

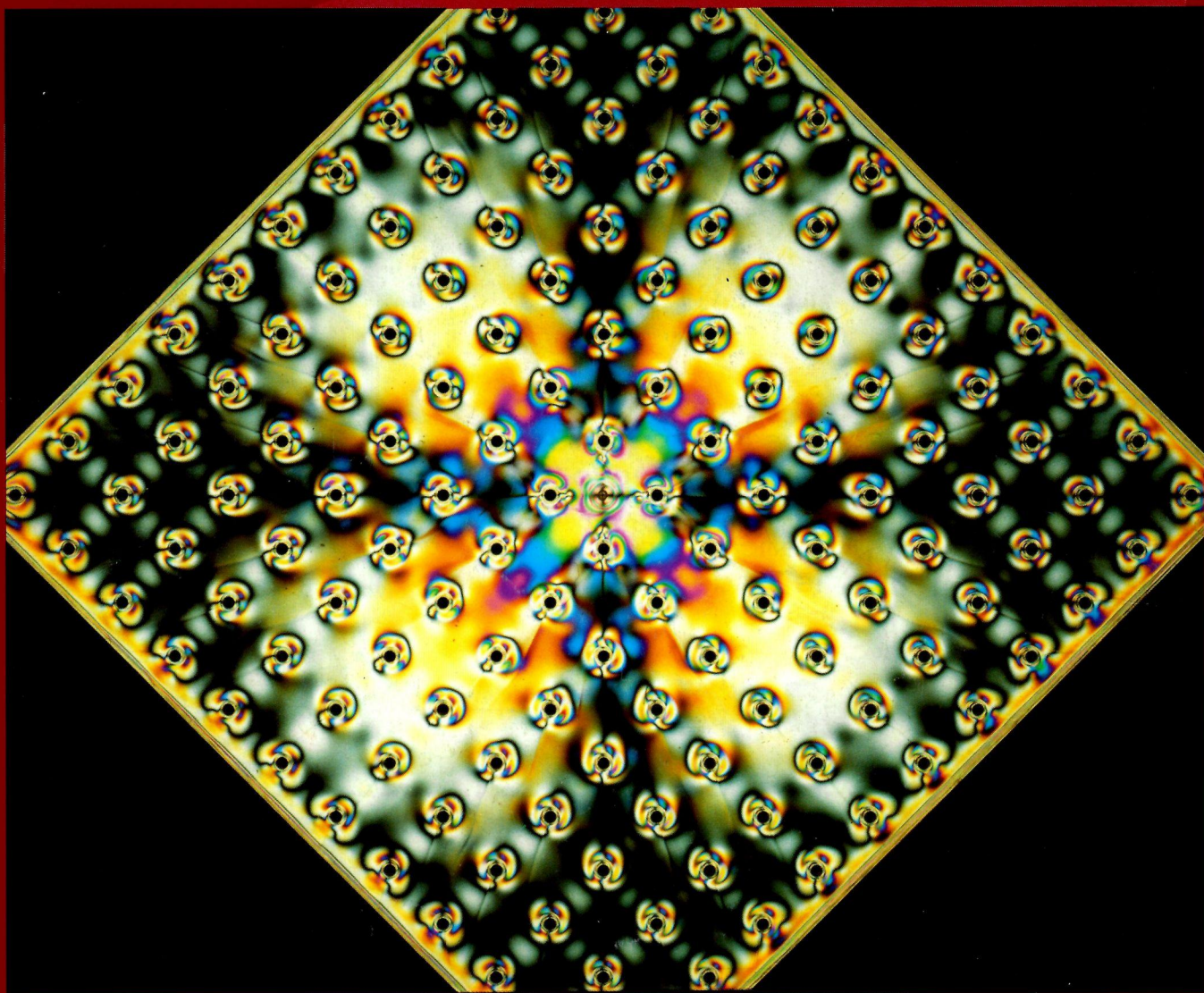
CERN COURIER

INTERNATIONAL JOURNAL OF HIGH ENERGY PHYSICS

VOLUME 33

3

APRIL 1993



Quand seul le meilleur



Suffit!

Le catalogue
 25 000 produits, tous tenus en stock
 Tous les grands fabricants répertoriés
 Facile à consulter
 Deux éditions par an : février et septembre

La gamme
 Un sommaire clair pour
 une consultation
 plus simple et plus rapide

Le service
 Aucun minimum de commande
 Tarif fixe pour la durée du catalogue
 Service STAR®, une ligne directe avec
 un technicien conseil
 au (16) 44 02 55 55
 Une équipe locale
 toujours disponible



1	Accumulateurs, piles et chargeurs
2	Alarmes et sécurité
3	Alimentations
4	Appareillage industriel
5	Câbles et fils
6	Câbles - accessoires
7	Châssis et coffrets
8	Circuits imprimés
9	Condensateurs
10	Connecteurs audio et vidéo
11	Connecteurs coaxiaux
12	Connecteurs multipoints
13	Connecteurs - supports
14	Connecteurs - autres
15	Dissipateurs thermiques
16	Entretien et maintenance
17	Equipement de dessin
18	Fibre optique
19	Filtres et protection
20	Fusibles
21	Haut-parleurs
22	Indicateurs de tableau
23	Inductances
24	Informatique
25	Interrupteurs et commutateurs
26	Opto-électronique
27	Relais
28	Réseaux locaux
29	Résistances et potentiomètres
30	Semiconducteurs - discrets
31	Semiconducteurs - logiques
32	Semiconducteurs - analogiques
33	Semiconducteurs - μ P mémoires
34	Transformateurs
35	Ventilateurs
36	Alimentations de laboratoire
37	Calculatrices
38	Environnement
39	Multimètres
40	Oscilloscopes et générateurs
41	Test électrique
42	Antistatique
43	Outils à main
44	Outils électro-portatifs
45	Production
46	Rangement
47	Soudage/Dessoudage
48	Visserie et fixations
49	Bibliothèque technique

Composants

Test et Mesure

Outils



NOUVEAU La rapidité
 Toute commande
 passée avant 18 h.
 est expédiée le jour même
 afin de garantir la livraison,
 franco de port,
 le lendemain



RS Composants
 (16) 44 84 72 72

Je désire recevoir gratuitement le catalogue février à août 93

Nom : _____ Prénom : _____
 Fonction : _____ Service : _____
 Société : _____
 Adresse : _____
 _____ Tél. : _____ Fax : _____

RS Composants - B. P. 453 - 60031 Beauvais Cedex - Tél. (16) 44 84 72 72 - Téléx 145 759 - Fax (16) 44 05 13 49

LIVRAISON RAPIDE DE PETITES COMMANDES

Advertising enquiries

Europe

Micheline Falciola
Advertising Manager
CERN
CH-1211 Geneva 23, Switzerland
Tel.: +41 (22) 767 4103
Fax: +41 (22) 782 1906

Rest of the world

Tim Serpico
Gordon and Breach Science Publishers
820 Town Center Drive
Langhorne, PA 19047
Tel.: +1 (215) 750 2642
Fax: +1 (215) 750 6343

Distributed to Member State governments, institutes and laboratories affiliated with CERN, and to their personnel.

General distribution

Jacques Dallemagne
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

Germany

Gabriela Heessel
DESY, Notkestr. 85, 2000 Hamburg 52

Italy

Mrs. Pieri or Mrs. Montanari
INFN, Casella Postale 56
00044 Frascati, Roma

United Kingdom

Su Lockley
Rutherford Appleton Laboratory,
Chilton, Didcot, Oxfordshire OX11 0QX

USA/Canada

Cyndi Rathbun (B90904 @ 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: Drukkerij Lannoo nv
8700 Tielt, Belgium

Published by:

European Laboratory for Particle Physics
CERN, 1211 Geneva 23, Switzerland
tel.: +41 (22) 767 61 11,
telex: 419 000 CERN CH,
telefax: +41 (22) 767 65 55

CERN COURIER only:
tel. +41 (22) 767 41 03,
telefax +41 (22) 782 19 06

USA: Controlled Circulation
Postage paid at Batavia, Illinois

Volume 33
No. 3
April 1993

Covering current developments in high energy physics and related fields worldwide

Editor: Gordon Fraser (COURIER @ CERNVM)*
Production and Advertisements:
Micheline Falciola (FAL @ CERNVM)*
Advisory Board: E.J.N. Wilson (Chairman), E. Lillestol,
H. Satz, D. Treille; with W. Hoogland,
H.I. Miettinen

**(Full electronic mail address... @ CERNVM.CERN.CH)*

1

Physics instrumentation for medical imaging
by D.W. Townsend, Geneva University Hospital
Radiography from Röntgen to Charpak

Around the Laboratories

11

CERN: LEP in the Alps
Out with the old year and in with the new

12

FERMILAB: First D0 results
Initial data from second major Tevatron collider experiment

14

KEK: 60GeV boson hunt
No bumps in the photon pairs

15

UNDERGROUND: ICARUS prepares to fly/New Soudan
detector nears completion
Major new underground detectors with visual appeal

21

ICFA
International affairs

21

Unification, small and large
Meeting report

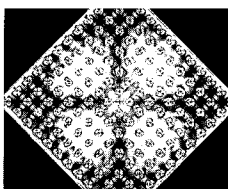
24

Bookshelf - meson science with muons

26

People and things

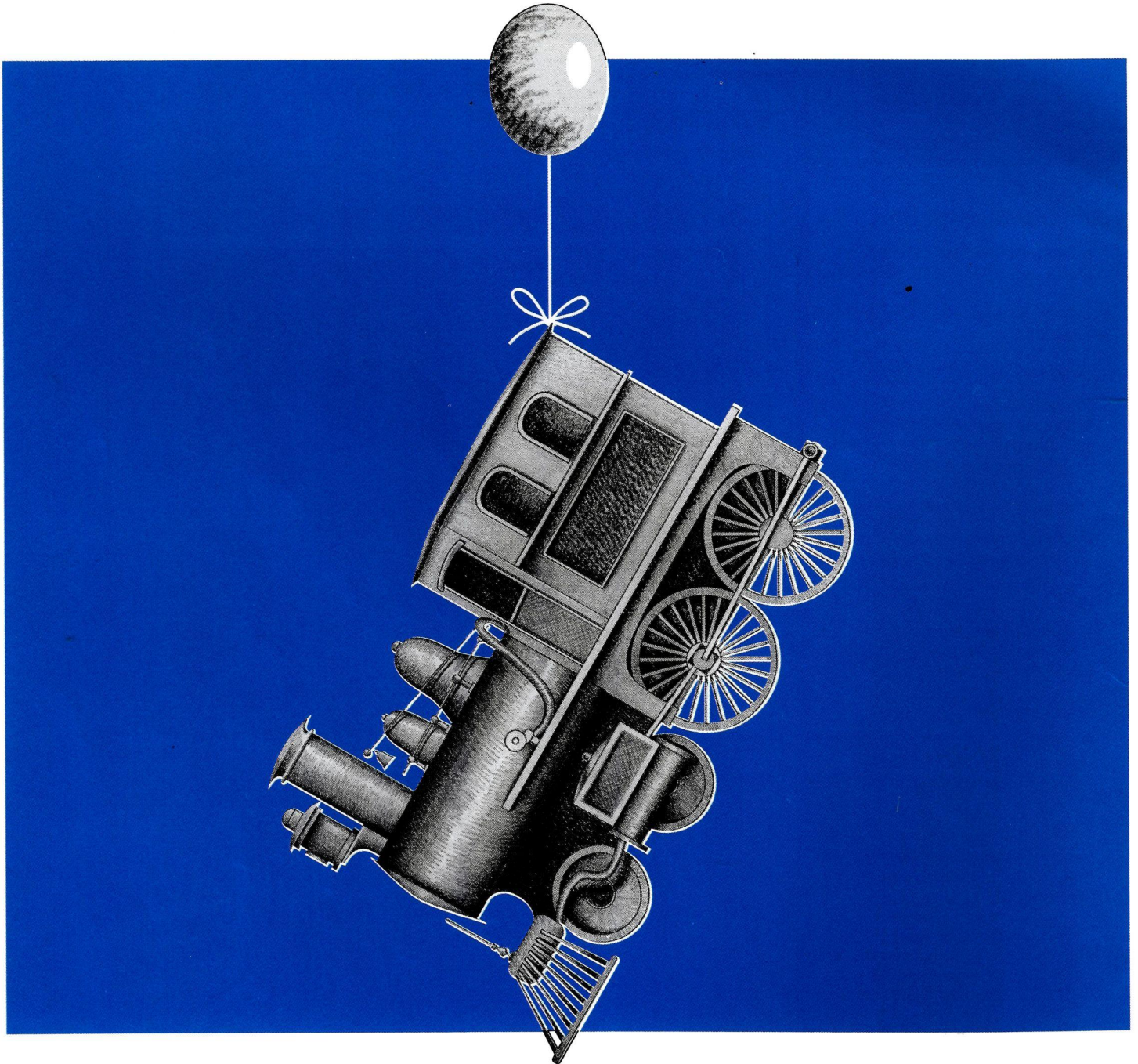
Reader service form, page 30.



Cover photograph: Polarized light shows up the normally invisible stresses in a sample of scintillator pierced by an array of moulded holes
(Photo CERN IT35.1.92)

VME FRONT END LINE

How little things can move great ideas:



V258 8 Ch Discriminator
V258B 16 Ch Discriminator (*)
V259 Multi-Hit Pattern Unit
V261 4x16 Fan in / Fan out
V265 8 Ch Charge Sensing ADC
V419 4 Ch Peak Sens. ADC

V462 Dual Gate Generator
V486 8 Ch Gate & Delay Gen. (*)
V488 8 Ch Multi-Event TDC (*)
V495 Dual Prog. Logic Unit
V512 8 Ch 4-Fold Logic Unit (*)

V513 16 Ch Prog. I/O Reg (*)
V533 50 MHz 32 Bit Pipeline Unit
V534 8 Ch Sampling ADC With Mem.
V538 8 Ch ECL/NIM/ECL (*)
V560 16 Ch 32 Bit Scaler

Note (*) V430 Cern backplane required

CAEN.

COSTRUZIONI APPARECCHIATURE ELETTRONICHE NUCLEARI S.p.A.
Iscritta all'Albo dei Laboratori di ricerca (Decr. Min. 25/3/90)

Via Vetraia, 11 - 55049 VIAREGGIO (Italy) - Tel. 0584/388398 - Tlx 501068 CAEN 1 - Fax 0584/388959 - E-mail: CAEN@VM.CNUCE.CNR.IT

All the High-Energy Physics Instruments You Wanted . . . BUT Couldn't Get!



Now in North America — for any HEP requirement — call EG&G, your instant link to European excellence . . .

Full range of instruments from:

CAEN — NIM, CAMAC, VME, High Voltage

CES — VME processors/interfaces to CAMAC and FASTBUS

WIENER — Crates, crates, and more crates

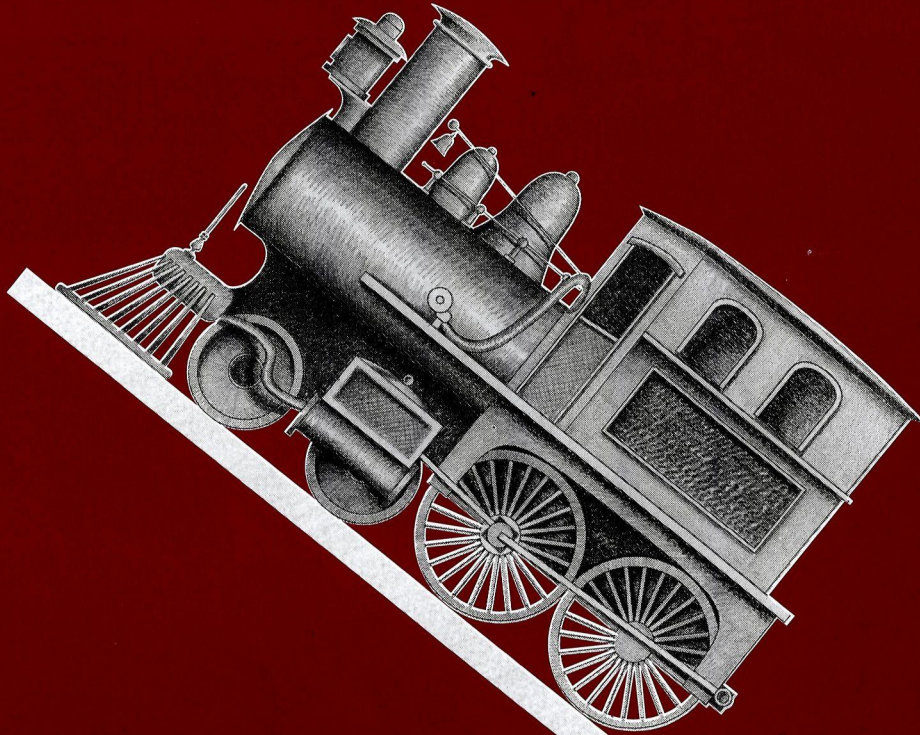
ORTEC — NIM, CAMAC

Call the **HOTLINE, 800-251-9750** (USA), **800-268-2735** (Canada),
or **5-568-7904** (Mexico) for INSTANT response
to your every HEP need.



HIGH VOLTAGE LINE

How little things can move great ideas:



SY527 Universal Multichannel Power Supply System

NEW!!!

Floating Power Supply Boards

*A515 16 Ch 100 V (40 mV) 200 μ A (50 nA)
A516 8 Ch 12 V (10 mV) 1.5 A (10 mA)
A517 32 Ch 18 V (10 mV) 10 mA (10 μ A)
A518 16 Ch 12 V (10 mV) 150 mA (40 μ A)
A519 16 Ch 200 V (40 mV) 40 μ A (10 nA)
A520 16 Ch 200 V (40 mV) 1 mA (250 nA)*

High Voltage P/N Board

A733 16 Ch 2.5 kV (0.2 V) 2.5 mA (1 μ A)

Distributor Board

A933 24 Ch PM. Positive Distributor ($\Delta V = 600$ Volt)

SY403 64 Ch High Voltage System

High Voltage P/N Boards

*A503 16 Ch 3 kV (0.2 V) 3 mA (1 μ A)
A504 16 Ch 600 V (40 mV) 200 μ A (10 nA)
A505 16 Ch 3 kV (0.2 V) 200 μ A (10 nA)
A507 16 Ch 60 V (40 mV) 200 μ A (10 nA)*

N484 H.V. Voltmeter

From - 20 kV up to 20 kV

SY 127 (NEW BOARDS) 40 Ch High Voltage System

SERIES A600 P/N Boards

*10 nA Current Resolution for all channels
Voltage Range from 200 V up to 20 kV
Current Limit up to 40 μ A*

SERIES A300/A400 P/N Boards

*A326 2.5 kV (1 V) 5 mA (2 μ A)
A327 1 kV (0.4 V) 10 mA (10 μ A)
A426 20 kV (5 V) 200 μ A (100 nA)*

NIM H.V. Power Supply

*N470 4 Ch Prog. H.V. up to 8kV/8W
N470A - 100 nA Current Resolution
N471 Low Cost 2 Ch H. V. up to 8kV/8W
N471A - 1nA Current Resolution
N472 Low Cost 4 Ch H.V. up to 6kV/8W
N570 2 Ch Prog. H.V. up to 15kV/7.5W*

CAEN.

COSTRUZIONI APPARECCHIATURE ELETTRONICHE NUCLEARI S.p.A.

