

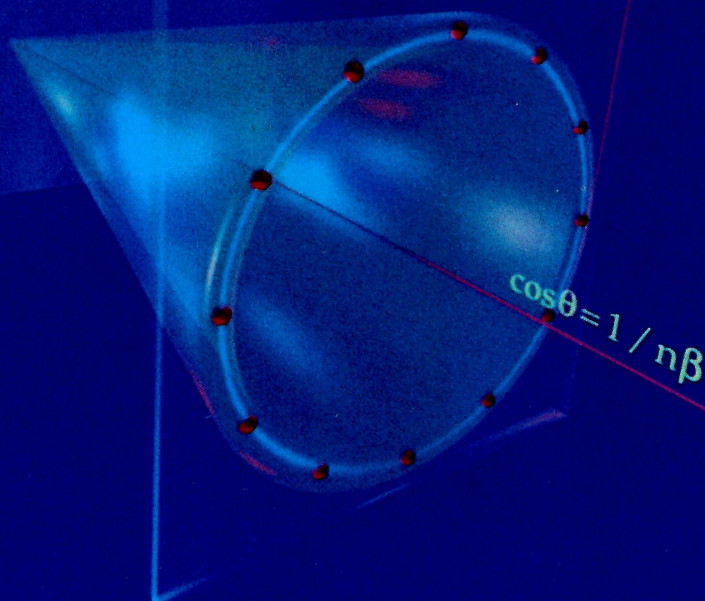
CERN COURIER

INTERNATIONAL JOURNAL OF HIGH ENERGY PHYSICS

VOLUME 34



JANUARY/FEBRUARY 1994



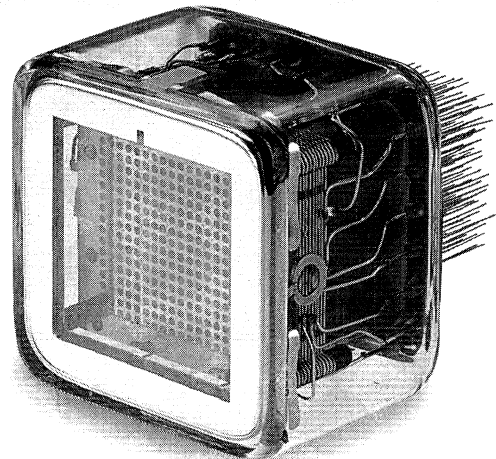
HAMAMATSU

For expanded SCIFI tracking,
Hamamatsu's Multi-Anode
PMTs are the key.

256ch

256-Channel readout.

Hamamatsu's Multi-Anode PMTs with 256-channel readout not only dramatically extend the conditions for SCIFI tracking and calorimeter measurement, they operate with 2 percent or less crosstalk. This ensures high performance and reliability in addition to decisive SCIFI readout. For detailed information on 256-Channel Multi-Anode 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

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 or Kerstin Techritz
DESY, Notkestr. 85, 22603 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 34
No. 1
January/February
1994

CERN COURIER

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 Bridging the centuries
CERN's LHC set to propel physics into the next millenium

Around the Laboratories

6 CERN: Preparing for LEP200/The first CLIC
Two scenarios for higher electron-positron collision energies

7 FERMILAB: Call for physics
New proposals invited for Main Injector

9 SUPERCOLLIDER: Going international

9 KEK/NAGOYA/SLAC: Highly polarized electrons

12 STANFORD (SLAC): Photon theory verified after 40 years

13 BROOKHAVEN: HERA helps RHIC

13 DESY: QCD workshop

16 PSI: Very slow polarized muons

17 GANIL: INDRA and the hot nuclei

18 CERN Accelerator School

Physics monitor

19 Against the grain
Explaining the higgs particle

20 New computing techniques for physics research

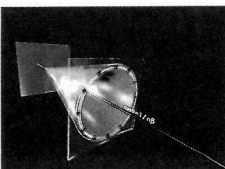
22 Elastic scattering: How goes the Odderon ?

22 RICH people: Exploiting Cherenkov radiation

Industry and spinoff

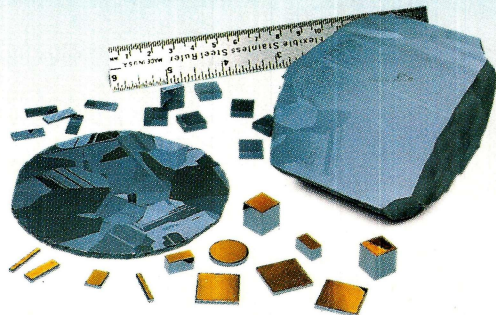
25 CERN: ESPRIT de corps
European programmes for applied data processing

28 People and things



Cover photograph: When high energy particles travel through a transparent substance faster than the 'allowed' velocity of light, so-called Cherenkov radiation is emitted at an angle depending on the particle velocity, in much the same as a shock wave accompanies supersonic aircraft. Knowing the momentum of the particle by magnetic tracking, and measuring the Cherenkov angle of the emitted photons, the mass can be measured in a momentum range where no other technique is so useful. Recent advances in this Ring Imaging Cherenkov (RICH) approach are described on page 22.

CdTe/CdZnTe ROOM TEMPERATURE SEMICONDUCTOR RADIATION DETECTORS



CdZnTe...A Breakthrough In Sizes

eV PRODUCTS announces the availability of High Pressure Bridgman grown CdZnTe in a wider range of sizes than previously offered. Grown in state of the art furnaces at our facility in Saxonburg, PA, the latest developments allow us to fabricate detectors up to 4 cm² in area, up to 1 cm thick, which provide good resolution and count rate capability. Already a leader in the field of low noise hybrid electronics, eV PRODUCTS is committed to the development and production of reliable, low cost, high quality CdZnTe for radiation detection and measurement.

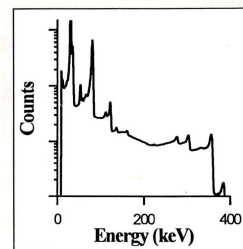


375 Saxonburg Blvd.
Saxonburg, PA 16056 USA

PHONE
1(412) 352-5288

FAX
1(412) 352-4980

- High efficiency, room temperature operation
- Low cost, high performance
- Wide range of mounting styles available
- Low bias field requirement (50-1000 V. cm⁻¹)
- Good energy resolution up to 137Cs (662 keV)

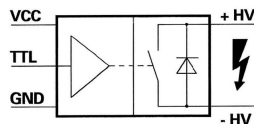


Call or fax us today for more details and specifications.

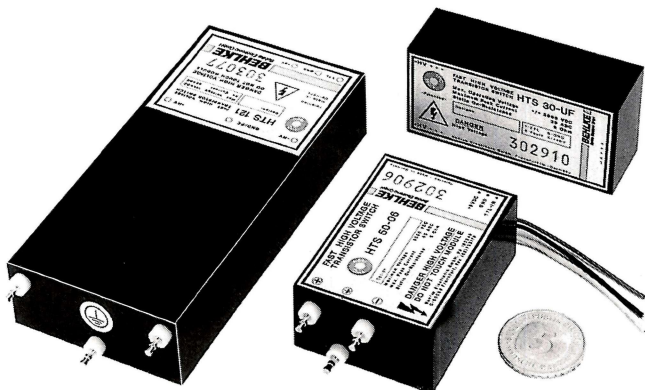
FAST HIGH VOLTAGE TRANSISTOR SWITCHES

Model Series HTS

- Voltages up to 65 kVDC
- Peak currents up to 5 kA
- Nanoseconds rise time
- TTL control input



For applications in laser, radar and EMC technology as well as for scientific instruments.



P.O.Box 190249 • D - 60089 Frankfurt, Germany
Phone +49 (69) 733215 • Fax +49 (69) 733179

BEHLKE
Behlke Electronic GmbH

Please ask for our catalogue!

Advertisements in CERN COURIER

Format A4

Monthly publication

All advertisements are published in both English and French editions. Second language versions accepted without extra charge.

Space (page)	Actual size (mm) width by height	Cost per insertion (Swiss Francs)			
		1 insertion	3 insertions	5 insertions	10 insertions
1/1	185 x 265	1980	1900	1830	1730
1/2	185 x 130	1170	1100	1040	960
1/4	90 x 130	690	630	590	550

These prices include no entitlement to special placing.

Supplement for:

— one additional colour 1500 SwF

— 1/2 page 900 SwF

— Covers:

Covers 2 and 3 (one colour) 2000 SwF

Cover 4 (one colour) 2500 SwF

Publication date 1st of month of cover date

Closing date for positive films and copy 1st of month preceding cover date

The cost of making films and of translation for advertisements are charged in addition.

Screen (offset) 60 or 54 Swiss (150 English)
Advertisements cancelled after 1st of month preceding cover date will be invoiced.

These rates are effective for the year 1994.

