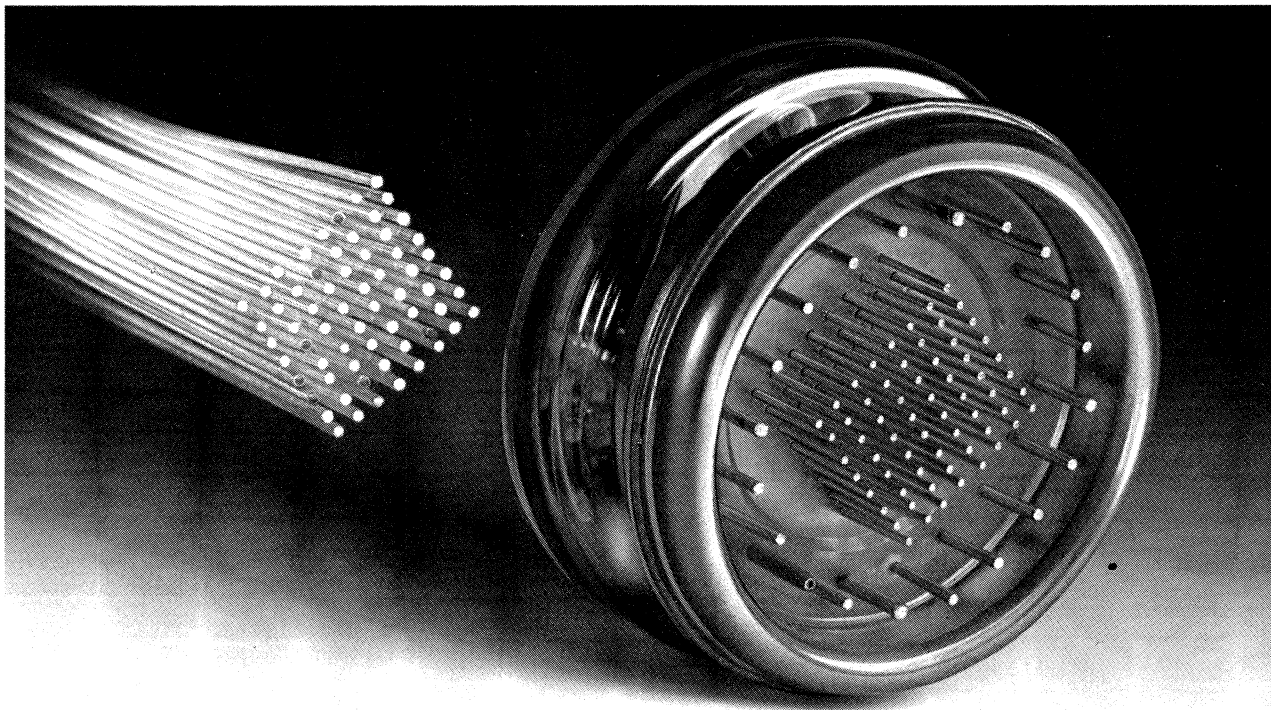
Demonstrated ability to lead technical staff in development, simulation and analysis of traditional linear and circular accelerator theory required. Extensive working knowledge of accelerator theory and practice essential as is effective oral/written communication skills as evidenced by technical presentations, substantial record of publication in technical journals and other accelerator literature. Permanent resident alien or U.S. citizenship required. A PhD in Physics or closely related discipline required.

Interested candidates should forward a resume and salary history to: Shelly Melton (MS P280), Personnel Services Division 80896-1, Los Alamos National Laboratory, Los Alamos, NM 87545.

Affirmative Action/Equal Opportunity Employer

University of California

Los Alamos



SCINTILLATING FIBRES?

XP4702 reads them out 64 at a time!

First of a new family, the XP4702 extends PMT talents into the realm of spatial as well as time resolution. Combined in a single envelope, 64 ten-stage multipliers with long-life CuBe dynodes produce an 8x8 mosaic of discrete pixels. With uniform channel-to-channel gain and transit-time. The common anode supplies an additional signal that can be used for amplitude analysis or triggering.



SK_e (λ)	40 mA/W at 400 nm
G	10^6 at 1400 V
t_r	4.8 ns at 1400 V
output	segmented last dynode, 8x8 matrix of 64 independent 2.54 mm x 2.54 mm elements
crosstalk	<5% (scanned by 50 μ m light spot)

XP4702 opens new opportunities in fibre readout, hodoscopy, calorimetry and coarse imaging. Reference: NIM A269 (1988) 246-260.

Fibres courtesy of Optectron, France.

For more information contact: Philips Components, Building BAF2, 5600 MD Eindhoven, The Netherlands. Telex 35000 phtcnl/nl jeveo.

STILL SETTING THE STANDARD

Philips Components



PHILIPS