Iscritta all'Albo dei Laboratori di ricerca (Decr. Min. 25/3/90)

Via Vetraria, 11 - 55049 VIAREGGIO (Italy) - Tel. 0584/388398 - Tlx 501068 CAEN 1 - Fax 0584/388959 - E-mail: CAEN@VM.CNUCE.CNR.IT

Physics instrumentation for medical imaging

by D.W. Townsend, Geneva University Hospital

From Röntgen to Charpak

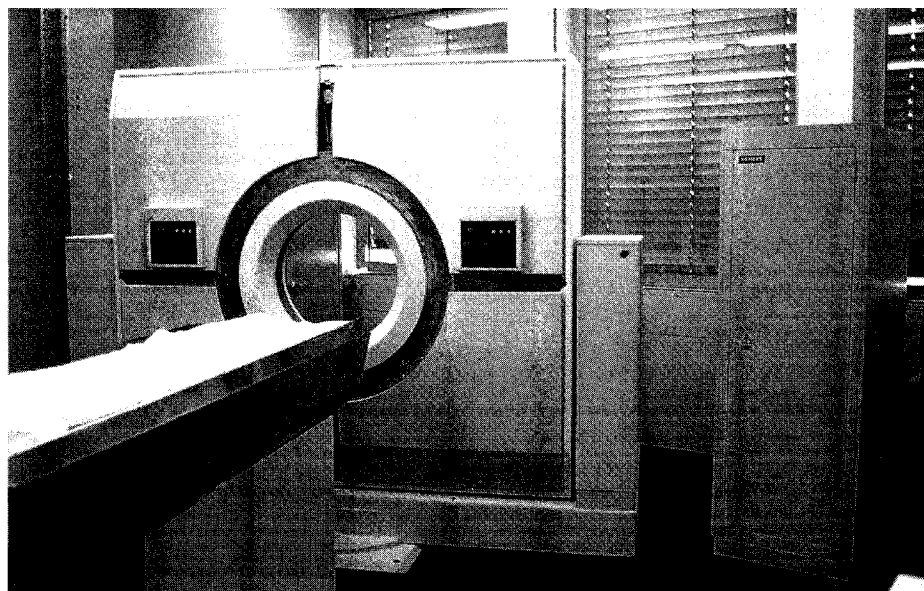
The first Nobel Physics Prize, awarded in 1901, went to Wilhelm Röntgen for his discovery of X-rays in 1895. This, and the most recent physics Nobel, to Georges Charpak last year for his detector developments, span several generations of applied science.

As well as helping to launch the science of atomic physics, Röntgen's discovery also marked the dawn of a medical science - radiography - using beams of various kinds to image what otherwise cannot be seen. Ever since, physicists and radiologists have worked hand in hand to improve imaging techniques and widen their medical applications.

Ever since Röntgen's discovery of X-rays in 1895, a great deal of effort, mostly using electromagnetic radiation and ultrasound, has been devoted to imaging the human body with the aim of identifying signs of disease as early as possible.

For the radiation to image internal organs, it must have sufficient energy to penetrate body tissues, but not too much so that it passes through unabsorbed. Internal structures are then visualized from the resulting absorption patterns.

X-rays (70-100 keV) readily distinguish bone from surrounding soft tissues, with the image captured on film. The medical speciality of radiology was established to interpret the often subtle radiograph effects. However even experts sometimes had difficulty with an image where all tissues between the source and the film were projected onto a single



plane. In addition, such images were purely anatomical and revealed little, if anything, of the behaviour of internal organs.

During the late forties, a new technique made its appearance in which a radioactive substance was administered (either orally or intravenously), and its distribution inside the patient's body monitored externally through the emitted radiation. The advantage over conventional radiography is the ability to target a particular organ and follow its behaviour. This procedure has now developed into the speciality of nuclear medicine, with its own experts to interpret the images.

The most widely-used radionuclide for nuclear medicine is an isomer of technetium, ^{99m}Tc , which decays with a half-life of 6 hours, emitting a 140 keV photon. Sodium iodide (NaI) crystals are highly efficient detectors of these photons, and the gamma camera, a large sodium iodide crystal with photomultiplier readout invented by Hal Anger at Berkeley, has been

PET scanner assembled at CERN and operational at Geneva's University Hospital for the past two years. About 200 patients have been scanned.

the standard imaging device for nuclear medicine since the mid fifties.

To form an image, a collimator, consisting of a thick lead sheet perforated with many thousands of small holes, must first be placed between the incident radiation and the crystal to eliminate obliquely-incident photons. In theory, the holes allow only perpendicularly-incident radiation through, although in practice it is impossible to prevent some penetration by obliquely-incident photons. The collimator greatly reduces the effective sensitivity of the sodium iodide crystal. In practice only about 0.02% of the radiation from the patient contributes to image formation.

Like conventional radiographs, nuclear medicine images are projections of a three-dimensional distribution onto a two-dimensional plane.

The Computer-assisted Tomography (CT) scanner images a section of the body transverse to the long axis, perpendicular to the plane of a conventional radiograph. The section is typically a few millimetres thick, and is obtained by measuring not just a single projection, but many, each from a different direction.

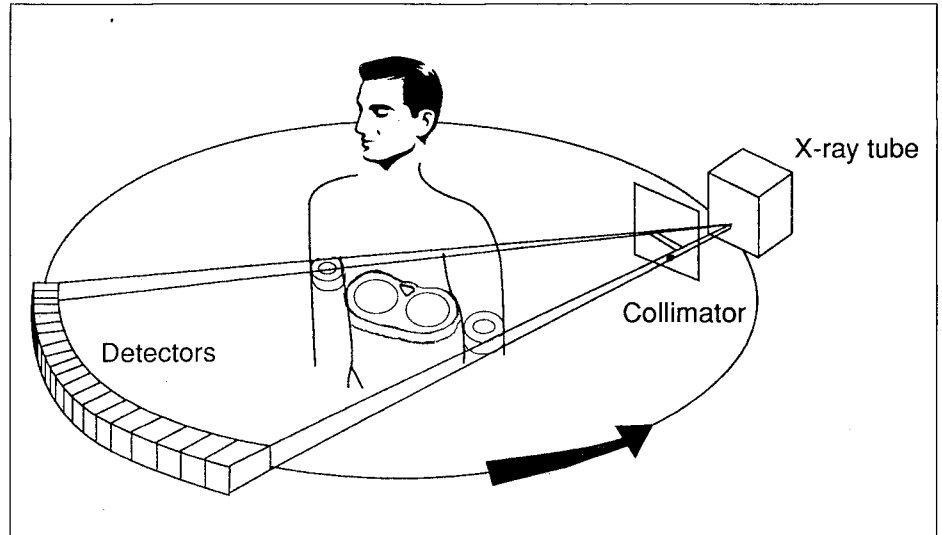
With depth information missing, interpretation of the images requires special skills, as the effect of the surrounding structures is often extremely misleading.

This problem was dramatically solved in 1972 with the appearance of the Computer-assisted Tomography (CT) scanner, the brainchild of Godfrey Hounsfield at EMI, who shared the Nobel Prize for Physiology and Medicine with Alan Cormack in 1979. The CT scanner images a section of the body transverse to the long axis, perpendicular to the plane of a conventional radiograph. The section is typically a few millimetres thick, and is obtained by measuring not just a single projection, but many, each from a different direction.

The X-ray source, collimated into a fan beam within the section, is rotated around the patient, and the transmitted beam captured by an opposing arc of high pressure xenon detectors. One-dimensional projection profiles are reconstructed into a two-dimensional image of a transverse body section.

Within a few years, tomographic methods were also applied in nuclear medicine. A gamma camera rotating around the patient takes a series of two-dimensional projections from different directions. Applying CT reconstruction techniques, the internal distribution of the radioactive tracer can be recovered simultaneously for parallel two-dimensional transverse sections. This technique, called Single Photon Emission Computed Tomography (SPECT), is particularly useful for three-dimensional imaging of certain tracer distributions in the brain and heart.

Although the most common radionuclide used in nuclear medicine is ^{99m}Tc with its 140 keV pho-



tons, this is by no means the only possibility. Isotopes with lower energy photons such as ^{201}Tl (80 keV) and ^{178}Ta (55-65 keV) are useful for imaging the heart, ^{201}Tl for tumour imaging, and ^{133}Xe (80 keV) for lung ventilation studies. With lower energy photons, alternative detectors, such as multiwire proportional chambers, can be used. Pressurized xenon wire chambers have been used with ^{178}Ta for imaging the heart by J. Lacy's group from Houston, Texas.

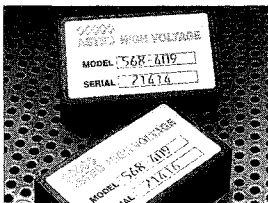
L.I. Shekhtman's group in Novosibirsk has looked at wire chambers to replace film in conventional radiography. The advantages include lower X-ray doses and high resolution digital images with a large dynamic range. Since the wire chamber is more efficient for detecting charged particles, Jean Saudinos and Georges Charpak in the late seventies tried using a proton beam instead of X-rays. While these low-dose proton radiography results were interesting, the need for a 500-1000 MeV proton beam limits application.

Some radionuclides used in nuclear medicine emit photons with an energy greater than 140 keV, for example ^{123}I (160 keV), ^{131}I (360 keV), ^{51}Cr (323 keV) and ^{111}In (250 keV). In principle radiation energies from a few tens of keV up to several hundred keV can be used to image the human body. However at higher energies the gamma camera collimator must be especially thick to minimize penetration, thereby reducing efficiency and degrading spatial resolution.

The highest energy radiation currently used for medical imaging is 511 keV, with photons from the annihilation of a positron with an electron. During the early fifties, medical researchers such as E.R. Wrenn and co-workers, and G. Brownell and W.M. Sweet in Boston realised that neutron-deficient isotopes emitting positrons instead of single photons offer some particularly interesting possibilities.

The annihilation of a positron with an electron produces two 511 keV photons emitted back-to-back, and detecting these coincident photons

Low-cost tracking converters feature extended output to 6kV



With a power rating of 3W, Brandenburg's 568 DC converters are low-cost, fully isolated modules providing outputs to 6kV. Being tracking converters, these modules are adjustable between 30 and 100% of full output simply by altering the

supply between 4 and 15V.

Nine models cover full range outputs from 300V to 6kV. A feature of this tracking design is that output is floating and easily tied for negative or positive polarity. Combined with an input-to-output isolation of 3.5kV, this makes the 568 suitable for a very wide range of applications from photomultipliers, Penning gauges, radiation counters etc.

Output ripple is low, at 0.01% to 0.5% and load regulation varies from +10% no load to -10% at full load. Dimensions and weight are 64 by 38 by 22 and 87g respectively.

HV lab source now offers RS232

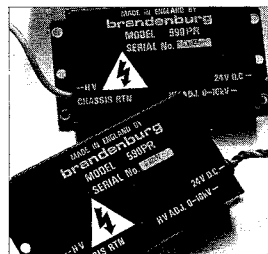
Intended primarily for precision research and development work, Brandenburg Alpha III bench power supplies provide up to 30kV at 1.5mA with very low ripple and a drift figure of less than 20ppm over 15 minutes.

Three models in the range - all now available ex-stock - are the 3507 supplying 0 to 5kV at 10mA, the 3707 for 0 to 15kV at 3mA and the 3807 for 0 to 30kV output. Maximum ripple figures for the three are 0.5V, 1.5V and 3V respectively. Load regulation is 0.002% or less while line regulation is less than 0.001%.

Positive or negative outputs are selectable, as are two operating modes providing either constant voltage or constant current. An optional interface allows computer control via an RS232 interface.

An over current trip is provided in voltage mode. Local or remote switch control is provided via a 0-10V analogue signal. A remote on off TTL signal is available.

Compact 5W converters supply up to 10kV



Both 12 and 24V versions of Brandenburg's 590 series low-profile DC-to-DC converters provide up to 10kV at 5W yet measure only 19mm high. Fully regulated, these modules feature a ripple figure of less than 4V pk-pk and incorporate flashover and short-circuit protection.

Normally, output voltage is set by an internal potentiometer but is optionally programmable between 0 and 10kV via a 0 to 10V analogue signal. Both positive and negative output versions feature a temperature coefficient of typically 150ppm/°C.

Compact, efficient and feedback regulated, 590 series modules have a 9S by 49 by 19mm footprint - including RFI screening. Weight is just 150g and having flying leads, they are suitable for PCB or chassis mounting.

High performance 1.7kV converters feature less than 0.02% ripple

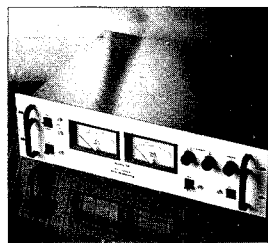
Designed for photomultipliers and low-noise applications, Brandenburg 3479 high-voltage DC converters feature very low ripple combined with excellent temperature stability and small size.

Measuring only 95 by 49 by 24mm, the 3479 provides an output of 50 to 1700 volts at 1mA with typically 30mV of ripple and noise over a 100kHz bandwidth. Short term drift is less than 15ppm per 15 minutes while temperature coefficient is 20ppm/°C. Output is user programmable via a 0 to 10V analogue signal.

There are 30 different output current/voltage modules in this range, with 12V and 24V input.



There are also positive or negative output polarity types, PCB mounting or fly-lead options. All weigh just 200g.



brandenburg

A Division of Astec Europe Limited
High Street, Wollaston, Stourbridge, West Midlands DY8 4PG
Telephone: 0384 393737 Fax: 0384 373511

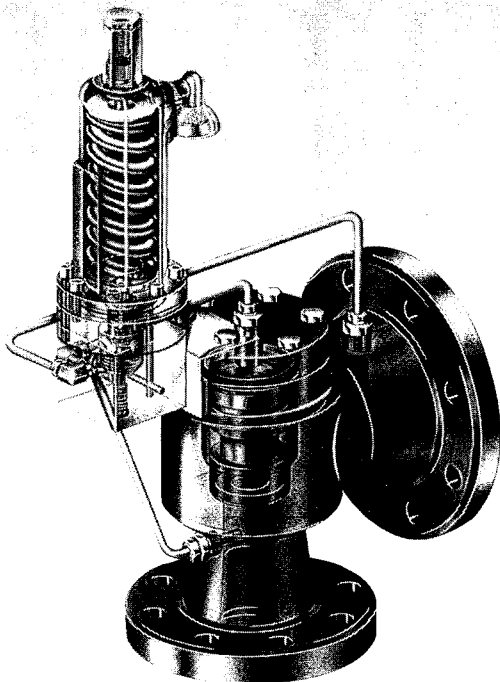
ASTEC



For information on the products above or for a copy of the catalogue, please circle the number on the enquiry card.

55 Circle advertisement number on reader service form

ALFA PIPING COMPONENTS



Get set!

With high precision from 7mbar up to 414 bar!

ALFA supplies AGCO pilot-operated safety relief valves for all pressure relief applications.

Their main features are

- high discharge capacity
- insensitivity to back pressure
- tight shut-off at up to 100 % of set pressure
- adjustable blowdown (difference between set and reseal pressures).

No compromising on safety!

ALFA REPLY SLIP

Please send me more information on AGCO pilot-operated safety relief valves.

Company

Name

Street

City/Postal Code

CC4

ALFA-INGENIEURBURO AG · WEIDENWEG 16-17 · CH-4310 RHEINFELDEN
PIPING COMPONENTS DEPARTMENT · TEL 061/831 58 58 · FAX 061/831 65 11



**LABORATORY HV SUPPLIES...
to 60 kV and 45 W**

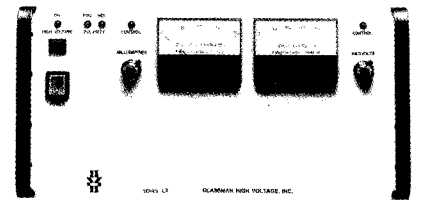
High performance and low cost DC high voltage are now available for the lab bench with the EL Series of tightly regulated, low ripple, and highly stable power supplies. Voltage ranges are 0 to 3 kV through 0 to 60 kV. Operating features include low stored energy for safety and an automatic crossover from constant-voltage to constant-current regulation for protection from overloads, arcs, and shorts. **Glassman High Voltage**



**100 W POWER SUPPLY TO 60 kV
3.5 in. and only 13 lbs.**

The EH Series offer 100 W high voltage power supplies of superior quality in a compact and low weight package and at an affordable price. Rack panel height is only 3.5 inches and weight 13 lbs. Standard features include local and remote control and monitoring, tight regulation, low ripple, and fast response. Voltage ranges are 0 to 1 kV through 0 to 60 kV. Positive, negative, or reversible polarity models are available. **Glassman High Voltage**

**2 kW HV SUPPLIES TO 125 kV...
only 8.75 in. and 47 lbs.**



No longer does the combination of high DC voltage and high power mean a big, clumsy supply. The new LT Series from Glassman provides up to 2 kW of power with voltage ranges, depending on the model, from 0 to 1 kV through 0 to 125 kV in only a 8.75 inch high rack panel. Weight is less than 47 pounds. Line voltage is 220/240 V single-phase.

Voltage regulation is better than 0.005% for both load and line variations. Ripple is less than 0.03%. Automatic crossover from constant-voltage to constant-current regulation protects both the supply and load against shorts, arcs, or overloads. Current regulation is 0.05% from short circuit to rated voltage. The LT Series can be ordered with an optional current "trip" circuit that can be switch-selected to provide either current limiting or trip operation in the event of an overload.

All LT Series supplies feature full remote control capabilities including voltage/current program and monitoring terminals, TTL high voltage enable/disable, safety interlock terminals, and a +10 V reference source. Positive, negative, or reversible polarity models are available. Choice of dual analog or digital meters or a blank panel.

Glassman High Voltage

**TWO UNBEATABLE
HV MODULES...15 W/75 W**



The 15 W Series MJ, with outputs from 0 to 3 kV through 0 to 30 kV, and the 75 W Series MK, 0 to 1 kV through 0 to 60 kV, both provide premium regulated and low-ripple power supply performance in a line-operated, compact, and lightweight package. Air insulation allows for easy serviceability, in contrast to wasteful "throw-away" modules.

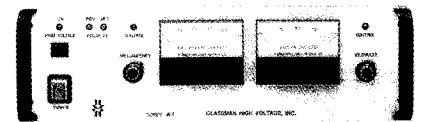
- Constant voltage/constant current operation
- Low stored energy for safety
- Local and remote control
- Remote TTL enable/disable
- External interlock terminals
- Available with positive or negative polarity

Call for full information on the MJ and MK Series, or other Glassman supplies, 1 kV to 500 kV, 15 W to 15 kW.

Innovations in high voltage power supply technology.

GLASSMAN HIGH VOLTAGE INC.

Glassman High Voltage, PO Box 551, Whitehouse Station, NJ 08889, telephone (908) 534-9007. Also Glassman Europe, in the UK call (0256) 810808 and in Asia, Glassman Japan (044) 877-4546.



**HV TO 75 kV AND 1000 W
Rack panel height only 5.25 in.**

The WX Series of 1000 W regulated power supplies are available with DC outputs from 0 to 1 kV through 0 to 75 kV. Rack panel height is only 5.25 inches and weight less than 30 lbs. The Series WX is offered with a choice of dual analog voltage and current meters, dual digital meters, or with a blank panel for OEM/system applications. Positive, negative, or reversible polarity models are available. **Glassman High Voltage**

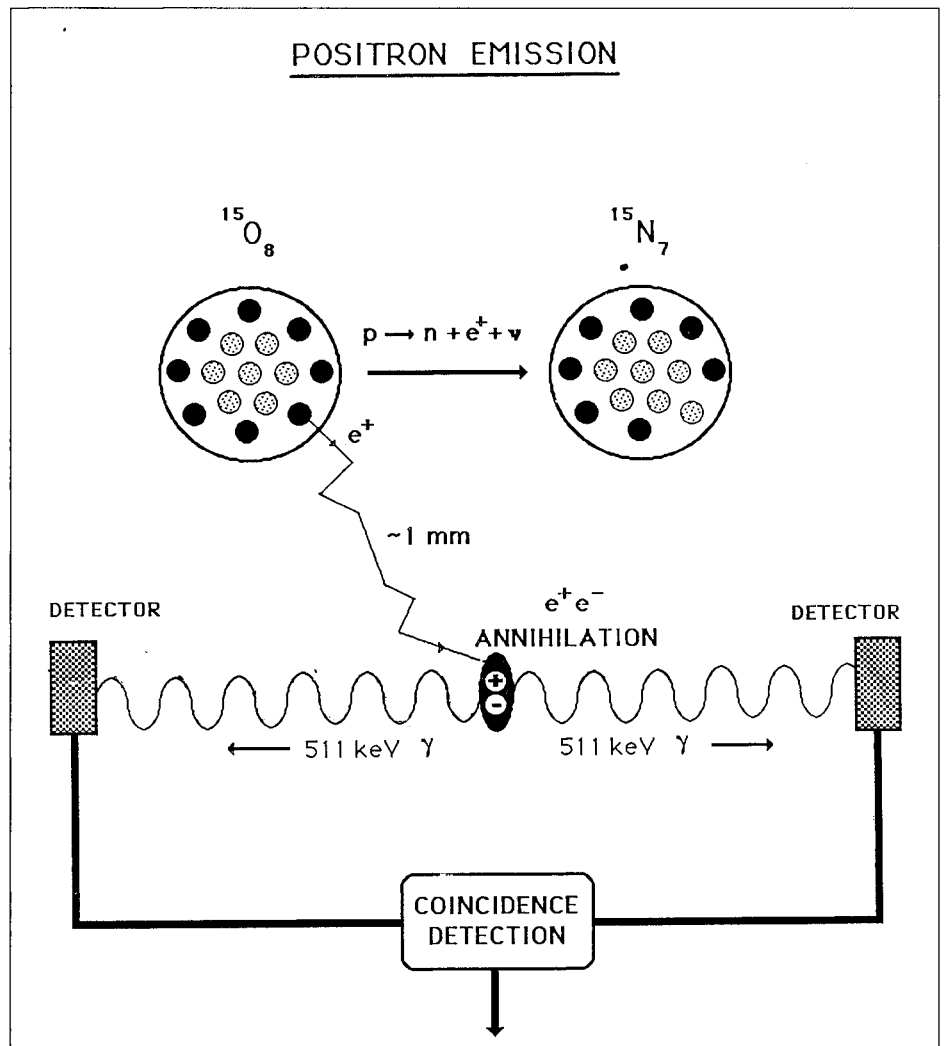
measures the direction of the event immediately, without the need for a collimator (which at 511 keV would have to be impracticably thick). With no collimator, photons at all angles can be accepted, increasing the sensitivity compared to SPECT by a factor of 20 or more.