Inquiries for Europe:

Micheline FALCIOLA / CERN COURIER – CERN

CH-1211 Geneva 23 Switzerland

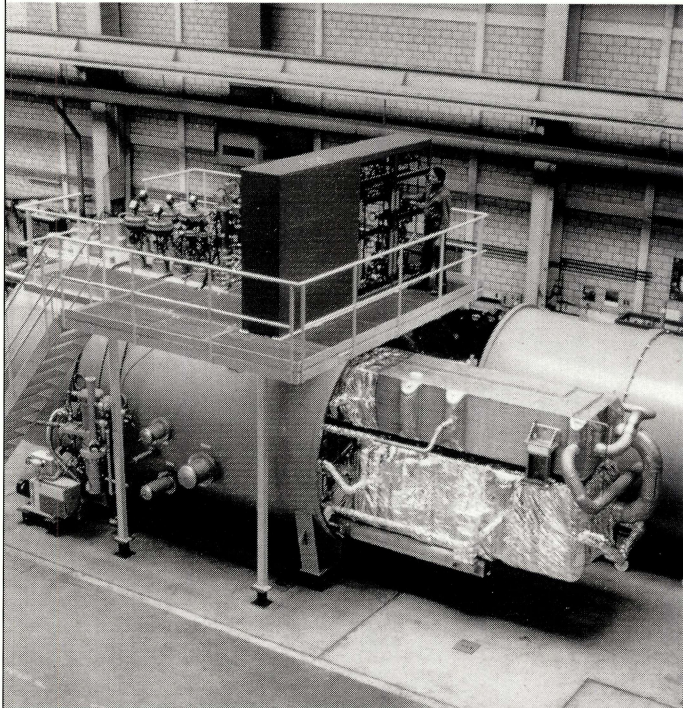
Telephone: 022/767 41 03

Telex 419 000 CER CH

Telefax 022/782 19 06

Inquiries for the rest of the world: please see page III.

Dependable Cryogenics



A 12 kW 4.5 K refrigerator for the LEP cavities – one of the 33 cryogenic plants supplied to CERN by Linde.

Engineering, contracting, after-sales service and manufacturing facilities in Germany, Great Britain, Switzerland and the USA.

Linde
your partner in cryogenics

LINDE AG
Werksgruppe Verfahrenstechnik und Anlagenbau
Dr.-Carl-von-Linde-Str. 6 – 14
82049 Höllriegelskreuth
Germany
Tel. (089) 7445-0
Fax (089) 7445-4929

LINDE KRYOTECHNIK AG
Dättlikonerstrasse 5
8422 Pfungen
Switzerland
Tel. (052) 31 05 55
Fax (052) 31 05 50

LINDE CRYOGENICS LTD.
Blackwater Way
Aldershot
Hampshire GU 12 4 DR
Great Britain
Tel. (0252) 331351
Fax (0252) 343062

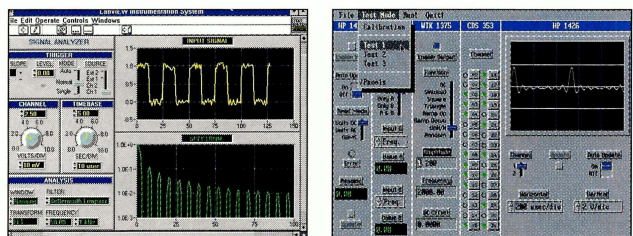
LOTEPRO CORPORATION
Mount Pleasant Corporate Center
115 Stevens Avenue
Valhalla, New York 10595
USA
Tel. (914) 747 3500
Fax (914) 747 3422



Multivendor VXI – We Make It Work

We're building the software standards that make multivendor VXI systems a reality. And we're not just talking about our industry-leading LabVIEW® and LabWindows® software. We're also talking about our NI-VXI™ software, which works across platforms with languages like C, BASIC, ATLAS, and ADA.

Sure, we offer state-of-the-art VXI controllers like our 66 MHz 486DX2 embedded PC. And yes, we invented MXIbus to bring embedded VXI performance to desktop computers. But our finest VXI technology is our software. It's what sets us apart and keeps your system open.



Call for a **FREE** VXI brochure.

To make VXI work for you,
call (512) 794-0100.

NATIONAL INSTRUMENTS®
The Software is the Instrument®

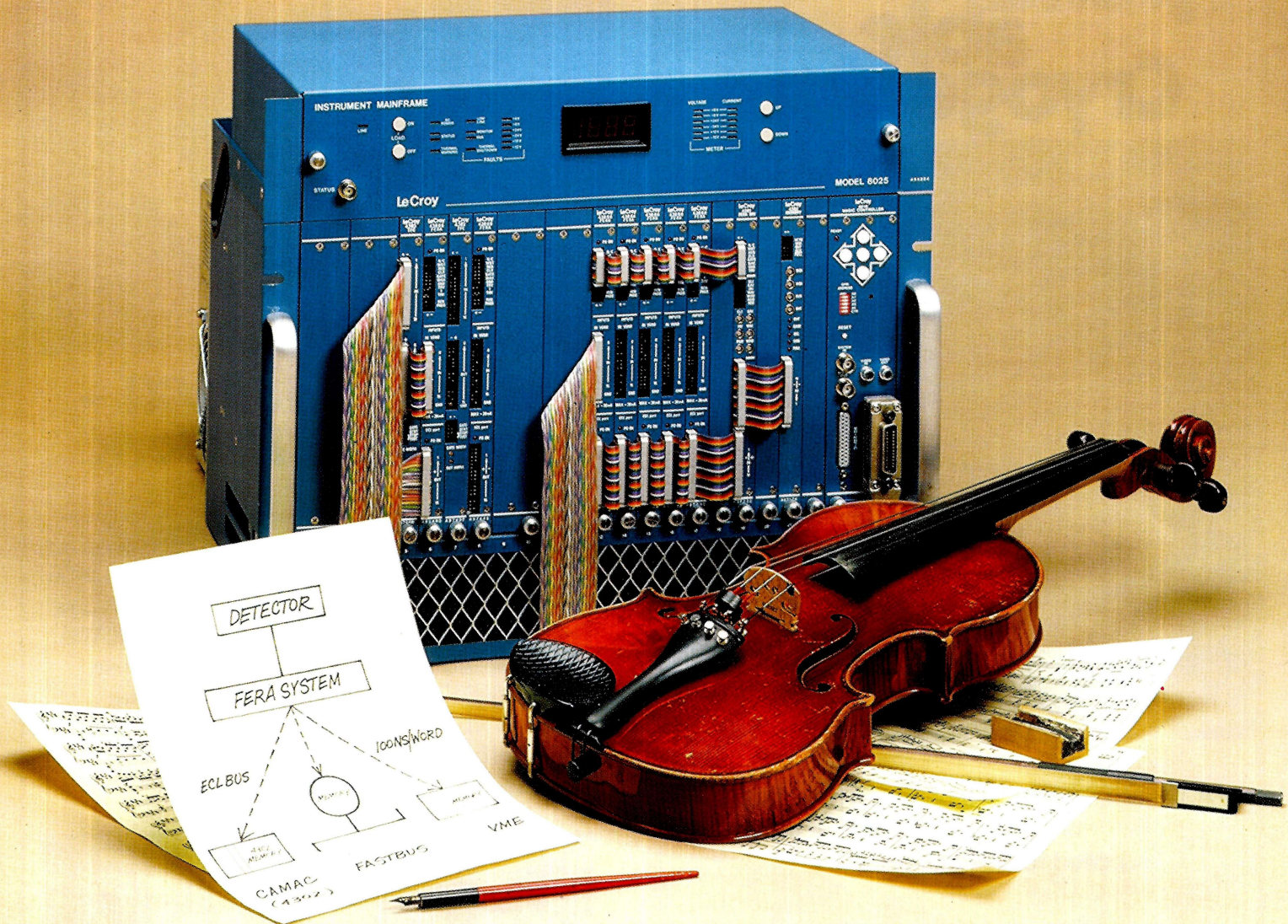
6504 Bridge Point Parkway
Austin, TX 78730-5039
Tel: (512) 794-0100
Fax: (512) 794-8411

See us at the **MACWORLD Expo in Sweden**

Branch Offices: Australia 03 879 9422 • Austria 0662 435986 • Belgium 02 757 00 20 • Canada 519 622 9310
Denmark 45 76 26 00 • Finland 90 527 2321 • France 1 48 65 33 70 • Germany 089 714 50 93 • Italy 02 48301892
Japan 03 3788 1921 • Netherlands 01720 45761 • Norway 32 848400 • Spain 91 640 0085
Sweden 08 730 49 70 • 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.

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

Bridging the centuries

CERN's LHC set to propel physics into the next millenium

A hundred years ago, a series of scientific discoveries in Europe by individual researchers working with modest means went on to revolutionize our view of the world. At the end of the 20th century, Europe is poised once more to propel the quest to understand the innermost structure of matter into a new era of discovery.