Only hydrogen among the principal elements of life does not offer a convenient positron-emitting isotope. In fact, for medical imaging the only useful isotopes of oxygen, nitrogen and carbon provided by nature are positron emitters with short half-lives - 2, 10 and 20 minutes respectively.

Despite these obvious advantages, it was almost thirty years before the first commercial scanner became available for positron emission tomography (PET), built by EG & G ORTEC in the USA and based on work by Mike Phelps and Ed Hoffman at UCLA and Michael Ter-Pogossian at St. Louis. The reasons were essentially technological - the problems with using NaI crystals to detect 511 keV photons, the difficulty of recovering the underlying tracer distribution from the annihilation data, and the need for a nearby cyclotron to produce the short-lived isotopes. In the forty years since the concept of PET was first proposed, the first two difficulties have been largely overcome, while cyclotron proximity remains a constraint.

During the seventies and early eighties, the advantages of positron-emitting isotopes stimulated research into detectors optimized for 511 keV photons. Once again, multiwire proportional chambers played a role by offering large area detectors with high spatial resolution at low cost, with pioneering work by Victor Perez-Mendez in Berkeley.

The problem is to make the detectors sensitive to 511 keV photons,



In Positron Emission Tomography (PET), the annihilation of a positron with an electron produces two 511 keV photons back-to-back, and detecting them measures the direction of the event immediately.

and to localize incident photons to within one or two millimetres. Proposed solutions for the necessary high density proportional chambers included increased gas pressure in the chamber, and the insertion of converters constructed from multiple lead sheets (E. Bateman at the UK Rutherford Laboratory), perforated thick lead stacks (A. Jeavons at CERN) or fused lead-glass tubes (A. Del Guerra in Pisa). While good spatial resolution was achieved, adequate sensitivity was not, and multiwire chambers were only a

modest success for clinical PET imaging.

The widely-used sodium iodide crystal is far from being the ideal high energy radiation detector. Early attempts to develop a crystal-based PET scanner centred around two geometries: a circular hexagonal configuration of small sodium iodide crystals proposed by Lars Eriksson in Stockholm and Michael Ter-Pogossian and colleagues at St. Louis, and a pair of uncollimated gamma cameras operated in coincidence, by Gerd Muehllehner and co-

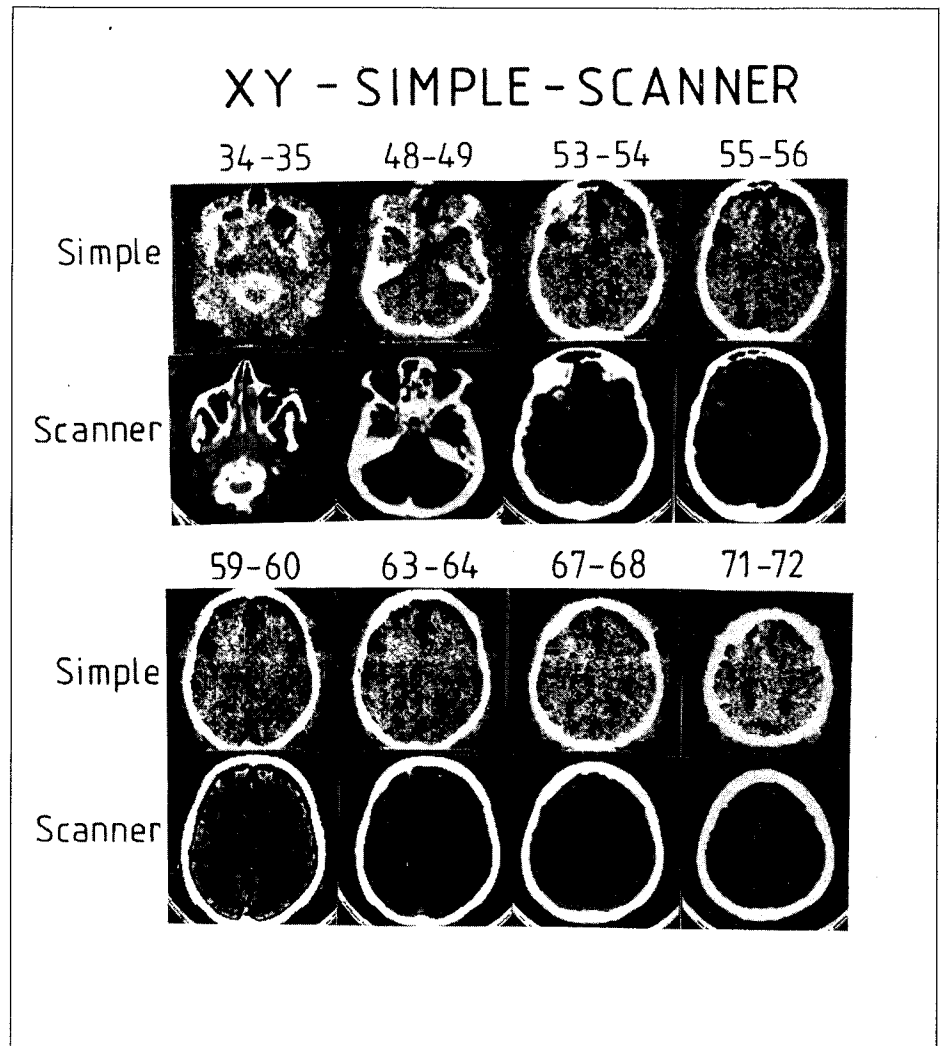
Since the wire chamber is more efficient for detecting charged particles, Jean Saudinos and Georges Charpak in the late seventies pioneered radiography using a proton beam instead of X-rays. Here the results ('Simple') are compared with a CT scan of the time.

workers at Searle Radiographics in Chicago. Then, in the late seventies, the first PET scanner using bismuth germanate (BGO) crystals was developed by Chris Thompson and colleagues at the Montreal Neurological Institute in Canada, and since then almost all commercial PET scanners have been based on multi-ring BGO configurations, built by CTI Inc in Knoxville, Tennessee and the former Scanditronix Co. (now GE) in Uppsala, Sweden.

BGO has better stopping power, although poorer energy resolution, than NaI. Alternative crystals, such as the fast scintillators BaF₂ and CsF, suggested by R. Allemand and colleagues from LETI in Grenoble, and Michael Ter-Pogossian in St. Louis, are interesting because they can measure the time difference between the arrival of two photons, although they are intrinsically less efficient than BGO for stopping 511 keV radiation. The search for the ideal detector material - fast, large nuclei (high Z), good light output - has been led by Steve Derenzo from Berkeley for the past few years, and recent candidates include cerium fluoride, lead carbonate and lutetium orthosilicate.

Liquid scintillators have also been suggested. An idea which emerged in the late 80s gave new life to the possibility of using multiwire chambers for PET. Recognizing that fast, high Z crystals offer the best efficiency, Charpak at CERN and Bateman at the Rutherford Laboratory have investigated a hybrid configuration of BaF₂ crystals inside a wire chamber, aiming for both good efficiency and high spatial resolution, at reasonable cost and complexity.

In the past few years, positron tomography has become an important research and diagnostic tool. Despite the cost and complexity of

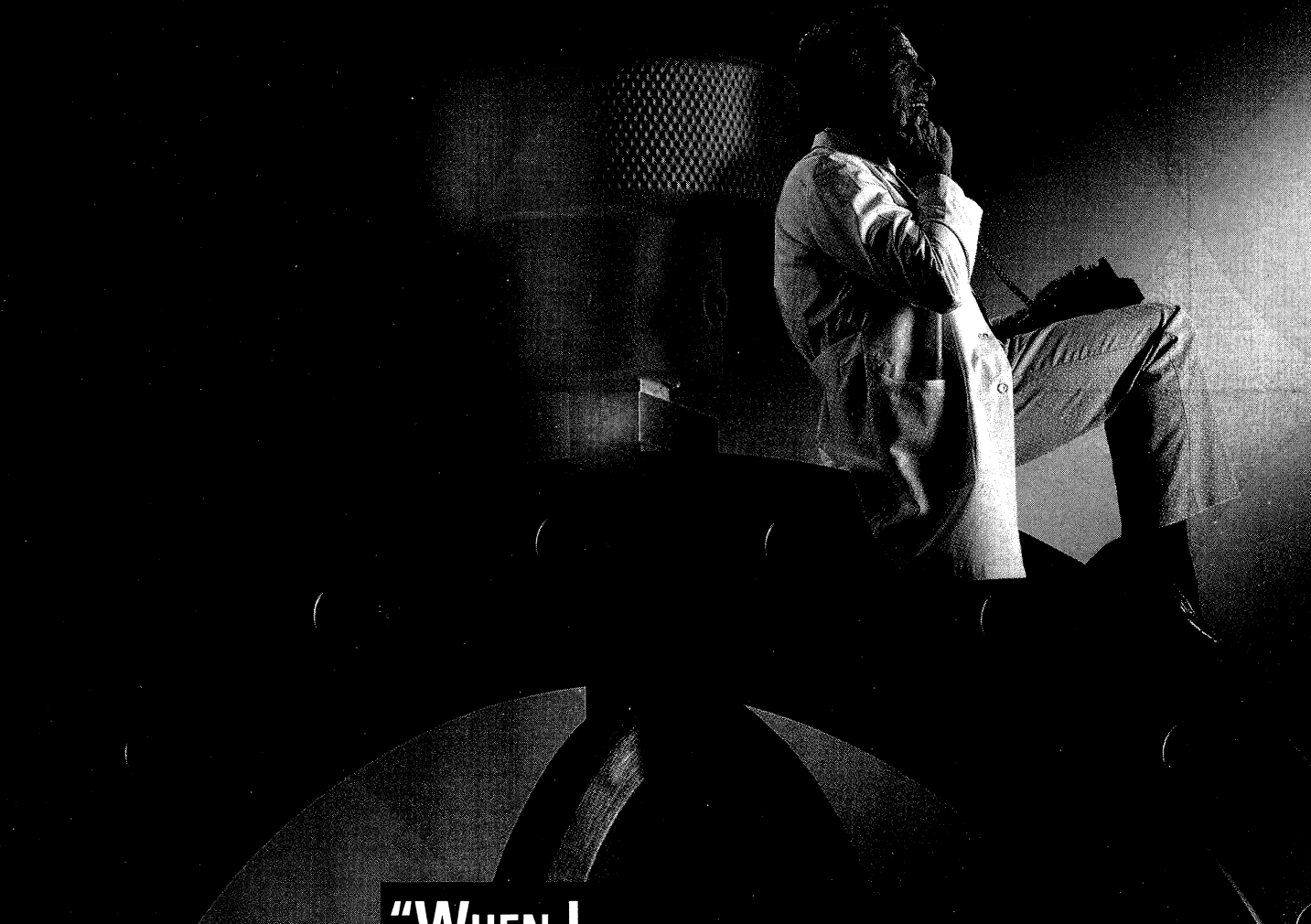


the accompanying technology, PET's potential is considerable, not only in medical research, but also for more routine applications. The ability to measure both blood flow and metabolism of internal organs, to label the brain's chemical mediators, to follow cancer drugs, to localize tumours and to pinpoint epileptic foci in the brain, are just some of the applications that drive efforts to reduce the cost and simplify the technology.

A lower-cost, BGO-based PET

scanner, designed in collaboration with Siemens/CTI and assembled at CERN by Martin Wensveen (with financial support from the Swiss Commission for the Encouragement of Scientific Research - CERS - in Berne), has been operational at the Cantonal Hospital in Geneva for the past two years. Hopefully this development will open up clinical PET studies to a wider medical community.

A few groups have been using PET to study normal brain behaviour.



**"WHEN I
WANT TO TALK
VACUUM
VALVES,
I TALK TO
HUNTINGTON."**

**More valves.
Better design.
First-class tech support.**

Whether you need butterfly or gate valves. Pneumatic or manual. Bakeable or elastomer-sealed. Right-angle, in-line or straight-through – Huntington is the place . . .

Broader selection and better designs. Like their unique conical seats, for tighter seals. Or their patented butterfly floating shaft, for perfect flapper centering. Or their solid construction, with less welding for better integrity . . .

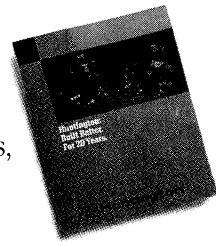
And when you call Huntington, you get intelligent

answers. Because their engineers *know* valves. And how to solve vacuum problems.

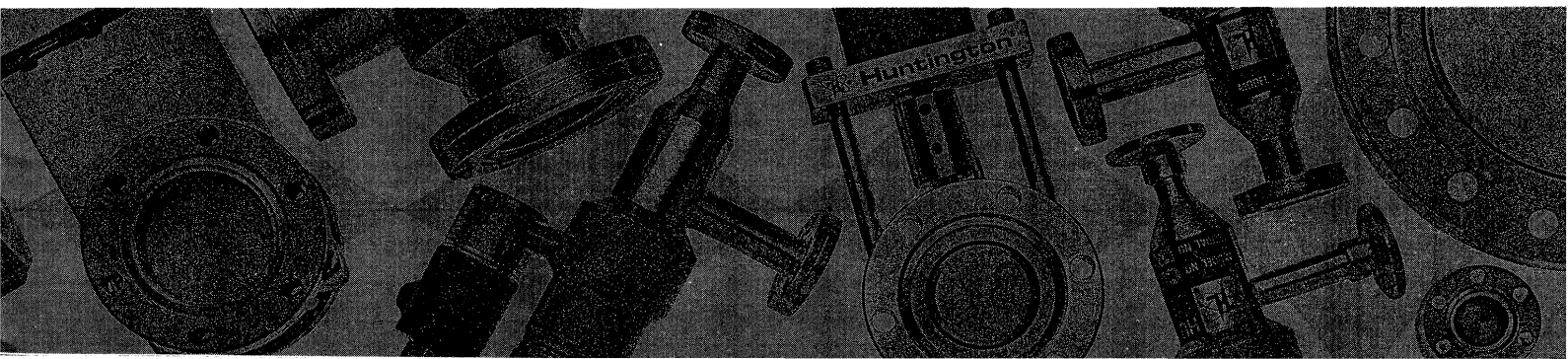
Plus, they've got a lot more than valves . . .

It's all in the free catalog.

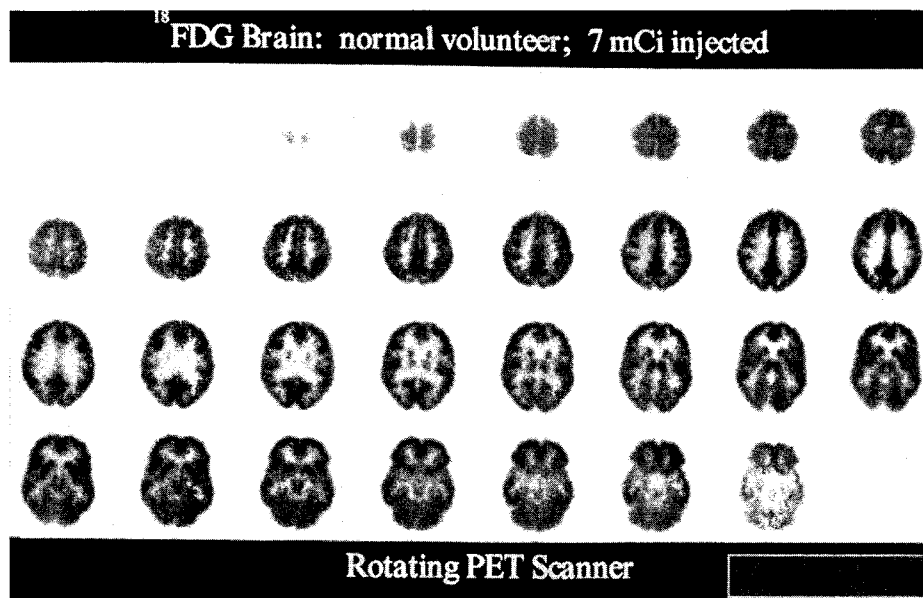
Everything. From positioners to connectors to full custom chambers. To get the catalog, just call: Huntington Laboratories, 1040 L'Avenida, Mountain View, CA 94043. (800) 227-8059 or (415) 964-3323.



 **Huntington**
Better-Built Vacuum Components



Imaging the utilization of glucose in the brain
by the BGO-based PET scanner at Geneva
University Hospital.



Understanding the functioning - and malfunctioning - of the human brain remains one of the greatest challenges facing mankind. Subtle changes in blood flow can be detected by PET and related to areas which respond to particular stimuli. Centres for language, vision, motion, colour, memory and even pain have been identified at a number of centres, including Richard Frackowiak and his group at the MRC Cyclotron Unit in London, and Marcus Raichle and colleagues at St Louis in the US. Such maps were previously possible only in animals, using invasive techniques.

Prior to using a new radioactive tracer in humans, it has often been necessary to validate its behaviour in animals and develop an appropriate biological model. The usual procedure is autoradiography, where the tracer is injected and then, at the appropriate moment, the animal is sacrificed, frozen and sectioned. Each section is then placed on photographic film and exposed, often for many days. This gives a high

resolution image of the tracer . biodistribution, but the process must be repeated (with a different animal) to follow the complete biological process.

Gaseous detectors have recently made a significant impact on the autoradiographic technique. Two devices, a wire-chamber-based system developed by Alan Jeavons, now at Oxford Positron Systems in Oxford, and an avalanche chamber with optical readout developed by Georges Charpak in Geneva are able to produce good quality, digitized images in hours rather than days or weeks. Such devices are also used successfully for imaging DNA sequences and electrophoresis plates.

Recent PET technological progress is also having an impact on conventional autoradiography. Two groups, one under Terry Jones at the Medical Research Council's Cyclotron Unit in London and a second at Brussels' Free University led by Stefan Tavernier are developing small-scale animal scanners, based respectively on a small ring of BGO crystals, and

a pair of hybrid BaF₂-wire chamber detectors. Their success in achieving high spatial resolution will enable the biodistribution of new tracers to be followed in a small animal, which then lives to tell the tale. PET applied to humans has been termed *in vivo* autoradiography, and hopefully this can be 'extended' to animals with these new detector developments.

Photon energies around 80-100 keV are used for radiological (X-ray) imaging, whereas for radioisotope imaging somewhat higher energies are usual (140-200 keV), the annihilation radiation of PET setting an upper limit at 511 keV. Below a few tens of keV, approaching the region of visible light, the human body becomes increasingly opaque, (which is at the root of the whole problem!).

Infrared and microwaves can penetrate a small distance into human tissue, and infrared imaging of low density structures such as the breast are current research areas. Somewhat surprisingly, another window then opens, magnetic resonance (MR), using very low energy, non-ionizing radiation of 10⁻¹⁰ keV. Since the early eighties, this technique has made a tremendous impact, after early developments by Paul Lauterbur at Stony Brook, Peter Mansfield in Nottingham, England, and others.

An external magnetic field initially orients the spins of hydrogen nuclei within a body section. Then radiowaves are used to manipulate these spins, and the radiofrequencies emitted as the nuclei return to their original state can be captured by an antenna close to the patient. Additional magnetic field gradients are used to recover the spatial distribution of hydrogen (water) within the body section.

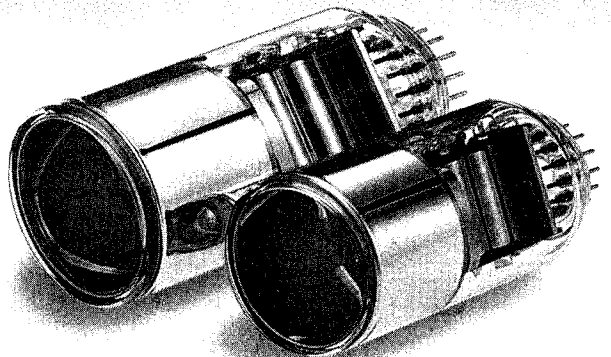
HAMAMATSU

For futuristic SCIFI calorimeters,
Hamamatsu's Green-Extended
PMTs are the key.

5 million

5 Million PMTs in service.

Hamamatsu's Green-Extended PMTs for SCIFI calorimeters and wavelength shifters address SCIFI needs current and future. Our experience, quality and name in high-energy applications are reflected far and wide. Over five million Hamamatsu PMTs have been specified worldwide for a variety of applications. For more information on Green-Extended PMTs, just contact Hamamatsu Photonics at the office nearest you.



HAMAMATSU

HAMAMATSU PHOTONICS KK., Electron Tube Center
314-5, Shimokanzo, Toyooka-village, Iwata-gun, Shizuoka-ken, 438-01 Japan.
TEL: 81-539-62-5248 FAX: 81-539-62-2205 TLX: 4289-625

U.S.A.: Hamamatsu Corporation. TEL: 1-908-231-0960 FAX: 1-908-231-1218
Germany: Hamamatsu Photonics Deutschland GmbH. TEL: 49-8152-3750 FAX: 49-8152-2658
France: Hamamatsu Photonics France S.A.R.L. TEL: 33-(1) 49 75 56 80 FAX: 33-(1) 49 75 56 87
United Kingdom: Hamamatsu Photonics UK Limited. TEL: 44-81-367-3560 FAX: 44-81-367-6384

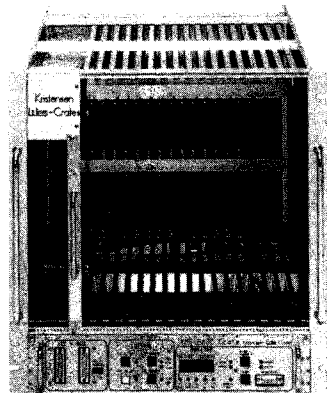
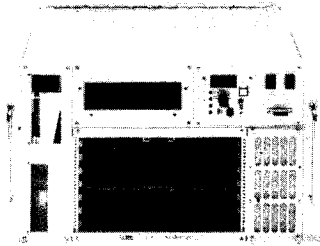
North Europe: Hamamatsu Photonics Norden AB. TEL: 46-8-59032190 FAX: 46-8-59094567
Italy: Hamamatsu Photonics Italia S.R.L. TEL: 39-(02) 935 81 733 FAX: 39-(02) 935 81741
Spain: Hamamatsu Photonics Espana S.L. TEL: 34-3 699 65 53 FAX: 34-3 588 19 66

Powered Crates

Further to all our CERN approved CERN-Spec Crates NIM-, CAMAC-, FAST BUS-, VMEbus 422/430 Wes-Crates supplies other Crates based on our Systems Some of this Crates are shown here:

VMEbus-Crates

6u height, 7 slot with cooling. Insert modules for disk/ drive. Backplane: J1, J2 (like Spec V-422) or J1, J2 and JAUX (like Spec V-430) Contrl./monitoring like Spec V-425. Interchangeable system to our CERN-Spec power supplies for CERN-Spec Crates V-422 / v-430

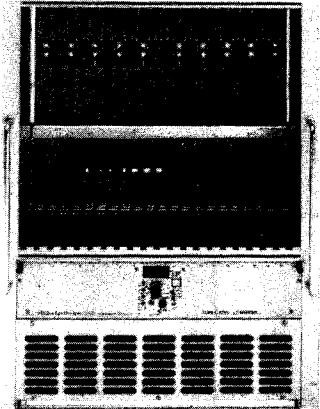


VMEbus-Crates

11u height, 21 slot for VME modules 366,7 mm height, 340/400/460 mm depth. Backplane: J1, J2, ("J0" custom) or J1, J2, JAUX, ("J0" custom). Fan unit with contrl./monitoring like CERN Spec V-425 or with IEC-488. Interchangeable system to our CERN-Spec power supplies system for FAST BUS-, and VMEbus Crates. The picture shows this crate for VMEbus FADC-Crate for DESY, H1.

VMEbus-Crates

14u height, 21 slot for VME modules 366,7 mm height, 220 mm depth. Air intake from the front, out on the back. High volume fan cooling. Backplane: J1, J2, ("J0" custom) or J1, J2, JAUX, ("J0" custom). Contrl./monitoring like Spec-425. Interchangeable system to our CERN-Spec power supplies for CERN-Spec Crates V-422/V-430.



NEW - NEW - NEW - VXIbus-Crates

Size C and D, using the same design standards as our other crates and power supplies.

Custom Crates and Power Supplies

WES-Crates is flexible because of our modular systems for crates and power supplies.

WES-Crates

Wes-Crates GmbH
Pattburger Bogen 33
D-2398 Harrislee/Flensburg
Germany

Telefon 0461 / 77 41 77
Telefax 0461 / 77 41 41
International + 49 461 /

Your contact in Geneva: HiTech Systems Sa, Avenue Wendt 16, 1203 Geneva, Tel.: 022 / 3 44 77 88, Fax: 022 / 3 45 65 51

Your contact at PSI and ETH Zürich: Dipl.-Ing. Kramert AG, Villigerstr. 370, CH-5236 Remigen, Tel.: 056 / 44 15 55, Fax: 44 50 55

Siège Social et Usine: Sainte-Marie-de-Frugie,
24450 LA COQUILLE
Téléphone: 33/53 52 88 93
Télécopieur: 33/53 52 04 83

Luziesa

France

Contrôle non Destructif DEFAUTS ARTIFICIELS

Réalisation à façon de défauts artificiels par

- Usinages conventionnels
- Electro-érosion
- Ultrasons
- Laser
- Soudure par diffusion moléculaire

Autres réalisations

- I.Q.I. hexagonaux - à gradins - à fils
- Etalons de corrosion
- Eprouvettes de ressuage
- Stenopes
- Usinage par électro-érosion de cavités internes

Toutes prestations de services relevant de ces techniques

Fabrication de machines spécifiques pour

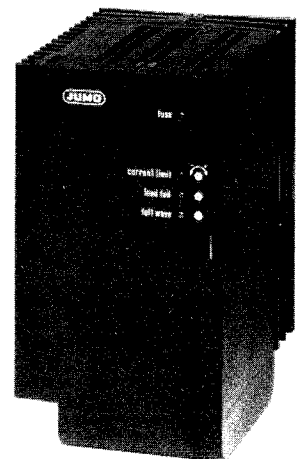
- Micro-usinages par électro-érosion
- Fabrication de défauts artificiels

52 Circle advertisement number on reader service form

JUMO

Thyristor power regulator for wall or rail fitting dimensions 110 x 195 x 152 mm

- continuous control
- for ohmic and inductive loads
- phase section or pulse group operation
- part-load and fuse failure display via LED and relay contact
- soft start and current limitation in phase section mode
- ignition pulse lock
- load currents: 25, 50 and 63 A
load voltages: 115, 230 or 400 V
- U²-regulation



Meß- und Regeltechnik AG, Seestr. 67, CH-8712 Stäfa
Telefon 01/9 28 21 41 • Telefax 01/9 26 67 65

26 Circle advertisement number on reader service form

27 Circle advertisement number on reader service form

Around the Laboratories

Resonance ensures that sufficient nuclei emit together (in phase) for the signal to be detectable, even though the energy of each individual photon is only 10^{-7} eV. For hydrogen at least, the nuclear density is enough (about 10^{23} per cubic centimetre) for a detectable signal to be obtained from a small volume. Additional information on the chemical state of body tissues is given by the decay characteristics of the nuclear resonance signal.

These high quality images, obtained without ionizing radiation, ensure an important role for magnetic resonance in clinical medical imaging. In research, recent applications by Jack Belliveau and colleagues at Massachusetts General Hospital and Harvard University of sequences for rapid repetitive manipulation of nuclei within a brain section has extended MR to activation studies, once an exclusive PET domain. For activation work, as with other studies, MR offers both better temporal and spatial resolution than PET.

With these techniques, it is now possible, for example, to monitor directly the changes in a volunteer's brain when subjected to different visual stimuli. Applied science has come a long way since Röntgen first X-rayed his hand in 1895.

CERN LEP in the Alps

In January, when CERN's LEP electron-positron collider is enjoying a well-earned break, it has now become traditional for the hard-pressed LEP team to have no respite. Instead they pack their bags and depart for Chamonix in the nearby French Alps to review the past year's experience and plan for the future.

In the cold January 1993 light of Chamonix, 1992 (January/February, page 4) was deemed to have been a good year for LEP operations, with the switch to 90° betatron phase operation having paid off. The 65% improvement in integrated luminosity over 1991 was attributed to longer beam lifetimes, faster filling and improved overall efficiency. The commissioning of the eight-bunch 'pretzel' scheme was facilitated with the new optics, and break-even quickly achieved, so that physics

could benefit from more bunches in the machine.

During 1992, the injection chain was fully tested with eight bunches, and when this comes into routine operation this year, the pretzel scheme will benefit. Pretzel running also opens the possibility of still higher luminosity, up to 2×10^{31} per sq cm per s, doubling the present level.

However the finishing touches to high luminosity running are still more an art ('haute cuisine') than a science. Continuing studies of the inter-correlation of different LEP conditions will help make this more systematic.

The main factors affecting performance at 45 GeV are transverse mode coupling instabilities. The present working point gives good results, but there are still potentially interesting regions which need to be checked out.

Beam lifetime and background are both limited by beam size and aperture. Background was reduced by improved focusing, while beam size is dominated by beam-beam effects.



At their annual January strategy meeting in Chamonix in the French Alps, CERN's LEP electron-positron collider team review the previous year's running and plan for the coming year.

90° operation proved its worth in 1992, but the inability to produce polarized beams was a disappointment, and a combined 90°/60° horizontal/vertical combination looked like offering the best of both worlds.

Although some realignments, etc, could yet bring polarization with 90° operation, this is by no means certain. With polarization providing precision fixes on the beam energy for physics, the 90°/60° combination was voted clear favourite for 1993 running.

45 GeV running continues to be LEP's bread-and-butter, but behind the scenes (and sometimes even in front of them) preparations are pushing ahead for boosting LEP beam energy towards 100 GeV (LEP2). Chamonix sessions reviewed LEP2 progress (January/February, page 1) and looked at the expected performance. Producing an integrated physics luminosity of 500 inverse picobarns (over several years) will call for some ingenuity but is not ruled out.

A major LEP2 milestone this year will be the installation of a complete niobium-coated four-cavity superconducting radiofrequency module, supplied by industry.

FERMILAB

Collider detectors

At Fermilab's Tevatron proton-antiproton collider, the CDF detector, in action since 1985 and now significantly upgraded, has been joined by D0. Both are logging lots of data in the continuing search for the long-awaited sixth ('top') quark.

Last year's excitement of the first collisions in the D0 detector at Fermilab's Tevatron proton-antiproton collider was the culmination of more than eight years of hard work by a large and dedicated group. D0 is now really in business.



First D0 physics results

The excitement of observing the first collision in the D0 detector at Fermilab's Tevatron proton-antiproton collider on May 12 1992 was the payoff for more than eight years of hard work by a large and dedicated group of physicists, students, engineers, technicians and other support staff. The D0 detector - an international collaboration of about 370 physicists (including some 65 graduate students) from 36 institutions - had completed the journey from design (1983-1984) to final construction and subsequent rolling in to the collision hall in February 1992.

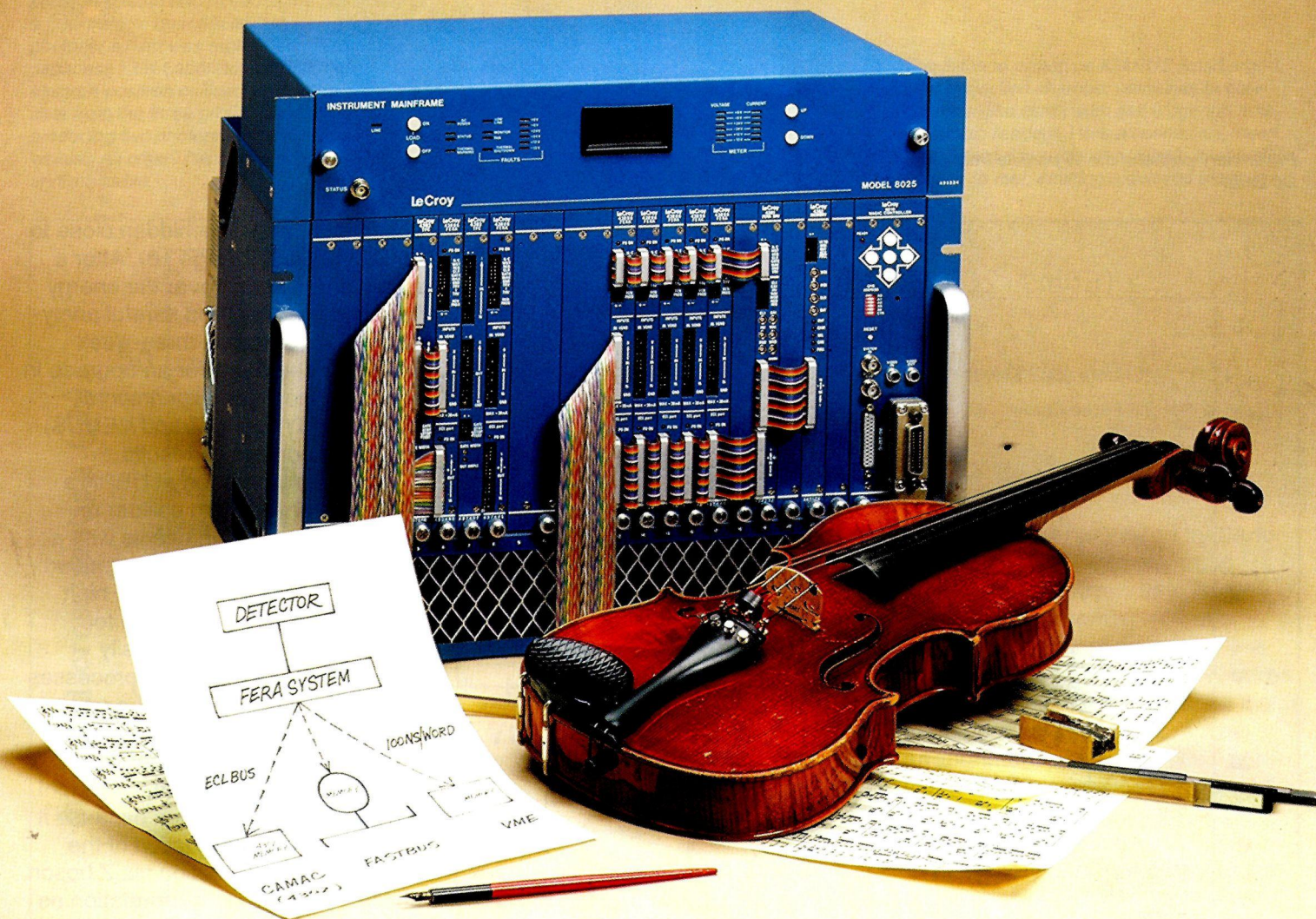
Commissioning the detector with beam lasted from May-July 1992 and went very well. The collaboration showed that the detector was well on the way to achieving design goals including precision measurements of

electrons, muons and photons, together with quark and gluon jets, and to be sensitive to missing transverse energy indicative of non-interacting particles such as neutrinos.

With the start of the physics run in August 1992, the collaboration turned its attention to extracting the first results in time for the major (DPF) meeting at Fermilab last November (January, page 12). By the mid-January break in the run, D0 had accumulated about 7 inverse picobarns of physics data. Large samples of Ws and Zs have been logged in both electron and muon channels. This will allow sensitive studies of the W mass and of the triple WWZ gauge boson coupling.

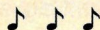
The strengths of the detector will provide a powerful tool to search for the elusive top quark. With the top expected to decay solely to a W boson and a b quark, sensitivity is needed to leptons, jets and missing

A Classic Performer



The FERA™ ADC/TDC Ensemble

The LeCroy Fast Encoding and Readout ADC System is a classic. For more than five years, FERA has been performing all over the world. Applications include high rate analog data acquisition, real time systems, colliding beam diagnostics and energy based triggers in both heavy ion and particle beam experiments. Today, the FERA ensemble gives the best performance at the lowest price.



The FERA quintet includes:

- 4300B/600** 10-Bit, 16-channel charge sensitive ADC
4.8 μ sec conversion time
- 4300B/610** 11-Bit, 16-channel charge sensitive ADC
8.9 μ sec conversion time
- 4301** FERA calibration, fanout, and ECL bus driver
- 4302** FERA multiport CAMAC memory
- 4303** Time-to-FERA converter, 50 psec resolution
(used with 4300B)

- ♪ Performs at Over 50 Institutions
- ♪ High Fidelity with 10-Bit or 11-Bit Resolution
- ♪ Fast Conversion and High Speed ECL Bus Output For Minimal Dead Time (Highest Throughput)
- ♪ Fast On-board Zero Suppression and Pedestal Subtraction for Readout of Compact Data
- ♪ Compatible With LeCroy Series ECLine Trigger Process Modules
- ♪ Direct Connection to High Speed FIFO Memories in FASTBUS, CAMAC and VME via the **NEW** Model 1190
- ♪ Wide Dynamic Range to Cover Most Applications
- ♪ Fast Delivery

Call or write today for more FERA product information and a LeCroy Research Instrumentation Catalog.

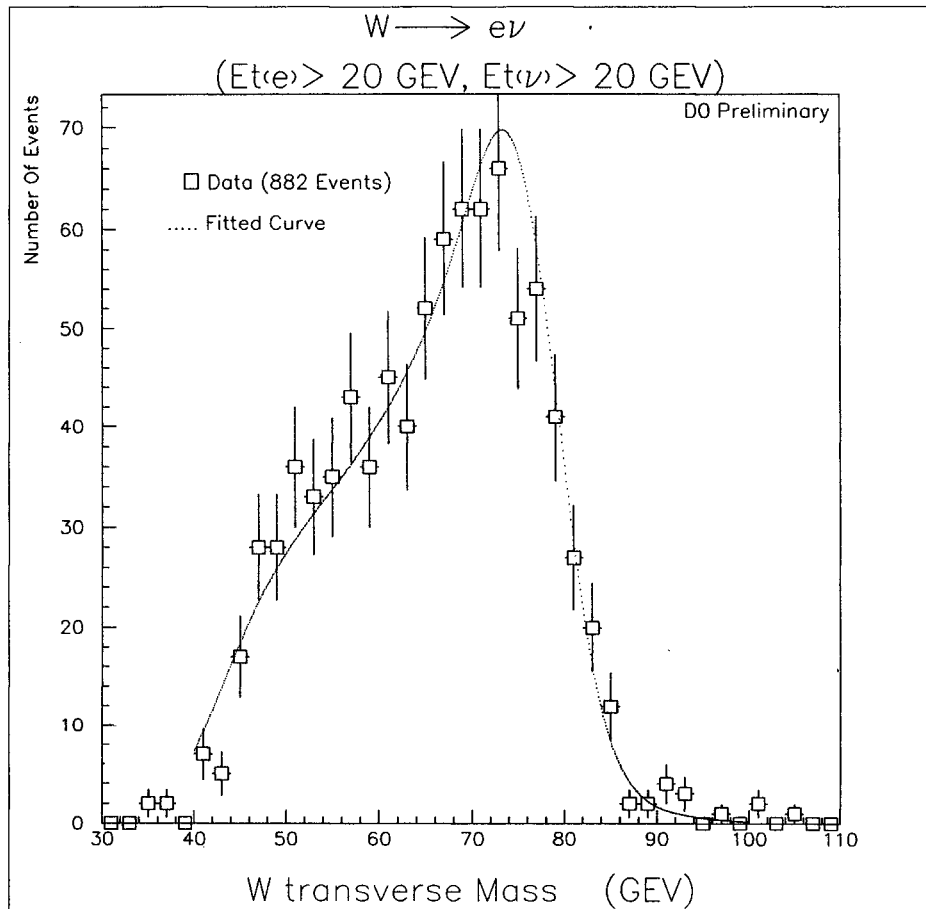
FERA is a trademark of LeCroy Corporation.
© 1993

700 Chestnut Ridge Road, Chestnut Ridge, NY 10977-6499 USA Tel: (914) 578-6013 Fax: (914) 578-5984
2, chemin Pre-de-la-Fontaine, 1217 Meyrin 1, Geneva Switzerland Tel: (022) 719 21 11 Fax: (022) 719 2230

LeCroy

Innovators in Instrumentation

Preliminary profile of the W particle from first D0 data.



unexpected might be hidden close to 60 GeV (January, page 16). After a month's rapid scan over the energy region in question and careful analysis, with an enforced three-week computer shutdown for an upgrade in between, the three experimental groups (AMY, TOPAZ and VENUS) now have conclusive results.