Because this science has made such great strides forward, the springboard this time is on a very different scale. Rather than table-top experiments in back-room laboratories, frontier advances need large machines whose planning is measured in decades, requiring resources far beyond those of individual countries, or even continents.

After the ravages of World War II, CERN was established in 1954 to set European physics back on track. At first hesitantly, slavishly following other ideas, front-line machines were designed and built. More difficult was the exploitation of these machines, designing imaginative experiments to consolidate a foothold on new scientific territory.

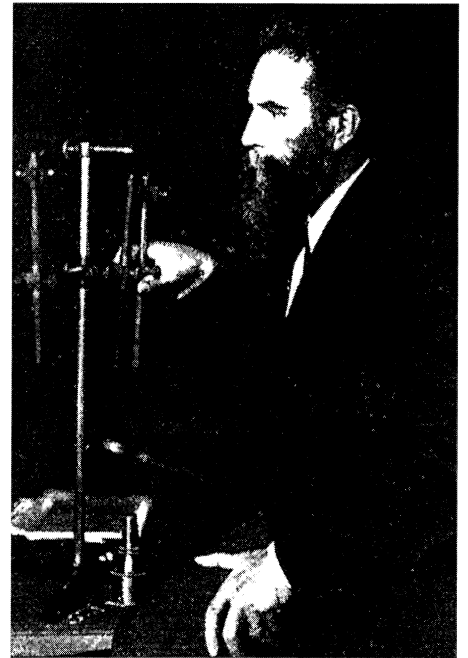
With skills difficult to master and confidence building slowly, success did not come overnight. But in the 1980s the SPS proton-antiproton collider and then in the 1990s the LEP electron-positron collider shifted the focus of this research from one side of the Atlantic to the other.

For the next step, CERN has planned the LHC proton-proton collider for the 27-kilometre LEP tunnel (December 1993, page 6). LHC will be the major physics focus for the beginning of the 21st century, attacking the next clearly defined frontier in the search for the ultimate structure of matter which began in earnest one hundred years ago.

A vital century

In Germany in 1895 Wilhelm Röntgen's discovery of X-rays was the spark that kindled an intellectual inferno. Working on routine investigations of cathode rays along lines suggested by Philipp Lenard, Röntgen stumbled across a new effect. Unfazed, he systematically

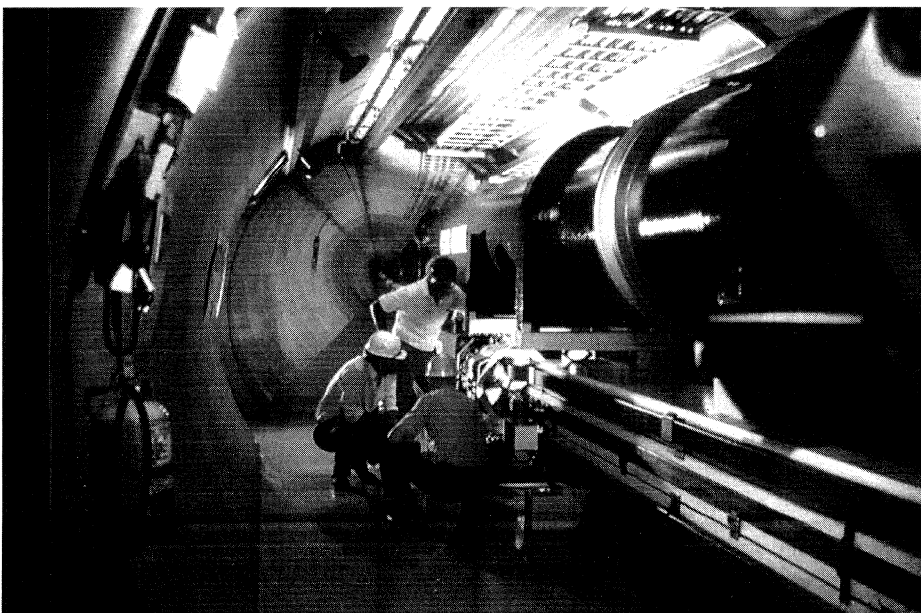
One hundred years ago, the discovery of X-rays by Wilhelm Röntgen set physics on a new road of discovery for the 20th century.



investigated the new radiation, showing how it penetrated matter. Normally a retiring man, Röntgen boldly decided to mail the news of his discovery all over Europe.

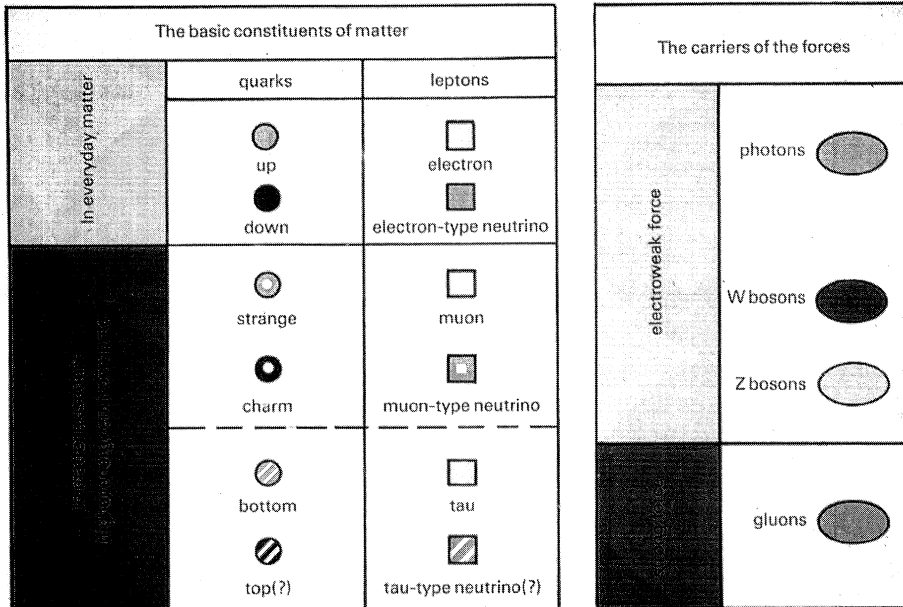
X-rays soon hit the headlines. After reading the news, Henri Becquerel in France extended his studies of fluorescence and discovered radioactivity. Meanwhile the cathode ray mystery was solved in 1897 when J.J. Thomson in the UK unveiled the electron. The following year in J.J. Thomson's Cambridge laboratory, a young researcher named Ernest Rutherford found that radioactivity came in different kinds.

To explain these puzzling new phenomena needed bold new ideas. Max Planck's embryonic quantum proposal in 1900 set the scene for Albert Einstein's explanation of the



The LHC proton collider project for CERN's 27-kilometre LEP tunnel aims for the physics of the 21st century. 'LHC is now ready for approval,' affirms CERN's new Director General, Christopher Llewellyn Smith.

In the 'Standard Model', six types of strongly interacting quarks and six types of weakly interacting leptons are grouped into three quark-lepton generations. After several years of intense scrutiny by LEP experiments, no inconsistency has been found in this dual picture which puts the strong and weak interactions alongside each other without actually unifying them.



photoelectric effect in 1903 and the realization that Nature works differently on a microscopic scale.

In 1911 Rutherford found the nuclear atom, while Niels Bohr showed how elementary quantum ideas helped understand the electronic structure of matter.

(The dramatic saga of 20th century progress in fundamental physics and the accompanying advances in understanding have been told many times, notably in a new CERN brochure 'The Next Step', introducing the physics of the LHC proton-proton collider - see page 4.)

The outcome of this century of patient investigation is handily packaged as the 'Standard Model'. Six types of strongly interacting quarks and six types of weakly interacting leptons are grouped into three quark-lepton generations. After several years of intense scrutiny by LEP experiments, no inconsistency has been found in this dual picture which uneasily harnesses the strong and weak interactions together without actually unifying them.

The Standard Model cannot be the

end of the story. Why are there only six quarks and leptons? Why do the quarks and leptons group together in the way they do? What gives them their masses? How are the strong and weak sectors connected?

In the Standard Model, particle masses come from an underlying field in the vacuum itself. This 'higgs' field (see page 19) is the source of subtle symmetry breaking, giving the vacuum a preferred direction, so that the photons of electromagnetism are massless, while its electroweak companions - the W and Z carriers of the weak force - are the heaviest particles known.

To explore this mechanism could need energies of around 1 TeV (1000 GeV) at the quark level, demanding in turn that the colliding protons containing the quarks have to approach 10 TeV. This sets the LHC energy scale.

With quarks imprisoned inside protons there is no sharp energy threshold. The proton constituents have a range of energies, and in order to be sure of reaching the highest energy quark collisions, the

collision rate (luminosity) of the collider has to be pushed as high as possible.