The L3 collaboration at CERN's LEP electron-positron collider recently reported clean events with a muon or electron pair accompanied by a widely separated pair of high energy photons. There were too many such events to be easily explained by conventional processes and, in particular, the photon pairs suggested a particle near 60 GeV.

This observation, together with some similar events from the Delphi group, attracted attention because it could signal the production of the long waited Higgs boson via Z boson decay. Although its interpretation as the Higgs seemed very unlikely because no similar clustering was seen with anything other than a photon pair, the phenomenon could nevertheless still have been related to a new heavy boson. Was it new physics?

The TRISTAN theory group, quickly calculated the rate expected from conventional processes, and the result agreed with the calculation reported by L3. Neither could explain the observed signal, and the L3 events stood as an excess. Not being Higgs-like, any new boson would have a sizeable coupling to electrons, and such an object should be observed at TRISTAN as a narrow peak in the electron-positron elastic scattering and in the reaction producing two photons. Furthermore, the observed rate being only a few out of a million Z events, it would take LEP experiments some time to settle the matter.

transverse energy, or combinations of them. The search is underway.

The full coverage of the detector, and the ability to trigger on jets at small angles makes it well suited for studies of quark field (QCD) dynamics. In addition, fine segmentation and good energy resolution allow good measurement of direct photons, revealing the gluon content of hadrons, while jet multiplicity distributions will test QCD and ultimately measure its parameters.

The large muon coverage as well as D0's compactness and thickness offer good potential for B physics. First studies will include measurement of the B production rate, B-particle mixing and searches for new particles containing b-quarks. High

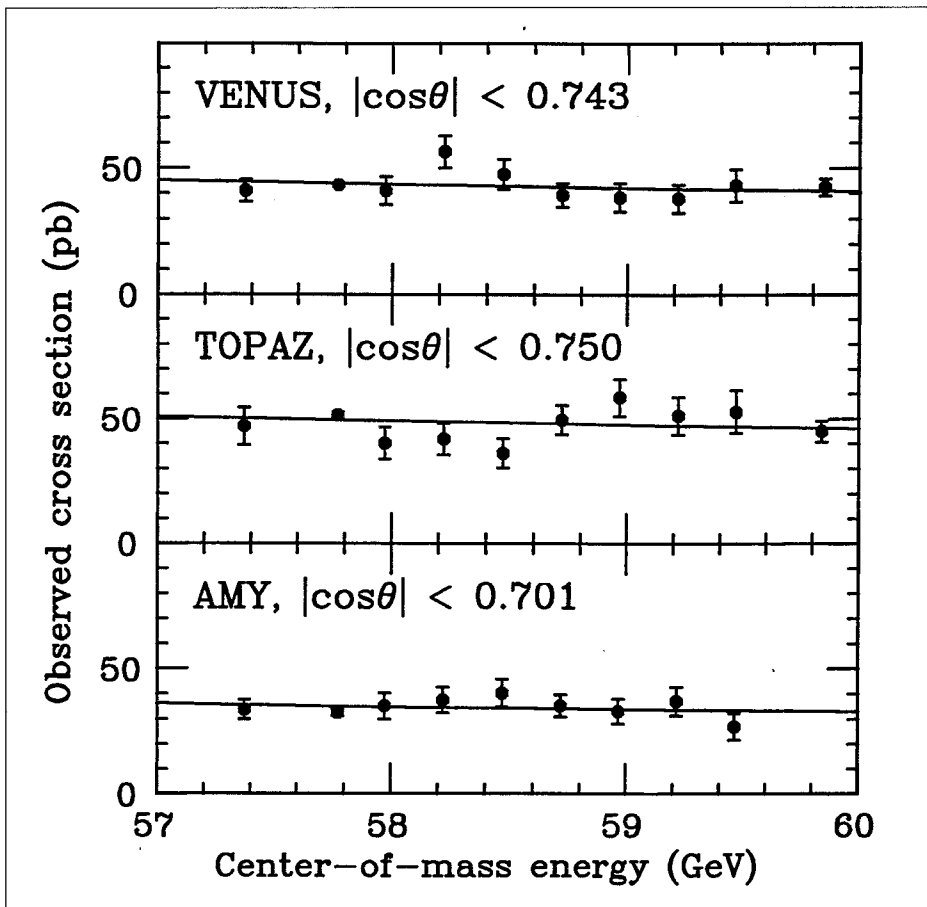
quality measurements of leptons, photons, jets and missing transverse energy could point the way to new physics, including new particles.

D0's rapid turn-on has been very gratifying, and with the detector working well, the collaboration is preparing for an early harvest over a broad range of physics.

KEK 60 GeV boson hunt

The Japanese KEK Laboratory had a busy December. The TRISTAN electron-positron collider, then running at 58 GeV, quickly acted on the news from CERN that something

After some evidence at CERN's LEP electron-positron collider had hinted at the possibility of a new particle near 59GeV decaying into two photons, a hunt was rapidly launched at the Japanese KEK Laboratory's TRISTAN electron-positron collider. Shown here are the data from the three groups for the reaction producing two photons, with no narrow peak visible. All other channels are similarly unremarkable.



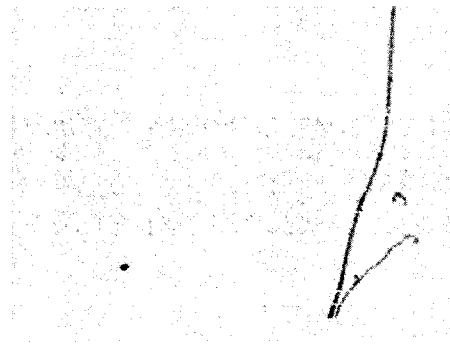
To search for a narrow boson, TRISTAN made an energy scan between 57.4 and 59.5GeV in about 0.25GeV steps. The measurement was done at the end of December, with about one inverse picobarn of data collected at each point. There is no indication of a narrow state - not only in the two photon channel, but also in all others. The result translates into very stringent upper limits and effectively excludes any new boson that predominantly couples to two photons, as well as leptons, in the suspected mass range. The L3 group's careful conclusion "a quantum electrodynamics fluctuation can not be ruled out" is strongly supported.

UNDERGROUND - 1 ICARUS prepares to fly

Operating at CERN since 1991 is a 3-tonne liquid argon time projection chamber, a detector breakthrough which combines the visual advantages of bubble chamber tracks with the flexibility of fully electronic data acquisition. The 3-tonne chamber is a prototype for a much larger configuration for the ICARUS* solar neutrino and proton decay detector to be installed in the Italian Gran Sasso underground laboratory.

ICARUS (Imaging Cosmic And Rare Underground Signals) is built around the cryogenic imaging cham-

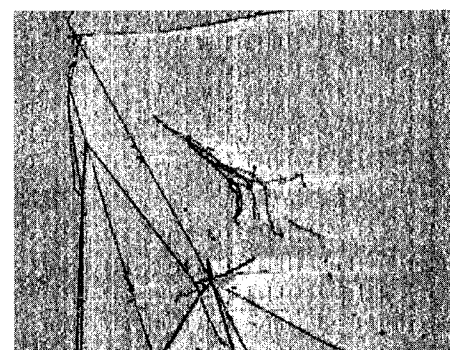
The 3-tonne prototype ICARUS liquid argon time projection chamber combines bubble chamber-like clarity with self triggering and electronic readout. Here a cosmic ray muon (top) slows down (denser signal), eventually coming to rest, emitting a delayed electron.



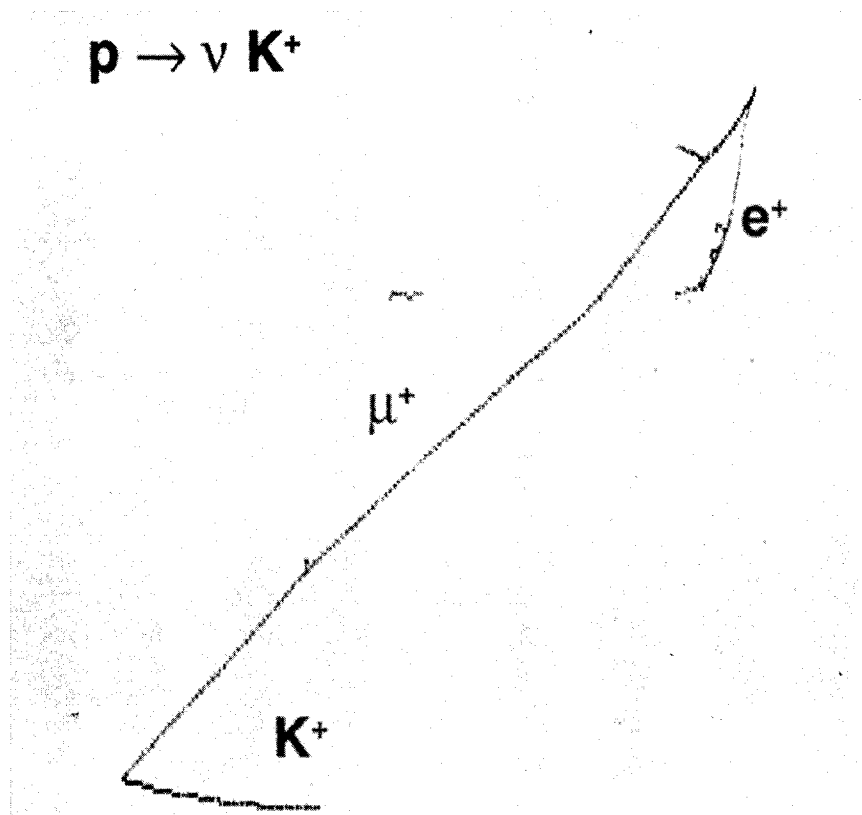
ber idea initially proposed by Carlo Rubbia in 1977. With electrons drifting for a relatively long time (several milliseconds) and with sensitive amplifiers picking up the ionization from just a few millimetres of track, events can be imaged inside the cryogenic volume. A special arrangement of readout wires provides drift time measurements and ensures simultaneous imaging in several different views.

The prototype has shown that the challenges of obtaining ultra-pure argon and operating readout techniques for large sensitive volumes have been met. The full ICARUS detector (with three liquid argon modules each containing 5,000 tonnes) will be able to detect low energy electrons (down to a few MeV) emerging from solar neutrino interactions, proton decays, or other rare events over a large volume.

An ICARUS prototype cosmic ray hadron shower.



A simulation of a possible proton decay as it would be seen in ICARUS. A static proton produces a kaon, which is gradually brought to rest before decaying in turn.



ICARUS' proponents call their detector an 'electronic bubble chamber' and the recorded tracks have an eerie bubble-chamber-like quality. However unlike a conventional bubble chamber, the events are self-triggering, the device is continuously sensitive, and has all the advantages of electronic readout. Resolution is 150 microns. In addition the bubble size (less than a millimetre in any direction) also gives a measurement of energy deposition.

Readout uses three parallel wire planes - a screening/focusing grid, and an induction plane and a collection plane with mutually orthogonal 2mm-pitch wires. Maximum electron drift distance in the prototype is 42 cm. For the full detector, where electrons will drift up to 2 metres, additional logic based on modern TV technology would give real time pulse identification.

To attain the necessary level of purity, industrially clean argon (1 part per million of impurities) passes through a molecular sieve and an 'oxysorb' impurity absorber. The technique is now able to handle liquid, a boon for such a large installation, even a small plant coping with some 50 tonnes of liquid per hour.

With precision Standard Model measurements from LEP now suggesting how the electroweak and strong forces might unify at higher energies, proton instability again becomes a burning issue, and ICARUS will be well suited to lifetimes up to 10^{34} years, and a wide range of potential decay processes.

The other major ICARUS goal is neutrino physics. With the solar neutrino question still wide open, ICARUS' ability to make model-independent solar neutrino measurements should lead to new insights.

Atmospheric neutrinos too need a closer look.

As well as natural neutrinos, ICARUS could also monitor what happens to a neutrino beam from CERN after 730 kilometres. To provide particles for CERN's future LHC proton collider, a new proton line would be built linking the SPS synchrotron with the LEP tunnel, and this points almost exactly in the right direction for Gran Sasso.

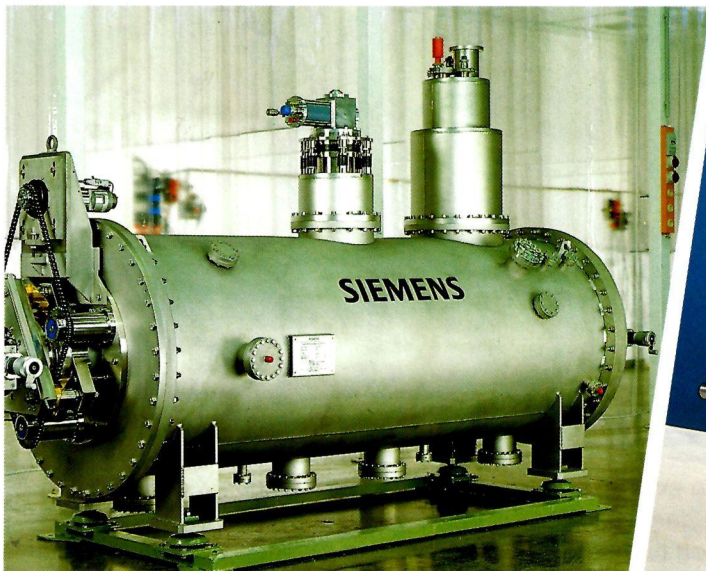
*(*In Greek mythology, Icarus tried to escape from Crete on wings made by his father, Daedalus. Venturing too close to the sun, the wax on the wings melted and he fell into the Aegean sea at the point now known as Icaria. Daedalus, an inventor employed by King Minos in Crete, had better luck, flying to Sicily. Hopefully the technology being developed for the ICARUS experiment will be more reliable than its mythological forebear.)*

UNDERGROUND - 2 New Soudan detector nears completion

Late last year a team at Argonne put the finishing touches to the 227th 4.3-ton calorimeter module for the Soudan 2 nucleon decay detector. This completed the fabrication of the steel and plastic drift chamber modules which began at Argonne and the Rutherford Appleton Laboratory in 1985 (June 1991, page 16).

Module components were constructed by collaborators at Minnesota and Oxford while Tufts built the active shield of proportional tubes which now surrounds the massive underground tracking calorimeter.

Accelerator and Magnet Systems for International Science



Superconducting accelerator module for the JAERI FEL experiment, Japan



Assembly of the first short model coils of CQM magnets for the superconducting super collider SSC, USA

Siemens offers the complete range of modern accelerator and magnet technology, extending from research and development, design, construction and manufacturing up to commissioning and service:

Superconducting accelerator modules for the JAERI FEL experiment in Japan

Within two years four modules were designed, built, successfully tested and then supplied early 1993. Each of them is equipped with duplex cryoshields for reduction of standby losses to about 3.5 W per module, a variable high-power coupler and a mechanical coarse and a piezo electric fine tuning system. Performance of the modules exceeds the guaranteed parameters.

Superconducting accelerator magnets for the super collider SSC

Under contract of the SSC laboratory/ Babcock & Wilcox Siemens is developing and building the collared coils of the superconducting CQM magnets for the SSC collider. First short model coils have already been fabricated and passed all tests with excellent results. 174 magnets will be built within the scope of prototype and low-rate initial production before series production of another 1,517 magnets starts.

We offer design, construction, commissioning and service for:

- Synchrotron radiation facilities
- Linear accelerators
- Proton tumor therapy accelerator systems
- Normal and superconducting accelerator cavities
- Normal and superconducting magnet systems
- Beam transport lines
- Vacuum chambers
- Cryogenic components and systems
- Beryllium windows

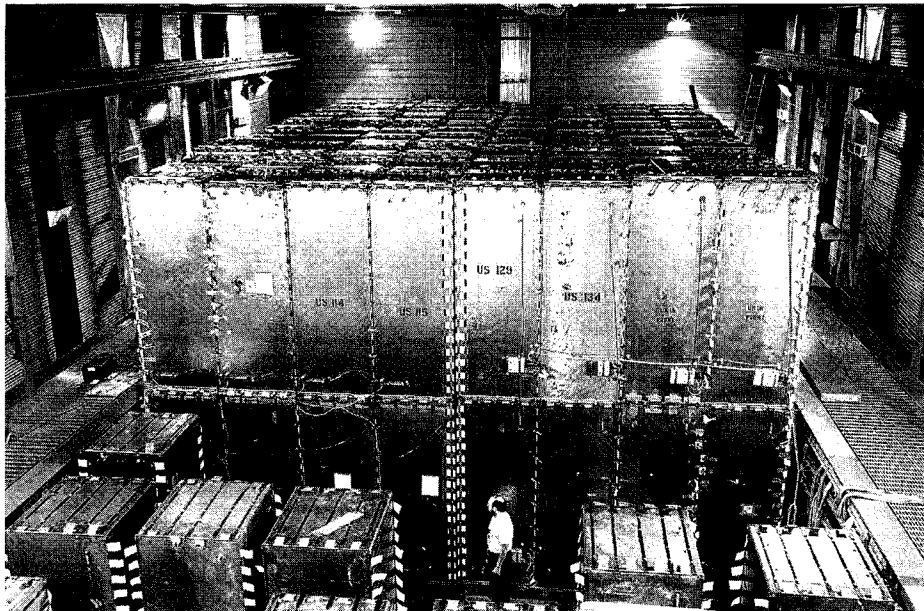
Siemens AG
Accelerator and Magnet Technology
Friedrich-Ebert-Straße
W-5060 Bergisch Gladbach 1
Germany
Telephone: + 49 22 04 84 23 00
Fax: + 49 22 04 84 23 05

A96001-U02-Z243-X-7600

PAC '93
Particle Accelerator
Conference
Washington
May 17 - 20, 1993
Exhibition of
Siemens
Accelerator and
Magnet Technology
Booth No. 34

Accelerator and magnet technology from Siemens – The full range of engineering and manufacturing services

The Soudan 2 detector, 700 metres underground. The rectangular boxes are the 4.3-ton calorimeter modules. The aluminum-extrusion proportional tubes of the active shield can be seen on the ceiling and walls of the cavern. Individual 4.3-ton modules in the foreground are undergoing performance tests prior to installation.
(Photo T. Kafka)



The experiment is set up in the Soudan mine in a specially excavated cavern 700 metres beneath northern Minnesota's Iron Range. This historic century-old iron mine is maintained and operated as a tourist attraction by the Minnesota Department of Natural Resources, which also provides valuable assistance in operating the underground research laboratory. The overhead rock shields off cosmic rays which would confuse the search for rare events - only neutrinos and a few of the highest energy cosmic ray muons can penetrate to this depth.

Soudan 2 is designed to detect the spontaneous decay of protons or bound neutrons, predicted by Grand Unified Theories (GUTs) of the strong and electroweak forces. It is optimized for decays producing charged kaons, predicted by the supersymmetric GUTs favoured by extrapolations of LEP results (November 1992, page 15), and for complicated modes difficult to analyse in large water Cerenkov detectors.