Using CERN's unique chain of interlinked accelerators as its injector, the LHC is an extremely cost-effective way of attacking these important physics goals.

One hundred years after the discovery of X-rays, Europe is once again the focus of fundamental physics. This time cathode rays have given place to CERN's LEP electron-positron collider and embryonic quantum theory to the incomplete Standard Model.

Around the turn of the century, its front-line work done, LEP will step down and leave the stage for the LHC proton collider to be built in the 27-kilometre LEP tunnel. One hundred years after Rutherford, LHC will be the centrepiece of 21st century physics.

Pushing for LHC

LHC has been part of CERN's planning for 15 years. Even before the drawing board stage, the far-sighted John Adams noted in 1977 that the tunnel for a future large electron-positron (LEP) collider should also be big enough to accommodate another ring of magnets.

'After a decade of workshops and reviews, LHC is ready for approval,' affirms CERN's new Director General, Christopher Llewellyn Smith. 'We need a decision soon to work towards physics in 2003.'

This early approval is vital to sustain LHC momentum for the physicists and engineers and for industrial partners, and to ensure prudent planning and optimal use of resources. It is also vital for a new phase of negotiations with non-Member States.

Pushing for LHC. Director General of CERN since 1989, Carlo Rubbia (right) handed over on 1 January to Christopher Llewellyn Smith (left).

Established by 12 West European nations in 1954, CERN quickly attracted scientists from further afield. The number of Member States has since grown to 19, while users from other countries currently make up about a quarter of the total number of researchers at the Geneva Laboratory.

With the demise of the US Superconducting Supercollider (SSC) project (December 1993, page 1), international interest from beyond the framework of CERN Member States in CERN's research programme now gets an additional boost.

To accommodate ex-SSC researchers in the LHC experimental programme and to capitalize on valuable SSC groundwork, the deadlines for submitting full technical proposals for LHC experiments have been deferred by several months. Initial discussions in December suggested that at least 500 additional researchers could join the LHC programme. This potential influx includes sizable contingents from other nations (Japan, Russia, China, Canada, India, Korea,...) as well as the US.

However the broad guidelines of the initial LHC experimental programme (December 1993, page 6) remain unaltered - two major proton-proton collision experiments (ATLAS and CMS), the ALICE heavy ion study, and a dedicated experiment to look at B particles containing the fifth ('beauty') quark. Other interest areas could be added.

Building a machine costing some 2230 million Swiss francs in a few years by a Laboratory whose constant annual budget is of the order of 1000 million Swiss francs clearly calls for some financial goodwill and/or gymnastics. LHC contributions could come in hardware, manpower and resources as well as hard cash.

While European countries have a



natural status in a European organization whose budget is voted by its Member States, non-European states are on a different footing. For example recent CERN protocols drawn up with Russia and with Israel cover additional contributions, mostly in kind. The HERA electron-proton collider at the DESY Laboratory in Hamburg showed how international partners could make major hardware contributions for a new research facility.

International guidelines of some 15 years standing have stipulated that access to major facilities should be open to all, on scientific merit. However at the time these guidelines were written, there was a fairly widespread range of world class facilities, so that scientific migrations tended to even out. Now the world scene looks very different.

After intensive discussions at its December meeting, CERN's governing body, Council, wishes to move to a decision on LHC in the first half of 1994 with the machine as part of the

basic programme of the Laboratory.

Council President Sir William Mitchell (UK) said Council 'is conscious of, and welcomes, the world interest in the (LHC) project and encourages CERN to report back in March on the modes of involvement of non-Member States. Council wishes that such involvement should be on the understanding that usage on a significant scale must involve the provision of resources to suit both CERN and the non-Member States concerned. These and other options of funding will be presented for further discussion in March 1994.'

(For 1994, Hubert Curien of France takes over from Sir William Mitchell as President of CERN Council.)

LHC External Review Committee

An LHC External Review Committee, chaired by R. Aymar, Director of Materials Science of the French Atomic Energy Commission, reported its findings in December.

The Next Step

A special 48-page colour brochure, 'The Next Step', explaining LHC's objectives is available in English, French, German, Italian and Spanish versions. Please write to Sylvette Stillebacher, Publications Section, CERN, 1211 Geneva 23, Switzerland.

While acknowledging that the LHC R&D programme has not reached the end of the road, the committee concluded:

- The LHC baseline design with 7 GeV proton beams and a luminosity of $10^{34}\text{cm}^{-2}\text{s}^{-1}$ is reasonable and realistic;
 - Two-in-one magnets and superfluid helium cooling are the only appropriate options to achieve the required performance with the lowest investment cost;
 - There is no doubt that a dipole field of 8.65T can be achieved and that an adequate safety margin is present;
 - The large and complicated cryogenic system is completely feasible;
 - The cost estimates are accurate and there are potential cost savings to avoid the need for contingency.
- Finally the committee urged that a 'strong signal' be given to focus ongoing LHC efforts.

LEP-LHC transition

In the lead-up to LHC, LEP remains CERN's priority physics for the 1990s. To capitalize on the LEP investment, preparations are pushing ahead to double the beam energy (see page 6). Instead of manufacturing just Z particles - the electrically neutral carriers of the weak force - from 1996 LEP, fitted with superconducting accelerating cavities to boost its energy, will also make pairs of W particles, the Z's electrically charged companions. In his final status report to Council as CERN Director General, Carlo Rubbia described this LEP200 scheme as the 'weld' between LEP and LHC.

Precision studies of the W - fixing its mass and measuring its coupling with the Z particle - will carry on from

the LEP work done so far around the Z resonance and provide the ultimate fix of the Standard Model. In addition, the higher energy range will open up searches for new particles, possibly providing initial evidence for the higgs particle at the root of electroweak symmetry breaking, and revealing new 'supersymmetric particles' - a mirror world of new matter to partner our own.

Such physics exploits the seething interactions inside the vacuum,

where 'virtual' particle states continually flicker on and off, transient pulses of energy borrowed by the Uncertainty Principle. If enough energy is supplied, these transient states can become real. This is a new 'constructive' type of high energy physics experiment, explained Rubbia, which contrasts with the traditional 'destructive' approach where particles are hurled at each other. 'Here LHC is the logical continuation of LEP'.

ECFA recommends LHC

The European Committee for Future Accelerators, ECFA, plays an essential role in shaping European experimental high energy physics. Most recently, the large and enthusiastic participation at its conferences and workshops on the LHC proton collider have demonstrated the strong and widespread community support for the project.

After careful and thorough discussion, ECFA considers the LHC to be the next logical step. The rapid advances in recent decades have provided the remarkably successful Standard Model with its great predictive power. Answers to the most urgent remaining questions in our field, such as the way masses are generated, are in close reach and could be given by experiments at the LHC.

The design and schedule for the LHC machine have now been defined. Basic machine parameters have been optimized and meet users' requirements.

Two large collaborations for the general purpose detectors ATLAS

and CMS are proceeding towards a technical proposal. A heavy ion detector, ALICE, and specialized b-physics devices are under consideration. Further experimental programmes will also be considered. ECFA confirms the need for two complementary general purpose facilities and specialized devices for heavy ion and b-physics, as well as encouraging continued study of other experimental activities.

The LHC schedule, aiming at completion and commissioning of the machine and detectors in 2002, is sound and consistent with current plans for exploitation of existing CERN facilities, in particular the upgrade of LEP, LEP200.

ECFA therefore strongly supports a CERN scientific programme in which the LHC has a central role. It considers a rapid approval essential to sustain progress on both machine and detector preparation and proceed towards construction.

ECFA therefore reiterates and confirms its recommendation given in 1990 and 1991 to fully support the LHC project and approve it as soon as possible.

The International Forum for Physicists and Engineers

Laser and Particle Beams

Pulse Power and High Energy Densities

Editor in Chief: George H. Miley, *Fusion Studies Laboratory, University of Illinois*

The Journal

Laser and Particle Beams is an international journal which deals with the generation of intense laser and particle beams, the interaction of these with matter, and their applications. Unique in its aims and coverage, it fulfils the need for an international publication specialising in this field.

Coverage

Subjects covered in **Laser and Particle Beams** include:

- ◆ intense sources of coherent radiation – from the microwave to the X-ray region
- ◆ physics of high energy densities
- ◆ hot dense matter
- ◆ atomic, plasma and hydrodynamic physics
- ◆ beam-wave interaction
- ◆ physics and technology of pulsed power devices

The subject matter spans a wide variety of fields such as nuclear fusion by inertial and magnetic confinements; astrophysics and space physics; and laboratory techniques of diagnostics, targets, theory and numerical simulation relevant to these subjects.

In addition to original research articles, **Laser and Particle Beams** publishes occasional review articles, surveys of research at particular laboratories and reviews of recent books of interest to its audience.