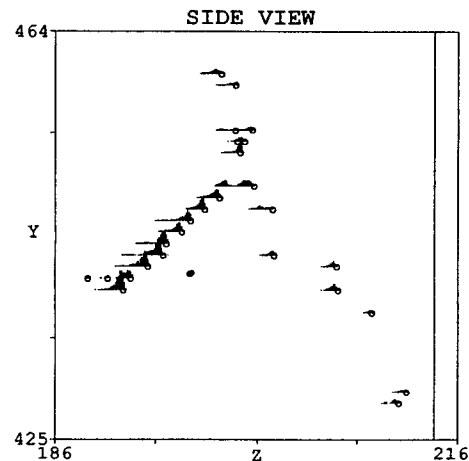
Ionization measurements and

bubble-chamber-like event reconstructions allow Soudan 2 to distinguish clearly between nucleon decay and the neutrino interactions which can mimic it. The ICARUS detector proposed for the Gran Sasso Laboratory (see previous story) will eventually be a strong competitor, but for the next few years Soudan 2 has a head start. The first 820 tons of Soudan 2 are now in routine operation, with the detector scheduled to reach its final mass of 960 tons by this autumn.

The experiment has been active since the first 250 tons came into full operation in 1989. So far more than 1 fiducial kiloton year of exposure has been recorded for nucleon decay and cosmic neutrino searches. A sample of 15 million cosmic ray muons is also being studied to learn about the nuclear composition of cosmic ray primaries. This is aided by a surface detector measuring the energies of the parent air showers for a subset of the underground muon events.

Soudan physicists have already published the results of a search for

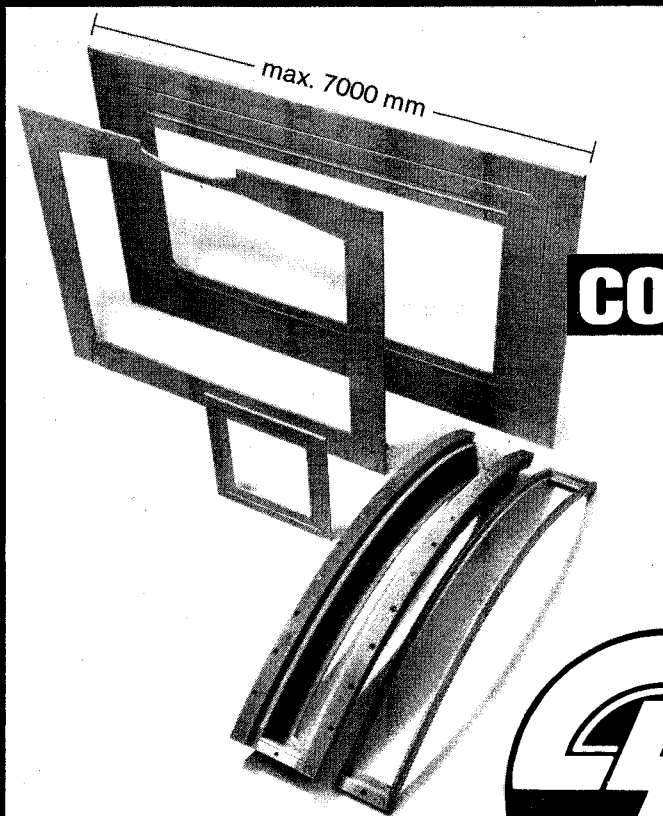
Candidate neutral current event from an atmospheric neutrino inelastic interaction in Soudan 2. A slow neutral pion (reconstructed mass of 137 MeV) decays into two nearly back-to-back gamma showers (top and lower right) which emerge from the neutrino interaction vertex. The straight track is the recoil proton, whose increasing ionization makes larger pulses as it slows down. Scales are in centimetres.



heavily ionizing magnetic monopole tracks, as well as tantalizing evidence for a burst of muons from the direction of Cygnus X-3 during its January 1991 radio flare.

Soudan recently presented preliminary measurements of atmospheric neutrino interactions from the first half kiloton year exposure. Although the statistics are still limited, the resulting ratio of muon- to electron-neutrino interactions appears to support the anomalously low value obtained by the Irvine/Michigan/Brookhaven (IMB) and Kamiokande water Cerenkov experiments. The Soudan neutrino sample will soon be doubled. A popular explanation of the unexpectedly low muon to electron neutrino ratio is that muon neutrinos oscillate into tau or electron neutrinos in the atmosphere.

Physicists from the Tufts Soudan group recently put forward an alternative idea: the electron neutrino rate may appear high because of contamination by positrons from proton decay (into a positron and a neutrino pair). Although physicists building big underground detectors have worked very hard to reduce the background to nucleon decay from atmospheric neutrinos, until now few have worried



fiberglass construction

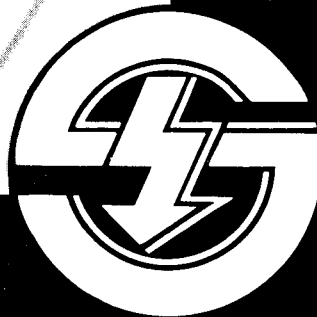
Stesalit resolves your individual problems in

for science and advanced technic.

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 Zullwil SO

Telephone 41.61.791 06 01

Fax 41.61.791 06 04

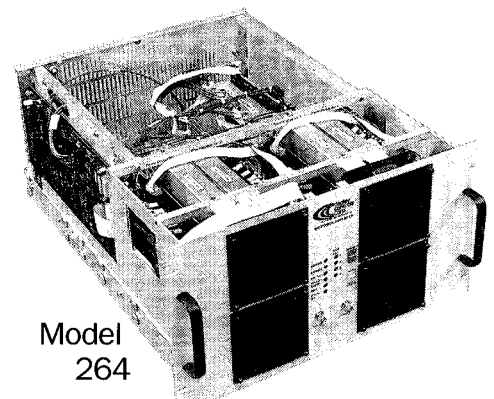
24 Circle advertisement number on reader service form

Wideband PWM 'Op Amp' Delivers 49kW

For particle beam steering & focus with 5mA/°C stability—or deflection and scanning with 9V/μs slew rate. Units parallel for higher power output.

Model	Continuous Output ¹	
220, 230	±75V @ ±12A	±150V @ ±10A
231, 261	±160V @ ±55A	±330V @ ±25A
233, 263	±160V @ ±110A	±330V @ ±50A
234-1, 264-1	±160V @ ±180A	±330V @ ±90A
234, 264	±160V @ ±240A	±330V @ ±120A
235, 265	±160V @ ±300A	±330V @ ±150A

¹ Rating for I_{PEAK} is $>2 \times I_{CONT}$ depending on duty factor and pulse width.



Model
264



**410 University Avenue
Westwood, MA 02090**

**TEL (617) 329-8200 • FAX (617) 329-4055
Company Contact: Melvin A. Berger**

Copley Controls' wideband, filtered PWM power amplifiers look—to the load—like linear amplifiers. The 80 kHz switching frequency enables power filters to be built into the amplifier's case. MOSFET output bridge permits paralleling for high current. Copley amplifiers are ideal for driving a wide range of inductive loads.

Specifications include DC-4 kHz bandwidth, 0.2% THD, and 0.5mV/°C stability. Low heat dissipation yields >94% efficiency. Applications include beam steering, motion control, vibration suppression, magnetic levitation, and ripple/harmonic neutralization. Improved current mode DC stability can be achieved with external shunt.

9 Circle advertisement number on reader service form

RADIATION DETECTION & MEASUREMENT

This course is limited
to 50 persons.
Registration closes on 15/6/93

After last year's success

Dr. Glenn F. Knoll to hold 1993 European seminar



After the success of Dr. Glenn F. Knoll's first European seminar, HARSHAW/QS, Inter-technique and CEA/DTA/DAMRI announce a second conference for 1993.

This unique experience is designed to help practitioners refresh their knowledge in areas outside their field and offers an opportunity for all to gain a broader perspective of radiation measurement options. The well renowned professor, Dr. Glenn F. Knoll, is the

Dr. Glenn F. Knoll, holds a Master's degree from Stanford University and a Doctorate in Nuclear Engineering from the University of Michigan.

author of "Radiation Detection and Measurement". He will give an extended seminar elaborating on the second edition of his textbook. As a participant you will be able to interact with others in the same profession. The seminar atmosphere enables comfortable interaction and encourages open discussion. Take a

chance to share in a learning experience that could prove to be extremely valuable to your company/institution.

SEPTEMBER 20/24. 1993
AT JUAN LES-PINS ON THE FRENCH "COTE D'AZUR"

To receive complete information, please complete this form and mail or fax to ICA

- Yes, please send me complete information on Dr. Glenn F. Knoll European seminar.
 Yes, please register me on Dr. Glenn F. Knoll European seminar.

Name Surname
Company Function
Address
City State/Prov
Zip code Country
Telephone Fax

Information - Reservation

ICA

International Congress Agency

Tel. : (33-1) 47 61 99 11

Fax : (33-1) 47 61 07 09

Telex : 633 679 F

Address : 23, rue d'Issy.

92100 Boulogne. FRANCE.

Contact : Jeanne Catala

A SEMINAR ORGANIZED BY

CEA
DTA/DAMRI

HARSHAW QS

INTERTECHNIQUE

With its ability to cleanly identify a fraction of neutrino events by observing recoil protons, the Soudan detector will be able to test this idea experimentally. As with other major underground facilities, Soudan has also been considered as a distant target for a beam of synthetic neutrinos, in this case from Fermilab, searching for neutrino oscillations after 730 kilometres. If the atmospheric neutrino result is due to oscillations, many of Fermilab's muon neutrinos would become tau or electron neutrinos on their way to Soudan. This would decrease the fraction of the 900 interactions per year containing final state muons, and provide an unambiguous signal of neutrino oscillations.

Attractive features of this proposal are both the operating Soudan 2 detector and the possibility of building a bigger detector at the same site. When the US Department of Energy approved the excavation in 1983, they allowed for future follow-on experiments by funding a space large enough for a second major detector after Soudan 2. Several ideas are now being developed. The neutrino beam from Fermilab is expected to be ready in 1998, after completion of the planned 5 kiloton year exposure for nucleon decay. With the construction of Soudan 2 modules completed, the experiment is now on the threshold of a long programme of exciting particle physics measurements in its underground laboratory.

Fermilab Director John Peoples is ICFA Chairman 1993-5.

ICFA

The 23rd meeting of ICFA (International Committee for Future Accelerators) was held on 13 January at the Japanese KEK Laboratory. This committee, set up in 1976, promotes international collaboration in the construction and exploitation of very high energy accelerators, and organizes topical workshops and meetings.

At the KEK meeting, there was major discussion on planning for a future TeV electron-positron linear collider, envisaged as the next very large accelerator following the SSC and LHC proton collider projects. Already there is considerable international R&D collaboration for such a machine, and ICFA is much involved in promoting this collaboration and providing forums to discuss the accelerator and physics issues which arise as the project advances.

The DESY, Hamburg, Laboratory in May will host an ICFA seminar on 'Future Perspectives in High Energy



Physics'. These seminars, held every three years, are among the most significant in-depth international reviews of the state of high energy physics, covering both the science itself and the essential accelerator tools. A major topic at the DESY Seminar will be TeV electron-positron linear colliders.

ICFA people

In January, John Peoples of Fermilab became ICFA Chairman (until December 1995), succeeding Alexander Skrinsky of Novosibirsk. Long-serving (since 1978) Secretary Owen Lock (CERN) retired from ICFA in December, his place being taken by Roy Rubinstein (Fermilab). Continuity is provided by Helga Schmal (CERN), who remains as Assistant Secretary.

Unification, small and large

Fruitful exchanges between particle physics, astrophysics and cosmology have become a common feature in the last decade. In January, Coral Gables near Miami was the stage for a 'Unified Symmetry in the Small and the Large' meeting.

Coral Gables is a famous physics venue. In January 1964, the year that the quark model of hadrons emerged, Behram Kursunoglu initiated a series of particle physics meetings that continued for 20 years and formed a regular focus for this development. The final such meeting was in 1983, coinciding with both the 80th birthday of field theory pioneer Paul Dirac, who worked in Florida towards the end of his career, and

the discovery of the W bosons at CERN.

The resurrected Coral Gables meeting began with historical accounts of the emergence of Big Bang cosmology, by Robert Ralph and Herman Alpher, while Andrei Linde proposed our expanding universe as a small part of a stationary system, infinite both in space and in time.

The observational status of Big Bang cosmology was reviewed by Bruce Partridge, John Mather and Martin Harwit, emphasizing the cosmic background radiation, where temperature is now measured by the COBE satellite detectors to $2.726 \pm 0.010\text{K}$. The tiny fluctuations observed by COBE pose problems for standard cold dark matter models.

Edward ("Rocky") Kolb reported on new studies on the electroweak phase transition, based on an analogy with the physics of liquid crystals. Richard Holman discussed the fate of global symmetries at energies near the Planck (grand unification) energy, and Paul Steinhardt talked about tensorial and scalar metric fluctuations in the light of the COBE results.

Anthony Tyson gave an impressive description of dark matter studies using gravitational lensing, now emerging as a unique tool for indirectly observing intervening dark matter. A neutrino mass of 10 electronvolts could account for observed dark matter distributions, but fails to provide the necessary seeds for galaxy formation. A conservative limit for the cosmic mass density (Ω) is 0.2.

Theoretical problems of gravity and cosmology were dealt with by Behram Kursunoglu, Robert Brandenberger and Katherine Freese. Leonard Susskind emphasized the clash between general relativity and quantum theory arising through black hole singularities and

their evaporation. Louise Dolan, Pran Nath and A. Jevicki looked at supergravity and superstring theories.

In the neutrino physics session chaired by Frederick Reines, Paul Langacker and Stephen Mintz reviewed the status of the solar neutrino problem, while Frank Avignone reported on the ongoing search for neutrinoless double-beta decay, providing an upper limit of 1.4 eV on a Majorana neutrino mass. Pierre Sikivie covered the ongoing search for axions.

After a theoretical introduction by Boris Kayser, the programmes of CP-violation studies, including the B-particle sector, at electron-positron colliders and at hadron machines, were outlined by Jonathan Dorfan and Vera Lueth respectively. While Dallas Kennedy reported on sensitive radiative electroweak corrections, Edward York-Peng Yao and Martin Einhorn looked at the growing use of effective Lagrangians to describe heavy particles at low energy.

Alan Krisch emphasized the importance of polarized beams for strong interaction studies, especially nonperturbative quark field theory (QCD) effects, and Frederick Zachariasen described new analytic methods to derive the heavy quark potential. Chiral QCD liquids and their role in the physics of heavy nuclei and neutron stars were covered by Brian Lynn. E.C.G. Sudarshan described a new way to look at the decays of kaons. Stephen Pinsky, Charles Thorn and Mark Samuel looked at special particle topics, while Peter Carruthers described galaxy distributions in an unconventional way, linking them to the properties of multihadron spectra.

A substantial part of the time was given to speculations on the nature and origin of Standard Model con-

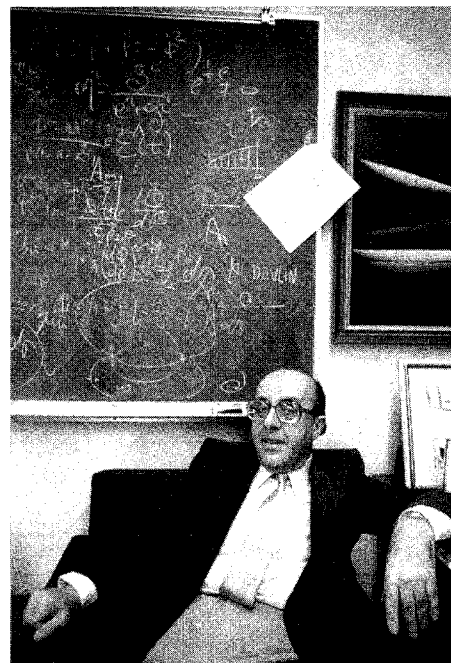
stants, especially fermion masses. After an introduction by Yoichiro Nambu, Sydney Meshkov, Harald Fritzsch and Pierre Ramond outlined a new view of quark and lepton mass spectra as signals of new types of broken symmetries, opening a possible window to physics beyond the Standard Model.

Gordon Kane reviewed supersymmetric possibilities at high energies.

The revived Coral Gables meetings will now continue, hopefully seeing the emergence of physics beyond the Standard Model. This year's meeting was organized by Behram Kursunoglu of Coral Gables' Global Foundation, assisted by Sydney Meshkov (SSC), Stephen Mintz (Florida) and Arnold Perlmutter (Miami).

From Harald Fritzsch

Behram Kursunoglu - putting Coral Gables on the physics map.



MAKE YOUR BUDGET GO FURTHER...

... if you have, until now, postponed purchasing high-quality ultra high vacuum components for financial reasons.

LEYBOLD has rationalised and updated its range of products so as to match market demand more closely, at the same time achieving price reductions of up to 50% for UHV components – and improving product quality.

Being the leading supplier of vacuum technology and process applications worldwide, LEYBOLD is the most competent partner you could have in the area of UHV systems.

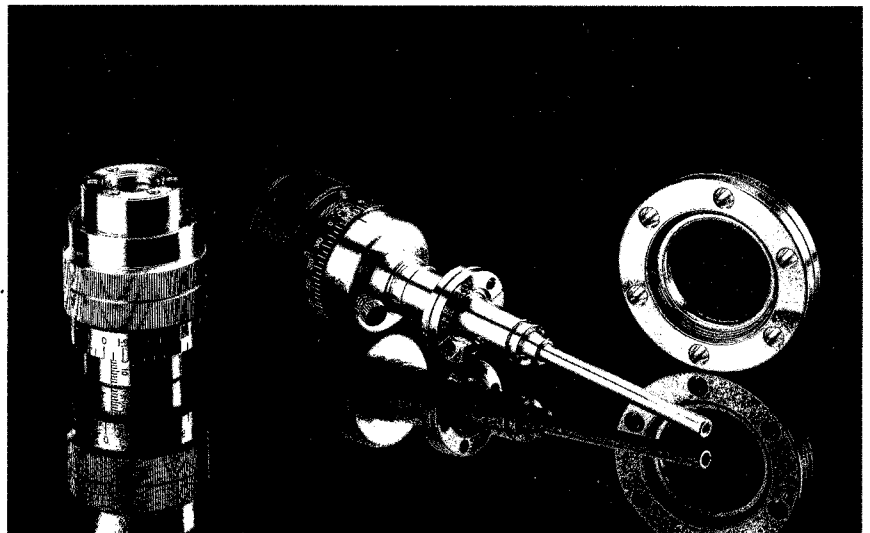
LEYBOLD – The first choice in UHV technology.

Do not hesitate to contact us, just ring:
Germany (+49-221) 347-1324 or -1281.

Switzerland (021) 691 8414

LEYBOLD AG

Bonner Strasse 498, D-5000 Cologne 51, Germany
Leutschenbachstrasse 55, CH-8050 Zürich, Switzerland



CD-Bonn 181-3.61.11.003.02



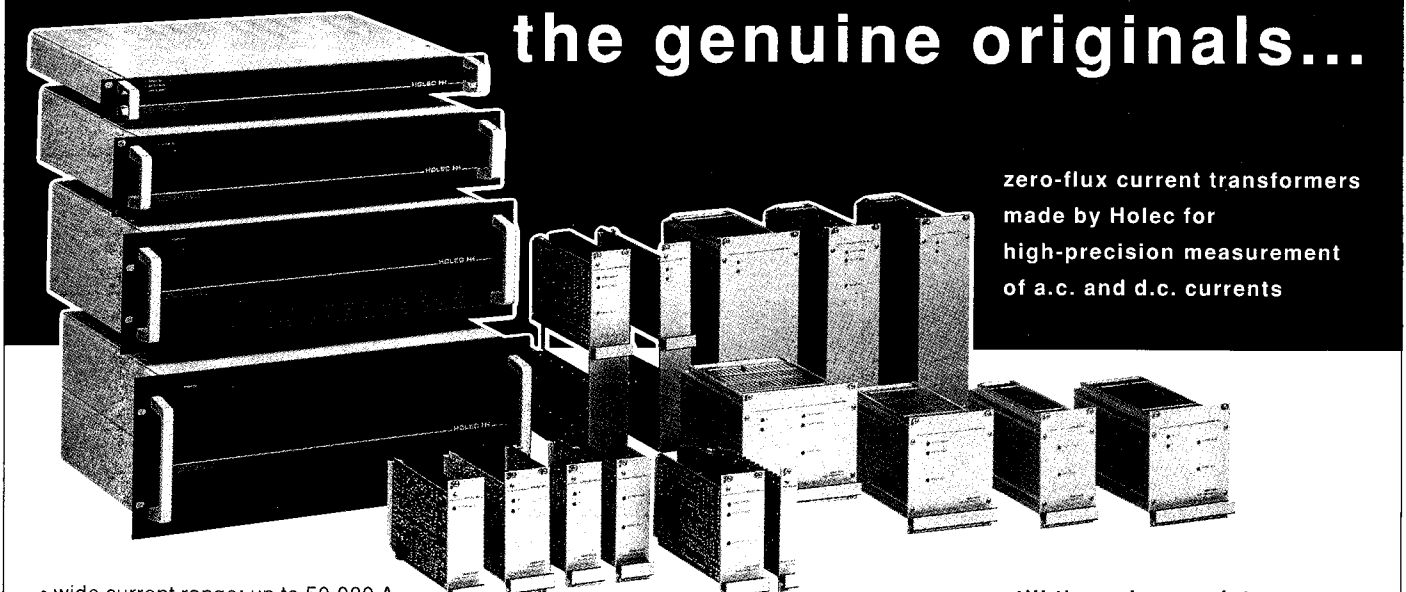
A Degussa Company

Innovative Vacuum Technology

19 Circle advertisement number on reader service form

the genuine originals...

zero-flux current transformers
made by Holec for
high-precision measurement
of a.c. and d.c. currents



- wide current range: up to 50,000 A
- large bandwidth: d.c. to 500 kHz
- short-circuit current:
up to 10x rated current
- unequalled accuracy
- temperature stability: < 1 ppm/K
- without any temperature control devices
- no warming-up time
- fast recovery after overload

- extremely low noise and ripple
- low power consumption
- true bipolar operation
- contact-free sensing
- high reliability: MTBF of 30 years
- fully magnetically screened
- highly EMI protected

still the only complete range

HOLEC HH

Holec Systems & Components B.V.
P.O.Box 23, 7550 AA Hengelo,
The Netherlands
Tel. +31.74.462850
Fax +31.74.464818

Bookshelf

Perspectives of meson science,
T. Yamazaki, K. Nakai and
K. Nagamine, Eds., Elsevier,
ISBN 0444895558

Unstable particles such as mesons and muons are now used in various domains of physics, chemistry, engineering, and life sciences. This book covers current applications and future perspectives from a very broad viewpoint, with 27 invited contributions from fields such as muon and muonium spin rotation, muon hyperfine interactions, muon catalyzed fusion, medical diagnostics, exotic atoms, mesons in nuclei, and exotic decays of mesons.

The examples are mainly drawn from work carried out at KEK in Japan and at TRIUMF in Vancouver under Japanese research grants, although major references are also made to results from Brookhaven, CERN, Los Alamos and PSI (Switzerland).

The book is, in a way, complementary with "The Meson Factories"

(T. Ericsson, V. Hughes and D. Nagle, Eds.) published recently by the University of California Press, which summarizes research in the meson factories.

Magnetism, superconductivity, diffusion of hydrogenlike impurities, and muonium chemistry, using positive muons stopped in solids, are the subjects of the first ten papers. Here spin rotation offers a unique tool, and the results have led to substantial theoretical work, deepening our understanding of condensed matter.

Two papers describe progress in muon catalyzed fusion. Although breakeven in energy production seems still remote, other applications are proposed in intense sources of 14 MeV neutrons for isotope production, and in sources of slow negative muons which could open new fields of meson science.

Advanced muon beam production is the topic of a fine paper by Nagamine and Ishida. They discuss many new ideas, including ultraslow muon beam production using re-emission

from material surfaces (already used to produce bright positron beams), or beam cooling, familiar from electron and antiproton synchrotrons.

What happens when a negatively charged hadron or muon is stopped in condensed matter? This familiar question is debated in three papers dealing mainly with exotic atoms and other low-energy muon and hadron physics.

Hypernuclear spectroscopy and other hadron-induced nuclear phenomena are covered in the remaining ten papers. The physics covers many aspects of modern nuclear and particle physics, including meson production and other relativistic heavy ion topics.

In his review "Low-energy muon science" J.H. Brewer claims "Muon science is one of the most dramatic interdisciplinary scientific legacies of the 20th century...". The reader of this book will quickly agree.

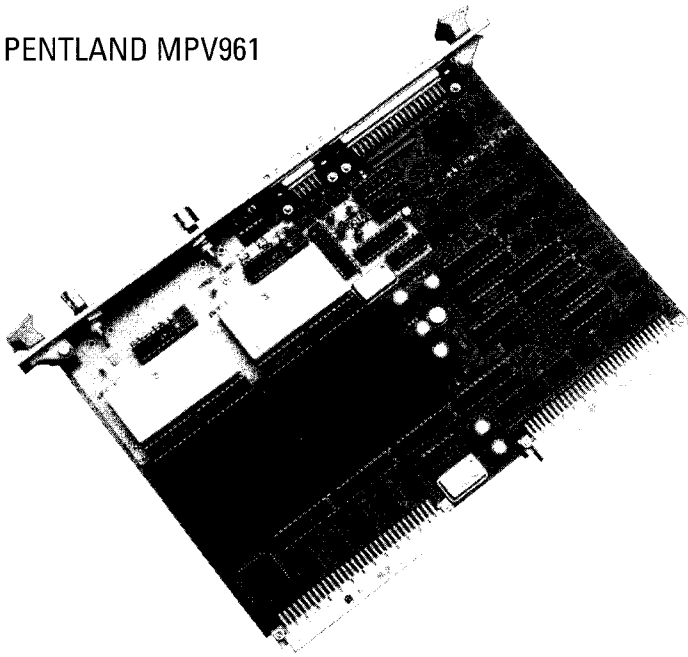
By Tapio Niinikoski



Tapio Niinikoski addresses the recent 10th International Symposium on High Energy Spin Physics in Nagoya, Japan.


The easy access to VME

PENTLAND MPV961





25 million samples per second 12-bit analog input card.

VMEI


MOTOROLA
 Computer Systems
 Blanket Purchase Order B1007 / CN

PENTLAND
 SYSTEMS LTD.
 Blanket Purchase Order B1008 / CN


Modular Computers®
 Blanket Purchase Order B1009 / CN


Your VME-Partner
 Omni Ray AG, Industriestrasse 31, CH-8305 Dietlikon/Zürich
 Phone 01-835 21 11, Fax 01-833 50 81

58 Circle advertisement number on reader service form

DATARAM

**MEMORIES for
DEC - HP/APOLLO - SUN
IBM6000 - Silicon Graphics**

LIFETIME GUARANTEE
FREE TRIAL PERIOD
FAST DELIVERY
EXPRESS HOT SPARE
SUPERIOR PERFORMANCES

TAKE BENEFITS OF THE SPECIAL CERN'S CONDITIONS :
Delivery directly from DATARAM USA to CERN site by speed post, exonerated from all taxes (icha) and duties.

Inter Access OFFICIAL DATARAM DISTRIBUTOR

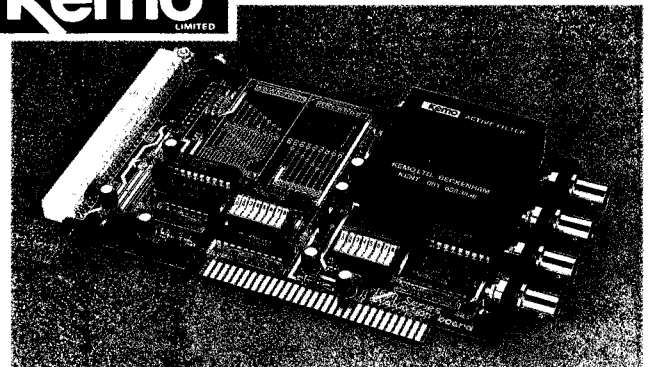
IAS Inter Access SA 4, av. de Champel CH-1206 Geneva
Tél: 022 346 04 40 Fax: 022 346 05 56

All references are trademarks of their respective manufacturers

16 Circle advertisement number on reader service form

High Accuracy Digitally Set Active Filters 135 dB/Octave

Kemo®
LIMITED



1600 Series

Small size, 8 bit word control, cutoff 2Hz to 51kHz (three moduals), wide dynamic range (typically < 0.006% THN+N). PC (and other busses) compatible carrier cards available.

Consult KEMO for all your fixed and variable filter applications.

1 Channel to 256 Channels, Attenuation up to 135 Db/octave, Frequency range 0.001Hz - 1MHz, Moduals or Systems, Computer and/or control, Customer defined OEM applications welcomed.

Extensive range of filter application notes available on request together with highly defined responce parameters. © Registered Trade Mark.

**Kemo Ltd., 12 Goodwood Parade, Elmers End,
Beckenham, Kent BR3 3QZ. Tel: 081 658 3838.
Fax: 081 658 4084. Telex: 895189 Kemo G.**

56 Circle advertisement number on reader service form

People and things

External correspondents

Argonne National Laboratory, (USA)
D. Ayres

Brookhaven, National Laboratory, (USA)
P. Yamin

CEBAF Laboratory, (USA)
S. Corneliussen

Cornell University, (USA)
D. G. Cassel

DESY Laboratory, (Germany)
P. Waloschek

Fermi National Accelerator Laboratory,
(USA)
M. Bodnarczuk

GSI Darmstadt, (Germany)
G. Siegert

INFN, (Italy)
A. Pascolini

IHEP, Beijing, (China)
Qi Nading

JINR Dubna, (USSR)
B. Starchenko

KEK National Laboratory, (Japan)
S. Iwata

Lawrence Berkeley Laboratory, (USA)
B. Feinberg

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)
Jacky Hutchinson

Saclay Laboratory, (France)
Elisabeth Locci

IHEP, Serpukhov, (USSR)
Yu. Ryabov

Stanford Linear Accelerator Center, (USA)
M. Riordan

Superconducting Super Collider, (USA)
N. V. Baggett

TRIUMF Laboratory, (Canada)
M. K. Craddock



On 1 March, Bjorn H. Wiik (above) became Director (more accurately Chairman of the Directorate) of the DESY Laboratory in Hamburg.

(Photo Petra Harms)

Below: Retiring DESY Director Volker Soergel (right) receives Germany's Distinguished Service Cross (Verdienstkreuz 1. Klasse des Verdienstordens der Bundesrepublik Deutschland) from Gebhard Ziller of the Ministry of Research and Technology.

(Photo M. Müller)



Parke Rohrer (left), Brookhaven's Associate Director for Management and Physical Plant, receives his Outstanding Contractor Program Manager Award from William Happer, Director of the US Department of Energy's Office of Energy Research. As well as two spells at Brookhaven, Rohrer has contributed to a wide range of DoE projects, having been general manager of the joint venture of architects and engineers that built Fermilab from 1968-74.

Bjorn Wiik becomes DESY Director

On 1 March, Bjorn H. Wiik became Director (more accurately Chairman of the Directorate) of the DESY Laboratory in Hamburg, succeeding Volker Soergel, in office since January 1981.

Born in Norway in 1937, Bjorn Wiik moved to Germany in 1956 for seven years of physics studies. After several years research in the US, he came to DESY in 1972, where he became, with Gustav-Adolf Voss, one of the leaders of the HERA electron-proton collider project. Wiik had long been an advocate of the hitherto untried electron-proton approach, with the apparently structureless electrons probing the parts of protons other beams cannot reach. His was the special responsibility for the superconducting proton ring.

For the future, as well as developing the HERA programme, boosting synchrotron radiation possibilities and overseeing the integration of the Zeuthen institute in former East Berlin, he stresses DESY's continuing and challenging role in the international planning and development work for new accelerators, and sees the decreasing resources available in today's cost-conscious climate as stimulating creativity and new ideas.

Volker Soergel

Volker Soergel's 12-year spell as DESY Director ended on 28 February. For his contributions to the Laboratory in general, and in particular for his role in developing international research collaboration, especially with scientists from Eastern Europe, he was awarded Germany's



Distinguished Service Cross (Verdienstkreuz 1. Klasse des Verdienstordens der Bundesrepublik Deutschland). Soergel now moves to Heidelberg, and becomes a member of Germany's delegation to CERN Council.

On people

After a two-year spell at the SSC Laboratory, Ray Stefanski returns to Fermilab to become Assistant Director, working with Associate Director for Technology Dennis Theriot.

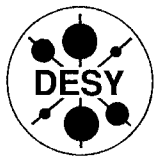
Meetings

A Summer School on QCD Analysis and Phenomenology, organized by the CTEQ Collaboration (Coordinated Theoretical/Experimental Project on Quantitative QCD Phenomenology and Tests of the Standard Model), will be held from July 25-

August 3 in Lake Monroe, Indiana. Jorge G. Morfin of Fermilab is Chairman. Further information from Cynthia M. Sazama, Fermilab MS 122, PO Box 500, Batavia, IL 60510; fax: 708-840-8589; e-Mail: CTEQSCHOOL@FNAL

The 6th European Conference on Integrated Optics, this time with an accompanying Technical Exhibit, claimed to be the first of its kind, takes place in Neuchâtel, Switzerland, from 18-22 April, at the Aula des Jeunes Rives, Espace Louis-Agassiz 1. Further information, fax +41 38 205 580.

An international meeting 'Neutral Currents Twenty Years Later', at the Ministère de la Recherche et de l'Espace, Paris, from 6-9 July will review the 1973 discovery of neutral currents and the current status of all fields of electroweak physics. Further



DESY is one of the leading laboratories in elementary particle physics and synchrotron radiation.

Applications are invited for the position of an

experimental physicist

The candidate is expected

- to take responsibility for a component of the ZEUS detector at the electron-proton accelerator HERA
- to participate in the data analysis
- to take a leading role in the research program of the ZEUS collaboration.

Applicants should have a PhD degree in physics, several years' experience in experimental elementary particle physics and be active in the research in this field. They should have an established record in analysis of particle physics experiments and be able to coordinate the work in close collaboration with the physicists and technicians of the ZEUS experiment.

The appointment will be indefinite with a salary according to federal tariffs (BAT Ib, IIa depending on experience and ability).

Letters of application including C.V., list of publications and the names of three referees should be sent to the personnel department until **30 April 1993**.

DEUTSCHES ELEKTRONEN-SYNCHROTRON DESY

Notkestrasse 85
D - 2000 HAMBURG 52
Tel. 040-8998 3628



EURODAΦNE

POSTDOCTORAL RESEARCH POSITIONS
in Particle Theory

A European Community supported network, EURODAΦNE, expects to support 3 two year postdoctoral positions starting October 1993, to study theoretical issues involved in the physics to be learnt from experiments at DAΦNE, the Φ-factory, presently being constructed at Frascati, Italy.

The areas of study for the 3 positions cover the following topics (at the corresponding centres) :

- CP violation and rare K-decays (Frascati and Roma),
- chiral perturbation theory and its applications (Bern),
- hadron spectroscopy and dynamics (Durham and Rutherford Appleton Laboratory).

The research associates will be based at the centres listed above, but will be encouraged to visit the other institutions of the network in Barcelona, Granada, Napoli, Orsay, Perugia, Thessaloniki, Trieste and Wien. EC rules require the appointees to be citizens of an EC country and to be appointed to a node of the network in a country of which they are neither a citizen nor in which they normally reside.

The gross annual reimbursement of 30-35000 ECUs (based upon age and experience) is intended to cover subsistence, mobility costs and special expenses for the publication of results including participation at scientific meetings.

Please apply by April 15th, 1993, sending c.v., details of recent research, publication list and names of three referees to:

Dr G. Pancheri, Laboratori Nazionali di Frascati, Casella Postale 13, I-00044 Frascati (Roma), Italy, indicating your preferences. Use Express mail or DECNET 39941::PANCHERI or Pancheri@IRMLNF.

Assistant Professor in Accelerator Physics at Stanford Linear Accelerator Center

The Stanford Linear Accelerator Center (SLAC) invites applications for an Assistant Professorship in accelerator physics. This is a tenure-track faculty position at Stanford University. The SLAC accelerator physics program focuses on electron accelerators for high-energy physics research and for synchrotron radiation-based research. Currently it includes:

- 1) improvement of the Stanford Linear Collider,
- 2) development of the NLC, a next-generation linear collider,
- 3) design and construction of PEP-II, a high-current storage ring collider (B-factory),
- 4) development of advanced synchrotron light sources based on storage rings and linacs.

Candidates should have an outstanding research record which encompasses a combination of theoretical and experimental research and shows potential for major accomplishments. The successful applicant is expected to take a leading role in the ongoing activities at SLAC or in related accelerator physics research. Applicants should send a curriculum vitae, a publication list, and the names of three references by June 1, 1993 to: **Professor Robert Siemann, Mail Stop 26, SLAC, Stanford University, Stanford, CA 94309, USA**. *Stanford University is an equal opportunity employer and welcomes applications from women and members of minority groups.*



STOCKHOLM
UNIVERSITY
Department of Physics

Chair in
"THEORETICAL PHYSICS,
especially theory of gravitation and
fundamental interactions"

(ref. number 611-96/93).

Applications should be addressed to

Rektorsämbetet
Stockholms Universitet
Personalenheten
Registrator
S. 106 91 STOCKHOLM
Sweden

and arrive at the latest **May 17, 1993**.

With the application should be submitted :

1. Curriculum Vitae and list of scientific publications.
2. Short written account of scientific and pedagogical activities. From this account it should be clear which investigations, results and other achievements should be primarily considered in the selection procedure in the applicant's own view.

More information on the application procedure including when and where reprints of scientific articles should be sent can be obtained from the administrative officer in charge (Mr. U. Lindgren, phone +46-8-163322, fax +46-8-6125960).



UNIVERSITETET I TRONDHEIM
DEN ALLMENNVIITENSKAPELIGE HØGSKOLEN

Professorship in Theoretical Particle Physics

is vacant at the Department of Physics, College of Arts and Science, University of Trondheim. A main activity in the theory group at the department is in elementary particle physics and astrophysics.

We want to hire a person with a strong background in theoretical particle physics, who can strengthen our activity in CERN-related research. It will be considered an advantage if, in addition, the appointee can support activities in high-energy astrophysics and cosmology.

Applications should include a curriculum vitae and a list of publications, in 6 copies, and be sent to

**Universitetet i Trondheim, AVH,
Personalkontoret, N - 7055 Dragvoll, Norway,**

before May 3, 1993. Please quote reference number 1663 in the application.

Within June 3, 1993 the applicants are furthermore supposed to provide 5 copies of the scientific papers they consider most important. The number of papers sent in should normally not exceed 10. A description of these papers, in six copies, should also be included.

For a more detailed description of the position and further information about the application procedures, interested applicants should contact

**Professor Kjell Mork, Department of Physics,
University of Trondheim, AVH, N-7055 Dragvoll,
Norway.**

**tel.:+47-7-59 18 65. Fax.:+ 47-7-59 18 52
e-mail:kjell mork@avh.unit.no.**

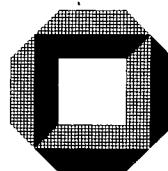
Associate Research Scientist Position At Yale University

Applications are invited for two Associate Research Scientist positions in Particle Physics at Yale University:

- 1) Precision measurements of the anomalous g-value of the muon at Brookhaven National Laboratory. Primary responsibility for data acquisition and the electron calorimeter. Also responsibility for precision magnetic field muon storage ring. Also will be involved in developing the shower maximum detector for the SDC experiment at the SSC.
- 2) The new SMC experiment at CERN to measure the spin dependent structure functions of the proton and neutron through deep inelastic scattering of polarized muons by polarized protons and deuterons in a hydrocarbon target is in progress. The fundamental Bjorken sum rule will be tested and the results will be important for understanding the internal spin structures of the proton and neutron. Experimental checkout and initial data-taking took place in 1991 and 1992. Additional major developments and data-taking are planned through 1993 and 1995.

Appointments are for one year, renewable, and are to be made at the earliest possible date. Interested candidates should send a curriculum vita and publication list and arrange to have three recommendation letters sent to either: Dr. Vernon W. Hughes or Professor Priscilla Cushman, Department of Physics, Yale University, 4th floor J.W. Gibbs, P.O. Box 6666, New Haven, CT 06511, USA.

Yale is an affirmative action/equal opportunity employer.



UNIVERSITÄT
KARLSRUHE

An der Fakultät für Physik ist eine

Professur (C3) für Theoretische Physik

wiederzubesetzen.