A Selection of Recent Articles ...

Nova upgrade program: Ignition and beyond,
E. Storm, E. M. Campbell, W. J. Hogan & J. D. Lindl

Analysis of experimental and theoretical research of nuclear-pumped lasers at the Institute of Technical Physics, *E. P. Magda*

Ejected electron energy dependence of ionization cross section of He and Ar atoms by fission fragments bombardment, *V. A. Rykov, P. P. Dyachenko, F. V. Mahrov & Yu V. Sokolov*

Measurement of multi-photon absorption and electron avalanche in optical thin films,
H. Nishioka, T. Kawasumi, K. Ueda & H. Takuma

Direct- and indirect-driven reactor targets, *K. Niu*

Third excimer continua in neon and argon, *W. Krötz, A. Ulrich, B. Busch, G. Ribitzki & J. Wieser*

Beam-smoothing effect in broad-band random-phase irradiation, *I. Matsushima, Y. Owadano, Y. Matsumoto, I. Okuda, T. Tomie, K. Koyama, R. Staffin & M. Yano*

Subscription Information

Volume 12 in 1994, published in February, May, August and November: £160 + VAT* for institutions; £55 + VAT* for individuals whose institutions subscribe; airmail £25.50 per year extra.

*Where VAT is applicable

Further Information

- Please send me a free sample copy of **Laser and Particle Beams**
- Please send me further information

Name _____

Address _____

Cambridge University Press has a large physics publishing programme. If you would like to receive further information, please tick appropriate box(es).

Journals

- Journal of Plasma Physics
- Journal of Fluid Mechanics
- Meteorological Applications

Books

- Applied Mathematics
- Mechanical, Civil and Aerospace Engineering
- Optics
- Quarterly Bulletin of New Science Titles
- Astronomy and Astrophysics
- Physics

Send coupon to: Journals Marketing Department, Cambridge University Press, The Edinburgh Building, Cambridge, CB2 2RU, UK

Tel: +44 (0)223 325806 Fax: +44 (0)223 315052

In the USA, Canada and Mexico, write to: Cambridge University Press, 40 West 20th Street, New York, NY10011-4211, USA



CAMBRIDGE
UNIVERSITY PRESS

51737

Around the Laboratories

LEP finished its 1993 operation around the Z resonance in mid-November with an accumulated electron-positron collision score 40% up on 1992 in 18% less days of running. Over eight million Zs have been logged by the four detectors.

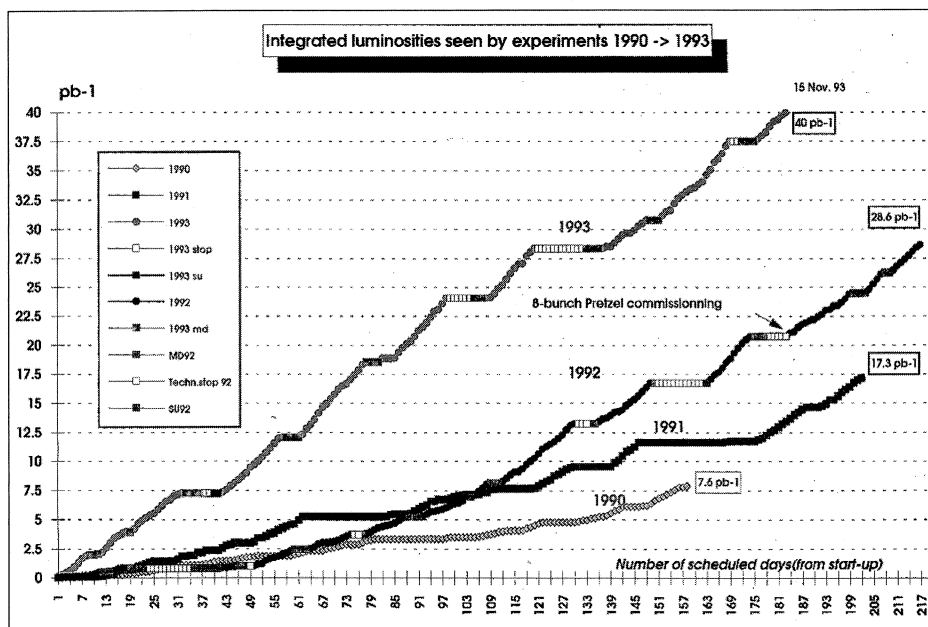
CERN Preparing for LEP200

By 1996, CERN's 27-kilometre LEP electron-positron collider should be operating for physics at twice the energy. With beam energies of the order of 90 GeV, LEP experiments will have their first taste of W particles, the electrically charged carriers of the weak nuclear force.

Since operations began in 1989, LEP has been operating around the energy of the Z, the electrically neutral counterpart of the W (January 1993, page 1). Systematic study of W physics over the remaining years of the century will round out LEP's precision studies of the internal consistency of the Standard Model.

The manufacture of niobium-coated superconducting cavities to boost LEP's accelerating power is pushing ahead, 64 of them (40 % of the total number) having passed the acceptance tests. The first four-cavity module assembled from industrial niobium coated cavities was operated in LEP as from October and has achieved the nominal accelerating gradient of 6 MV/m, with 6 mA beams. Its reliability at nominal gradient has however been affected by the power couplers, which showed a tendency to lose their radio-frequency conditioning (because of multipactoring) when the cavities are operated at gradients above 3.5 MV/m. A vigorous effort is underway to overcome this difficulty, which may be induced by quality problems on a component of the power couplers which now has to be replaced. To safeguard the installation programme, additional resources are being brought in.

In parallel with the installation of



these cavities, the four experiments have improvement programmes to prepare for this new era of LEP physics. No major rebuilds are needed as running at collision energies near 200 GeV was foreseen from the outset, and the basic architecture of the four experiments was developed accordingly. However special requirements emerge in the hunt for the higgs particle(s) and for supersymmetric particles.

For Aleph, the silicon microvertex detector, the original design of which dates from 1988, is being upgraded to increase angular coverage. Sensitivity will be improved by moving readout components out of the way of physics. Improved tagging of events producing b-quarks will benefit higgs searches.

At Delphi, the angular coverage of the barrel microvertex detector is being extended, as is tracking and hermeticity in the 'very forward' region (below 25°). Tagging counters will complement electromagnetic calorimetry. Development work is progressing for a new 'Very Forward

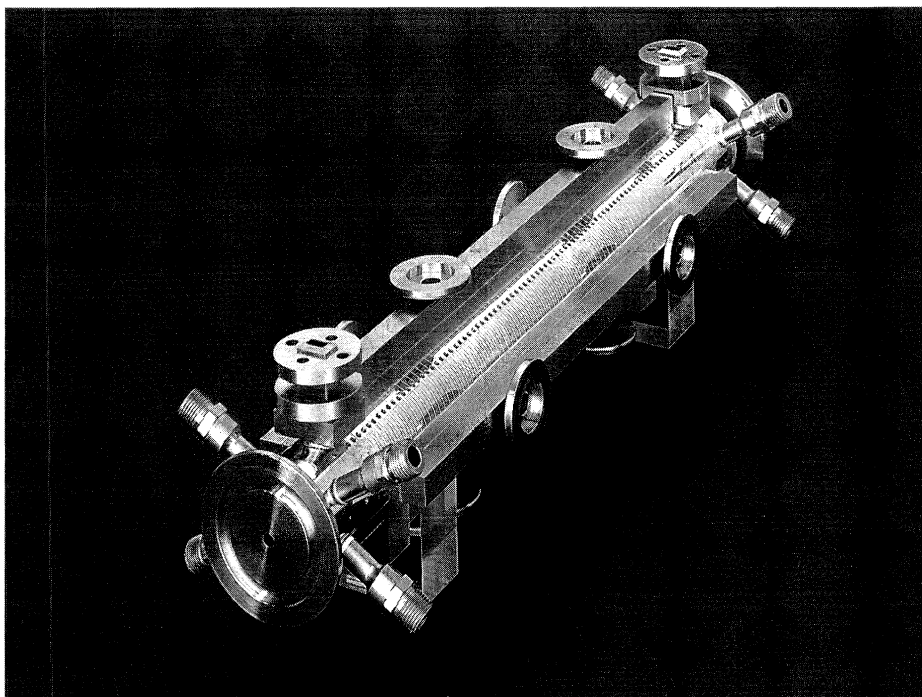
Tracker' using ministrips and macropixels, and a new trigger system will give better control under more severe experimental conditions, especially in the forward direction.

The biggest item on the L3 LEP200 agenda is the extension of precision muon chamber coverage from 43 down to 22 degrees, by adding a toroidal coil into the massive 'doors' at the ends of the detector, together with three planes of muon chambers.

L3 is also planning to increase its magnetic field from 0.5 to 0.6 tesla to improve tracking. Combined with new analysis software to give better measurements of jet energy, this will be important in the search for the higgs particle(s). Calorimetry will benefit from improved hermeticity (fewer 'cracks' where energy can leak out unnoticed). Trigger processing is being substantially rebuilt.

Opal foresaw good hermeticity from the outset. The trigger system too is in good shape for the new round of LEP physics. However a longer silicon strip microvertex detector will be built to extend angular coverage

Prototype accelerating section for the main linac of CERN's CLIC collider scheme. First beams have now been accelerated.
(Photo CERN AC22.6.91/2)



to match that of the rest of the detector.

Meanwhile LEP finished its 1993 operation around the Z resonance in mid-November with an accumulated electron-positron collision score 40% up on 1992 in 18% less days of running. Over eight million Zs have been logged by the four detectors. Highest average luminosity in all four experiments was 1.6×10^{31} . 50% of this running was off the Z peak to get a better picture of the Z resonance.

Eight bunch 'pretzl' running (October 1992, page 17) is now standard, and improved bunch currents and tune shift conditions paid dividends, while high polarization levels gave a beam energy fix to within a few MeV.

First CLIC beams

After successful initial tests at CERN's CLIC Test Facility (CTF), in December an electron beam was

accelerated by about 16 MeV using a prototype CLIC accelerating section at a frequency of 30 GHz and accelerating fields of 60 MeV/m.

CLIC - CERN Linear Collider - aims to provide beams at the TeV level for a new generation of electron-positron collider experiments (September 1993, page 1). Rather than the conventional klystrons to supply the radiofrequency accelerating power, CLIC uses a parallel drive linac.

In the latest tests, a prototype cavity was powered by 34 MW of radiofrequency power at 30 GHz transferred from a drive beam. This beam - a total charge of 34 nC in 24 5mm bunches was produced by a laser-driven photoinjector at high field (100 MV/m) and accelerated to 60 MeV/c.

The achieved accelerating fields of 60 MeV/m, well on the way to the 80 MeV/m nominally foreseen for CLIC, correspond to about 3.5 times the fields used in the operation of Stanford's SLC Linear Collider. The successful generation of a substan-

tial amount of high frequency r.f. power from a drive beam in this way, as well as the excellent behaviour of the 30 GHz structures at these high power levels and accelerating fields, are an important step towards demonstrating CLIC feasibility.

FERMILAB Call for physics

Several hundred physicists attended a special Fermilab 'All Experiment-er's Meeting' on November 20 to hear Director John Peoples call for new Tevatron Collider proposals for the years 2000 - 2005, when the new Main Injector (June 1991, page 13) will be complete.

At the Tevatron proton-antiproton collider, the CDF and D0 experiments are currently completing improvements for Run II to use the Tevatron when the Main Injector is complete later in this decade. New proposals would be aimed at a Collider Run III to follow these CDF and D0 efforts.

Deputy Director Ken Stanfield outlined the proposal schedule: Expressions of Interest are due in May, and a small number of these would be encouraged to develop more detailed Letters of Intent by January 1995. A few of these groups would then be asked to submit real proposals by May 1995, and two groups would be selected to develop Conceptual Design Reports by April 1996. Funds to begin working on the detectors could be available as early as November 1996, with first operation early in the next decade.

Financial constraints are likely, but parts of the existing CDF and D0 detectors would be recycled. Taiji

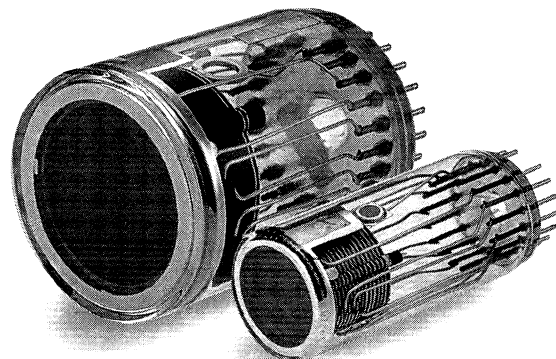
HAMAMATSU

For stable TOF measurements in
a high-magnetic environment,
Hamamatsu's "Fine-Mesh"
is the key.

1.5tesla

150 ps at 1.5 tesla.

Hamamatsu's Fine-Mesh PMTs for high-magnetic fields incorporate a newly designed dynode structure. As a result, they operate stably without any special shielding even in magnetic environments up to 1.5 tesla. Time resolution on the order of 150 ps yields larger and more reliable TOF measurements. For detailed information on Fine-Mesh 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

Yamanouchi in the Fermilab Program Planning Office can give additional details.

Fermilab is envisaging a broad neutrino programme for the Main Injector era. The laboratory has just approved a short baseline oscillation experiment, E-803, which may be sited in an existing experimental hall in the Proton Area or in a new location. A long baseline oscillation programme will necessarily proceed in stages, with the first step being investigation of possible beam extraction opportunities.

The laboratory already has produced a conceptual design report on Neutrino Physics at the Main Injector using 120 GeV extracted beam. A joint Research Division and Accelerator Division study group is now investigating the feasibility of several new ideas: 1 - extraction of 150 GeV beam to the existing switchyard; 2 - 120 GeV beam at the antiproton target station; and 3 - beam from the 8 GeV booster.

In conjunction with this study group, the Research Division is coordinating an evaluation of the geology and a civil engineering study for the extraction of a new long baseline beam from the Main Injector. The laboratory intends to call for long baseline proposals in the near future, and one proposal has already been received, P-822, to extract beam towards the Soudan-2 proton decay detector located in Minnesota at a distance of 806 kilometres.

Sid Drell chairs a new subpanel of the US High Energy Physics Advisory Panel (HEPAP) to look at international collaboration possibilities after the demise of the SSC project.

SUPERCOLLIDER Going international

In the wake of the Superconducting Supercollider (SSC) debacle in the US (December 1993, page 1), US particle physicists are regrouping. 'It is clear that physics interest cannot be changed by an act of Congress,' says Ed Berger of Argonne.

As part of the SSC winding up, US Secretary of Energy has been requested to produce a plan to 'maximize the value of the investment in the project and minimizing the loss to the US, including recommendations as to the feasibility of utilizing SSC assets in whole or in part in pursuit of an international high energy physics endeavour.'

To provide input for this plan, the High Energy Physics Advisory Panel (HEPAP), the 'voice' of the US particle physics community, has formed a new subpanel, chaired by Sid Drell, to study international



collaboration possibilities. An interim report is expected in February, and the final recommendations at the end of May.

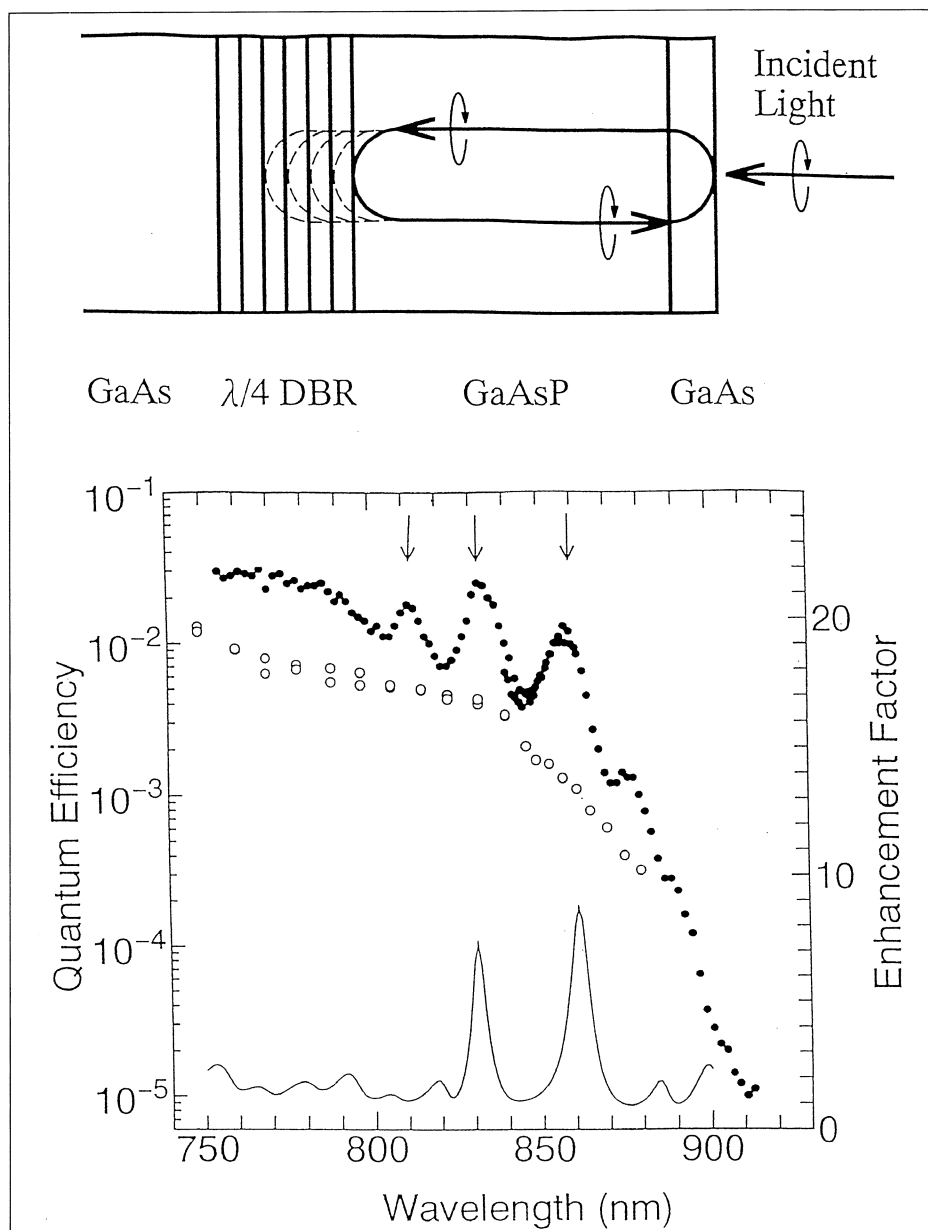
Informal exploratory talks have been held at CERN between spokesmen of major CERN experiments and experimental proposals and their counterparts from the major SDC and GEM projects which were being prepared for the SSC.