Gesucht werden Bewerberinnen und Bewerber mit dem Arbeitsgebiet Theorie der Elementarteilchen und Relativistische Quantenfeldtheorie. Vorausgesetzt werden Habilitation oder gleichwertige wissenschaftliche Leistungen sowie Lehrerfahrung.

Die Fakultät für Physik mit ihren beiden Schwerpunkten Festkörperphysik sowie Kern- und Teilchenphysik bietet vielfältige Möglichkeiten zur Zusammenarbeit, insbesondere mit bestehenden Gruppen der theoretischen und experimentellen Elementarteilchenphysik.

Die Universität Karlsruhe strebt die Erhöhung des Anteils der Frauen im Personalbereich an und fordert deshalb entsprechend qualifizierte Frauen nachdrücklich auf, sich zu bewerben.

Bewerbungen und Unterlagen über die bisherige Forschungs- und Lehrtätigkeit sowie Sonderdrucke der wichtigsten Publikationen werden bis zum **26. April 1993** erbeten an den Dekan der Fakultät für Physik, Universität Karlsruhe (TH), Postfach **69 80**, 7500 Karlsruhe 1.

UNIVERSITY OF OXFORD
in association with Somerville College
 University Lecturership in
EXPERIMENTAL PARTICLE PHYSICS

Applications are invited for the above post which commences 1 October 1993. Stipend according to age on the scale £ 13,400 to £ 26,407 per annum. The successful candidate may be offered a tutorial fellowship by Somerville College, for which additional emoluments would be available. Further particulars (containing details of the duties and full range of emoluments and allowances attaching to both the university and the college posts) may be obtained from Prof. R.J. Cashmore, Particle and Nuclear Physics, Keble Road, Oxford OX1 3RH.

The present experimental research programme of the Particle and Nuclear Physics Laboratory includes the DELPHI experiment at LEP (CERN) and ZEUS experiment at HERA (DESY); the SOUDAN 2 experiment; the Sudbury Neutrino Observatory project; the development of cryogenic detectors and preparations for high energy pp physics. The Department would expect the appointee to participate in some of the above programme, or possibly develop new initiatives associated with future accelerator or other project. Applications (eight copies except in the case of overseas candidates when only one is required) should be sent to arrive no later than 7 May 1993. These should include a curriculum vitae, list of publications, a statement of research interests and teaching experience and the names of three referees. Referees should be asked to send references direct to Prof. Cashmore to arrive by the above date.

Shortlisted candidates will be interviewed in Oxford on 10th and 11th June 1993. All applicants are asked to indicate a telex, fax, email or telephone number where they can be contacted during the period 21st May to 2nd June.

The University is an Equal Opportunity Employer



Das Deutsche Elektronen-Synchrotron DESY ist ein Zentrum der physikalischen Grundlagenforschung mit etwa 1.400 Mitarbeitern und ca. 1.000 in- und ausländischen Gästen. Wir suchen für unsere Abt. "Hochfrequenz-technik" eine(n)

WISSENSCHAFTLICHE(N)MITARBEITER(IN)

- Dipl.-Ing.(in) - Fachrichtung Elektrotechnik oder Physik

für Betrieb und betriebsnahe Weiterentwicklung der umfangreichen Hochfrequenz-Anlagen in den Elektronen- und Protonenbeschleunigern bzw. Speicherringen von DESY; dazu Studien- und Projektierungsaufgaben für mögliche zukünftige Projekte. Es handelt sich um umfangreiche Anlagen mit Teilchenbeschleunigungsstrecken (Hohlraumresonatoren), Hohlleitersystemen zur Leistungsverteilung und Senderanlagen (gepulst wie auch Dauerstrich) im Megawattbereich bei Frequenzen zwischen 3 MHz und 3000 MHz; hierzu gehören ferner umfangreiche weitgehend prozessorientierte Mess-, Steuer- und Regeleinrichtungen.

Wir erwarten ein abgeschlossenes Hochschulstudium der Elektromikrowellentechnik oder Physik; Promotion erwünscht sowie möglichst mehrjährige einschlägige Berufserfahrung aus Industrie oder Forschungslabors.

Wenn Sie gern in der aufgeschlossenen Atmosphäre eines modernen Forschungsinstitutes arbeiten möchten, bitten wir um Ihre schriftliche Bewerbung mit Angaben des frühesten Einstellungstermins und Referenzen an unsere Personalabteilung bis zum 17. April 1993.

Die Bezahlung und unsere sozialen Leistungen entsprechen denen des öffentlichen Dienstes.

Schwerbehinderte werden bei gleicher Eignung bevorzugt berücksichtigt.

DEUTSCHES ELEKTRONEN-SYNCHROTRON DESY,
 Notkestr. 85, 2000 HAMBURG 52. Tel.-Nr. 040 89 98 36 28.

The EISCAT Scientific Association performs ionospheric research with incoherent scatter radar systems operated in northern Norway, Finland and Sweden. As an important step in the evolution of the EISCAT Scientific Association a new radar station, the EISCAT Svalbard Radar (ESR), will be built on the island of Spitsbergen in the Svalbard Archipelago north of Norway.

For the construction of the EISCAT Svalbard Radar instrumentation, a

System Integration Engineer

will be installed. This engineer will assist the Radar Project Engineer in technical matters and conduct and supervise digital engineering as well as the interfacing of digital and analogue instrumentation of the ESR system, work on the acquisition of auxiliary subsystems, specification and execution of test procedures, the implementation of monitoring and control systems and the integration, tests and quality control of the ESR system to be installed on Svalbard.

A highly qualified and well motivated individual, possessing a degree in electronic engineering, computer engineering or technical physics as well as practical knowledge of digital and analogue instrumentation is required. Familiarity with modern system software design is important and practical knowledge of RF engineering is desirable. The successful candidate should be prepared to be substantially involved in the practical construction of the radar system. An ability to communicate effectively in spoken and written English is essential. The system integration engineer will initially work at the EISCAT site in Tromsø, Norway, but must also be willing to spend considerable time at the Svalbard site during the system implementation and tests.

This position will be available for a period of four years through the entire construction, implementation, test and initial operation phase of the EISCAT Svalbard Radar. The salary will depend on qualifications and experience and will follow the corresponding Scandinavian scales.

More information on the EISCAT Scientific Association and a detailed description of the EISCAT Svalbard Radar can be obtained from The Director, EISCAT Headquarters, P.O. Box 812, S-981 28 Kiruna, Sweden (Tel. +46-980-79153. Fax +46-980-79161). Applications should be sent to the same address by 30 April 1993.

READER SERVICE FORM
CERN COURIER

APRIL 1993

Please send information on items circled:

6	6a	9	13	15	16	17b	19	22	24
26	27	34	41	45	52	53	54	55	56
57	58	59	60	61	62				

Please send to:

Judy Pray, **CERN COURIER**
 Gordon & Breach Science Publishers
 820 Town Center Drive
 Langhorne, PA 19 047
 USA

Name _____	Title _____	
Employer _____	Dept. _____	
Address _____		
City _____	State _____	Zip _____
Telephone () _____		Country _____

On 18 January, a 'Festkolloquium' at the Hamburg DESY Laboratory marked the 60th birthday of theoretician Gustav Kramer, well known for his contributions to jet studies and heavy flavour transitions.



Magnetic field computation specialist C.W. ('Bill') Trowbridge, Chairman of Vector Fields and formerly of the Rutherford Appleton Laboratory, receives the UK's OBE award.



Departmento di Scienze Fisiche, Naples. The dates are 29th April to 5th May.

information - Ung Nguyen Khac, NC93, Ecole Polytechnique, 91128 Palaiseau cedex, France, email NC93@FRCPN11

CERN Accelerator School

The Fifth Advanced CERN Accelerator School will be held on the Island of Rhodes from 20th September until 1 October. The course, which complements the General School held in 1992, will mainly be of interest to staff in accelerator laboratories, university departments and companies specializing in the equipment for particle accelerators. It requires a knowledge, up to first degree level, of physics, mathematics or engineering. The course is being organised with the help of the University of Athens and N.C.S.R. Demokritos. Details and application forms are now available by e-mail (CASRHO@CERNVM.CERN.CH), by fax (+41 22 782 4836) or by writing to Mrs. S. von Wartburg, CERN Accelerator School, CH-1211 Geneva 23. (Please ignore a later date mentioned in an earlier issue).

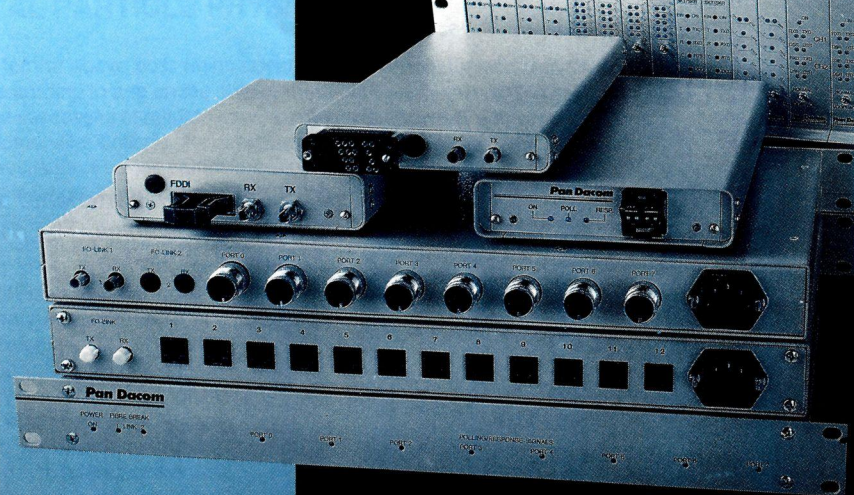
Meanwhile the next CERN Accelerator School will be in Capri on the subject of Radio Frequency Engineering. This is organized with the help of INFN Frascati and Naples together with the Universita degli Studi di Napoli, Federico II,



12 April marks the 80th birthday of Venedikt Dzhelepov, now Honorary Director of the Joint Institute for Nuclear Research, Dubna.

Fibre Optic

Multimode - Singlemode



We support following interfaces:

- X.21/RS 422
- V.35
- V.36/RS 449
- G.703
- RS 423
- RS 485
- V.24/RS 232
- 20 mA
- Twinax/ICS
- Coax
- Ethernet
- Token Ring

- Transceivers/Repeaters up to 16 Mbps for different interfaces
- Multiplexers up to 32 channels modular 19"-racks
- Networks ring or trunk networks for various computer systems
- Converters from Multimode to Singlemode, FDDI-, ST- or SMA-connectors

Pan Dacom

Pan Dacom Telekommunikation GmbH
 Fasanenweg 25 • D-2000 Hamburg 73 • Germany
 Phone: +4940-644 09 71 Fax: +4940-644 57 92

45 Circle advertisement number on reader service form



lannoo

Your partner for a full service:
 prepress – printing – binding –
 distribution

LANNOO PRINTERS
 Kasteelstraat 97, B-8700 Tielt-Belgium
 Tel. 32 51 42 42 11 - Fax 32 51 40 70 70

Graphical Programming for Instrumentation

LabVIEW® for Windows



LabVIEW for Sun

LabVIEW for Macintosh

Multiplatform

- Create virtual instruments instead of writing programs
- Build intuitive, interactive front panels
- Build block diagram programs
- Acquisition – DAQ, GPIB, RS-232, VXI
- Analysis – DSP, filters, statistics
- Presentation – GUI, hardcopy, file I/O

Available for

NEW Microsoft Windows

NEW Sun SPARCstation

Apple Macintosh



Call for a FREE demo disk (512) 794-0100



Corporate Headquarters

6504 Bridge Point Parkway

Austin, TX 78730-5039

Tel: (512) 794-0100

Fax: (512) 794-8411

Branch Offices

Australia 03 879 9422

Belgium 02 757 00 20

Canada 519 622 9310

Denmark 45 76 73 22

Finland 90 527 2321

France 1 48 65 33 70

Germany 089 7 14 50 93

Italy 02 48301892

Japan 03 3788 1921

Netherlands 01720 45761

Norway 03 846866

Spain 91 896 0675

Sweden 08 984970

Switzerland 056 27 00 20

U.K. 0635 523545

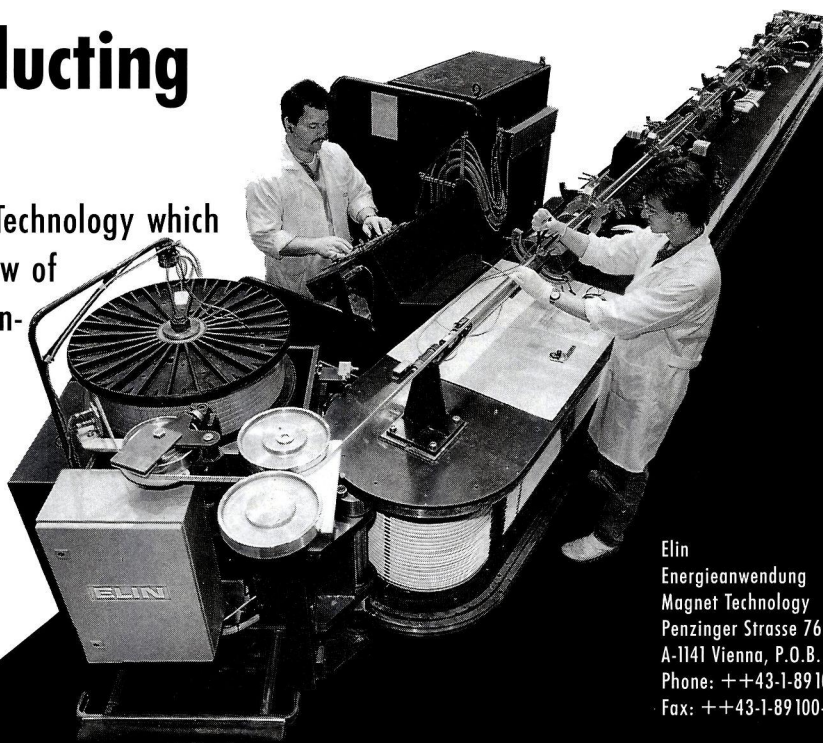
© Copyright 1993 National Instruments Corporation. All rights reserved.
Product and company names listed are trademarks or trade names of their
respective companies.

22 Circle advertisement number on reader service form

ELIN

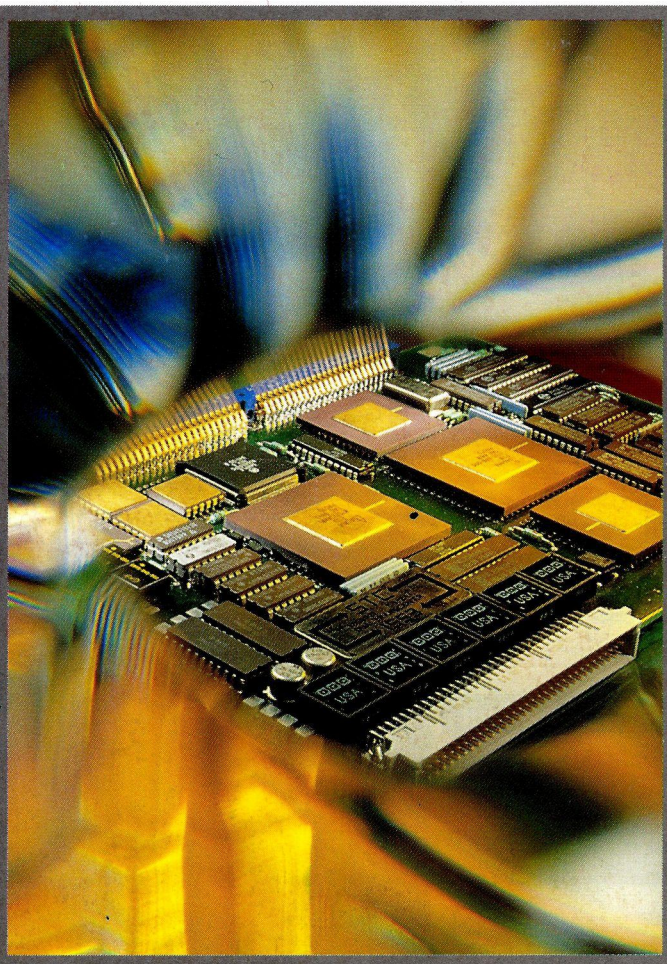
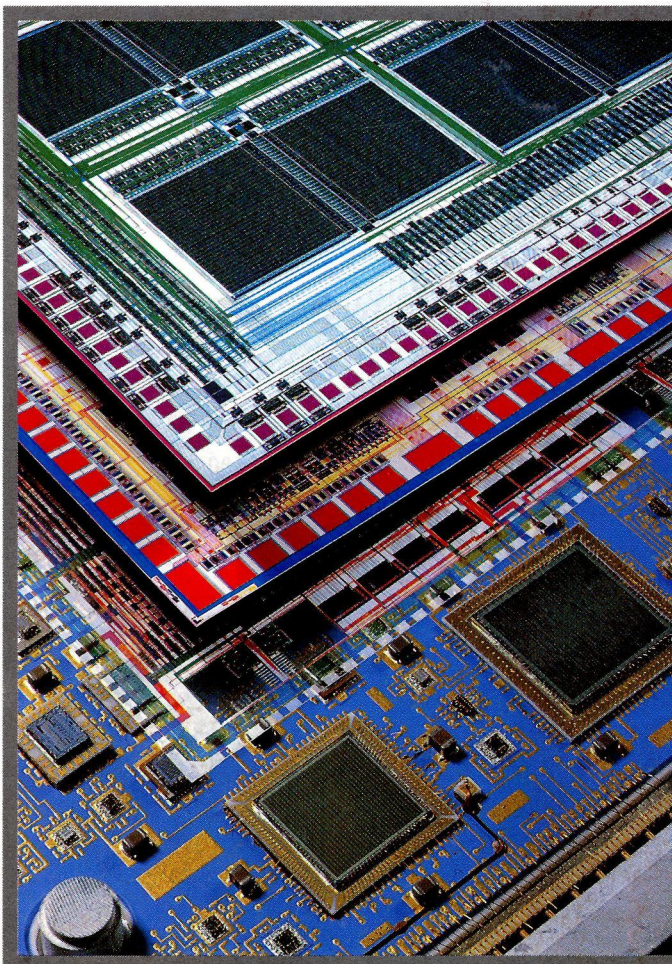
Superconducting Magnets

from the Elin Magnet Technology which combines the Know-How of manufacturing superconducting magnets with the associated tooling (e. g. winding machines, curing presses).



Elin
Energieanwendung
Magnet Technology
Penzinger Strasse 76
A-1141 Vienna, P.O.B. 5
Phone: ++43-1-89 100-39 55
Fax: ++43-1-89 100-154

Elargir le champ du possible



DASSAULT ELECTRONIQUE réunit l'ensemble des compétences indispensables à la conception des composants et circuits de demain.

Ses spécialistes proposent leur savoir-faire dans sept pôles d'excellence :

- Conception d'ASICs
- Conception de MCMs (multichip modules)
- Conception de MMICs
- Conception de sous-ensembles hyperfréquences
- Antennes
- Packaging
- Outils de CAO

Pour réaliser vos projets, de la conception à la production, DASSAULT ELECTRONIQUE est votre partenaire.

Contact :

Direction commerciale des activités industrielles
33 (1) 34 81 70 44

NOS DOMAINES D'EXCELLENCE

DASSAULT ELECTRONIQUE conçoit, développe et produit des équipements faisant appel aux technologies et techniques d'avant-garde : micro-électronique monolithiques, circuits hybrides, hyperfréquences, intelligence artificielle, systèmes experts, neuromimétique dans les domaines suivants :

Défense : Autodirecteurs pour missiles • Radars • Systèmes de guerre électronique • Calculateurs et systèmes de transmission de données numériques • Systèmes de commandement • Moyens d'essais • Logiciels.

Civil : Ingénierie • Logiciels.

Espace : Systèmes de télécommunications par satellites pour l'aviation • Localisation et collecte de données par satellite.

DASSAULT AUTOMATISMES ET TELECOMMUNICATIONS :

(Filiale de Dassault Electronique) Automates bancaires • Terminals financiers • Monétique • Contrôle et distribution de titres de transport • Systèmes informatiques • Télécommunications.



DASSAULT ELECTRONIQUE

55, quai Marcel Dassault, 92214 Saint-Cloud - France - Tél. 33 (1) 49 11 80 00 - Fax 33 (1) 46 02 57 58