Meanwhile ways could be found to use SSC termination funding to capitalize on detector research and development work already in the pipeline. On the SSC site in Ellis County, Texas, Fermilab Director John Peoples is supervising the windup of the project, while Joseph Cipriano has been replaced by James Hall as director of the Department of Energy's on-site office. 2,286 personnel had been working on the site, of which 1,983 were employed by the SSC.

KEK/NAGOYA/SLAC Highly polarized electrons

In the push by the Japanese KEK Laboratory, in collaboration with university groups and overseas laboratories, to develop new techniques for the future Japan electron-positron collider (JLC), a recent achievement is a significant increase in the efficient yield of highly polarized electrons.

In today's Standard Model, the electrically charged carriers of the weak force communicate only with left-handed particles. The handedness (or direction of the spin)



Increasing the effective thickness of a thin layer of strained semiconductor using a technique developed at Nagoya, Japan. Circularly polarized laser photons are multiply reflected between the semiconductor surface on one side and a Distributed Bragg Reflector (DBR) on the other using quarter-wavelength thicknesses.

The quantum efficiency is shown below - the solid and open points were obtained respectively with and without photon reflection. The solid curve shows the simulated enhancement. For 860nm laser photons giving 70% polarized electrons, the efficiency reached about 1.3%.

imum charge that can be extracted (if the photoelectron emission per absorbed photon is low) and place heavy demands on laser power.

In 1993, the SLC strained-crystal cathode achieved an efficiency of 0.5% at a wavelength of 865nm, a factor of five over initial measurements for the same type of cathode, attributed to not breaking the vacuum when loading the cathodes (load lock).

More recently, a substantial increase in quantum efficiency has been demonstrated using the KEK/Nagoya/NEC superlattice crystals, while a technique for increasing photon absorption has been developed and successfully tested at Nagoya.

Superlattice photocathode

The KEK/Nagoya/NEC collaboration has been working on GaAs-AlGaAs superlattice photocathodes. (In such a superlattice, the additional sites avoid the spin degeneracy problem.) Latest improvements include a special doping density and surface GaAs layer.

The polarization measurement was done at Nagoya under low current and gave a maximum polarization of 71% at 757 nm. As expected, the quantum efficiency increased for the shorter excitation wavelength. Tests of quantum efficiency and maximum charge were made at SLAC, using the SLC Polarized Gun Test Lab, as part of a collaboration between SLAC and Japanese research centres on future accelerator techniques.

As with the SLC, the cathodes are inserted into the gun without breaking the vacuum (load lock), avoiding deterioration of performance. Typically, efficiencies are improved by a factor of 3 to 5 this way.

is therefore a means of controlling the weak interactions.

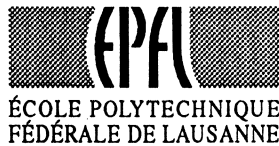
The first breakthrough of the 50% polarization barrier inherent in conventional gallium arsenide (GaAs) photocathodes (because of spin degeneracy) was made early in 1991 using strained lattice photocathodes and superlattice photocathodes. Both were designed to have suitably modified energy-band structure (May 1991, pages 4 and 6, and July/August 1991 page 16).

The next major step was a successful application of the new technique at the two-mile linac at SLAC, Stanford. Replacing a conventional crystal photocathode by a strained lattice, the linac routinely supplies intense 45 GeV electron bunches of

about 65% polarization (July/August 1993, page 5). The polarization of SLAC's SLC linear collider has considerably boosted the physics capability of the SLD experiment.

Key issues are the quantum efficiency of the photocathode - the number of photoelectrons per incident laser photon measured at low laser intensity - and the maximum charge that can be extracted in a short pulse irrespective of the maximum laser intensity available.

When originally tested, the efficiency of the new high polarization cathode materials was about an order of magnitude lower than obtainable with a low-polarization crystal photocathode. Low quantum efficiencies restrict both the maxi-



LOW-POWER / LOW-VOLTAGE IC DESIGN

Course 1 : June 27 - July 1, 1994

Low-Power / Low-Voltage IC Design : An Overview	M.DECLERCQ, EPFL & M.DEGRAUWE, CSEM
Micropower Packaging Techniques	J.JASPER, EM Microelectronic
Ultra Low-Power Digital Design	C.PIGUET, CSEM
Low Power Circuit Design - Basics	J. RABAAY, UCB
Low Power Design at Architectural and System Level	J. RABAAY, UCB
Computer Aided Design for Low Power	J. RABAAY, UCB
Device Modeling for Micropower ICs	C.ENZ, EPFL
Limits to Low-Power/Low-Voltage Analog Circuit Design	E.VITTOZ, CSEM
Basic Analog Circuit Techniques for Micropower	E.VITTOZ, CSEM
Analog Micropower Building Blocks and System Design	E.VITTOZ, CSEM
CMOS Op-Amps for LP-LV Applications	H.LEE, MIT
Low-Voltage SC and Continuous-Time Filters	R.CASTELLO, U.Pavia
Low-Voltage Switched-Capacitor Filters	M.STEYAERT, KUL
Nyquist-Rate Micropower A/D and D/A Converters	V.VALENCE, MEAD
Low-Power Oversampled A/D Converters	E.DJKSTRA, CSEM
Low-Power Mixed-Signal Design for Medical Devices	D.WAYNE, Hearing Innovation
LV/HV Interfaces: Supply Voltage Step-Down IC Design	G.TEMES, OSU
LP Low-Noise Sensor Interfaces and Measurements	P.JARRON, CERN
Low-Power Microprocessors and Memories	C.PIGUET, CSEM
Low Power Circuits for Portable Telecommunications	M.PARDOEN, CSEM
Low-Voltage Disk Drive ICs	T.SCHMERBECK, IBM

PRACTICAL ASPECTS in ANALOG & MIXED-MODE ICs

Course 2 : July 4-8, 1994

Technologies for Analog and Mixed-Mode ICs	E.LAES, MIETEC
Packaging Techniques	J.THOMPSON, Consultant
Analog and Mixed-Signal Circuit Layout Techniques	T.SCHMERBECK, IBM
Mechanisms and Effects of Noise Coupling in Analog ICs	T.SCHMERBECK, IBM
Design Strategies for Reducing Noise Coupling	T.SCHMERBECK, IBM
Analog and Mixed-Signal IC Layout and Floorplanning	T.SCHMERBECK, IBM
Passive Components and Parasitic Effects in Analog ICs	D.ALLSTOT, CMU
Current-Mode vs SC Signal Processing Circuits	D.ALLSTOT, CMU
Grounding and Bus Routing Techniques for Analog ICs	P.BROKAW, Analog Devices
Design of On-Chip Voltage References	P.BROKAW, Analog Devices
Practical Design Techniques for Commercial Analog ICs	P.FERGUSON, Analog Devices
Testing Analog ICs	P.FERGUSON, Analog Devices
Practical Design of Sigma-Delta Converters	P.FERGUSON, Analog Devices
CDS and Chopper Stabilization Techniques	G.TEMES, OSU
Practical Considerations in SC Circuit Design	M.REBESCHINI, IC Research
Noise Analysis for Cont.-Time and Sampled-Data ICs	C.ENZ, EPFL
BiCMOS Analog Circuit Design Techniques	H.CASIER, MIETEC
EMI/EMC Effects in IC design	V.TRIPATHI, OSU

Deadline for Registration : **May 31**

Registration Fees : Any One Course = 2'700.- CHF, Both Courses = 4'400.- CHF

CMOS & BiCMOS VLSI DESIGN '94

ADVANCED DIGITAL DESIGN

Session I : August 22-26, 1994

Evolution and Trends of Microelectronics	M.DECLERCQ, EPFL
Device Physics and Modeling	F.RAHALI, EPFL
CMOS & BiCMOS Static Logic	Ph.DUCHENE, EDAS
Dynamic Logic Structures	B.HOCHET, EPFL
High-Speed CMOS Circuit Techniques	K.ESHRAGHIAN, U.Adelaide
High-Speed BiCMOS Circuit Techniques	H.-J.PFLEIDERER, U.Ulm
Clocking Strategies, Memories, I/O	K.ESHRAGHIAN, U.Adelaide
Systolic Arrays	H.-J.PFLEIDERER, U.Ulm
Advanced Semicustom Arrays	Ph.DUCHENE, EDAS
Design Flow	C.PIGUET, CSEM
Design for Testability	A. OSSEIRAN, EPFL
VLSI Design Using VHDL	A.YACHOUX, EPFL
Economics and Cost Evaluation	M.DEGRAUWE, CSEM
Trends in VLSI Technologies	G.DECLERCK, IMEC

ADVANCED ANALOG DESIGN

Session II : August 29 - September 2, '94

MOS Transistors	E.VITTOZ, CSEM
Bipolar Transistors	E.VITTOZ, CSEM
Passive Components	E.VITTOZ, CSEM
Parasitic Effects	E.VITTOZ, CSEM
Layout Analog Techniques	E.VITTOZ, CSEM
Elementary Building Blocks	E.VITTOZ, CSEM
Analog Functional Blocks	W.SANSEN, KUL
Low-Noise Amplifiers	C.ENZ, EPFL
Voltage References	E.VITTOZ, CSEM
Oscillators	E.VITTOZ, CSEM
BiCMOS Building Blocks	H.CASIER, MIETEC
Off-chip Drivers	R.CASTELLO, U.Pavia
Analog and Neuromorphic ICs	E.VITTOZ, CSEM

INTEGRATED SIGNAL PROCESSING

Session III : September 5-9, 1994

Theory for SC and ST Filters	G.TEMES, OSU
On-Chip Continuous-Time Filters	J.KHOURY, AT&T
Practical Exercise on Filter Design	F.KRUMMENACHER, EPFL
State-of-the-Art SC Filter Design	G.TEMES, OSU
Practical Digital Filter Design	J.SCOTT, Crystal
Asynchronous Digital Filter Design	B.ADAMS, Analog Devices
CMOS A/D & D/A Converters	G.TEMES, OSU
Delta-Sigma Modulators I	G.TEMES, OSU
Delta-Sigma Modulators II	B.ADAMS, Analog Devices
DSP - Full Custom IC Design	H.HAERINGER, ITT Internet.
VLSI Architectures & CAD for DSP	H. DE MAN, IMEC

Deadline for Registration : **June 30**

Registration Fees : Any One Session = 2'600.- CHF, Any Two sessions = 3'600.- CHF, All Three Sessions = 4'600.- CHF

Courses Directors : Michel Declercq, Gabor Temes, Vlado Valence and Eric Vittoz

Contact : V. Valence, EPFL-LEG, EL-Ecublens, 1015 Lausanne, Switzerland, Tel : +41-21-693-3972(or 75), Fax : +41-21-693-3640, e-mail : valencic@elde.epfl.ch

- EPFL is member of the ESPRIT VLSI Design Action of the European Communities -

Developed by Landau, Pomeranchuk, and Migdal forty years ago, the LPM effect predicts that the production of low energy photons by high energy electrons should be suppressed in dense media.

In 1993 this was finally verified at Stanford (SLAC). The diagram compares data (crosses) with Monte Carlo simulations - one (dashed line) including LPM suppression and the other (dotted line) ignoring it - for 25 GeV electrons on uranium. Data recorded with two different targets were subtracted to remove edge effects.

In the test, a 20 mm diameter superlattice photocathode, biased at about 120 kV, has achieved a record performance; a current of 2.3×10^{11} electrons in 2.5 ns at 757 nm with a corresponding quantum efficiency of 2%, the latter representing a factor of 3 improvement over earlier measurements.

The achieved output current is not limited by the photocathode material but is comparable to the gun's space-charge limit. Since the output pulse shape is distorted only at the very highest laser power, charge limiting effects on closely-spaced bunches will also be minimal.

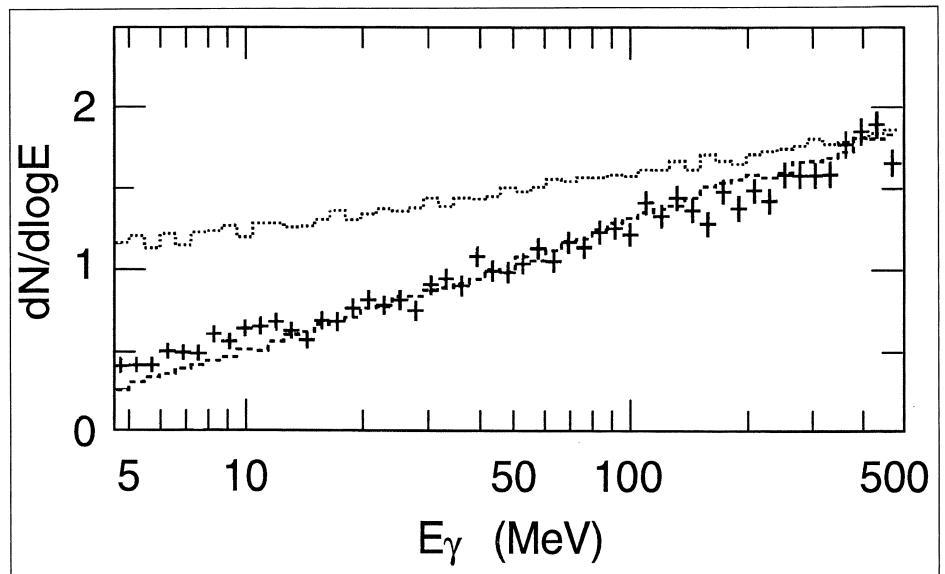
Strained crystal photocathode

With a strained crystal photocathode, the relatively low state-density of heavy-hole band semiconductor can be selectively pumped to produce highly polarized electrons, and the strain on the crystal lattice (which removes the spin degeneracy) can be maintained only over a layer of up to 0.3 microns. This keeps the quantum efficiency low.

Instead of asking for higher laser power, the effective photon pathlength within the useful layer could be increased by making the photons go backwards and forwards, sandwiching the thin crystal layer between parallel mirrors.

Absorption of reflected photons provides electrons of the same helicity as incident photons, as the photon circular polarization is reversed on reflection and so is the direction of electron emission.

The Nagoya group applied the idea of an optical Fabry-Perot cavity. One of the mirrors already exists - an interface between the GaAs crystal surface and the vacuum works as a reflector due to the difference in refractive index. The other, on the



reverse side of the crystal, was prepared as a distributed reflector, using many pairs of dielectric layers with different refractive indices. The thickness of each layer is chosen to be a quarter of the incident photon wavelength. Though the reflectivity of each interface is low, reflected photons add up coherently, giving overall high reflectivity. Multiple reflection between the two mirrors resonates when the round trip pathlength is an integer multiple of the photon wavelength.

The quantum efficiency is considerably increased at several photon wavelengths satisfying resonance. For 860nm photons, the quantum efficiency exceeds 1% for a 0.14 micron GaAs layer and the electron polarization is 70%. This rather low polarization (for this kind of source) results from the resonance peak position for the sample not matching the exact maximum polarization.

The technique should be applicable to any thin photocathode and decrease the demand for laser power.

STANFORD (SLAC) Photon theory verified after 40 years

A collaboration of physicists from the University of California at Santa Cruz (UCSC), the Stanford Linear Accelerator Center (SLAC), American University and Livermore has verified a theory that is almost forty years old. Developed by Landau, Pomeranchuk, and Migdal in the mid-1950s, the LPM effect predicts that the production of low energy photons by high energy electrons should be suppressed in dense media.

When an electron interacts with a nucleus and emits a (bremsstrahlung) photon, the longitudinal momentum transfer between electron and nucleus is very small. The uncertainty principle therefore requires that the interaction must take place over a long distance, called the formation zone. If the electron is disturbed while traveling this distance, the photon emission can be disrupted. The LPM effect predicts

that in dense media, multiple scattering of electrons is enough to suppress photon production at the low energy end of the bremsstrahlung spectrum.

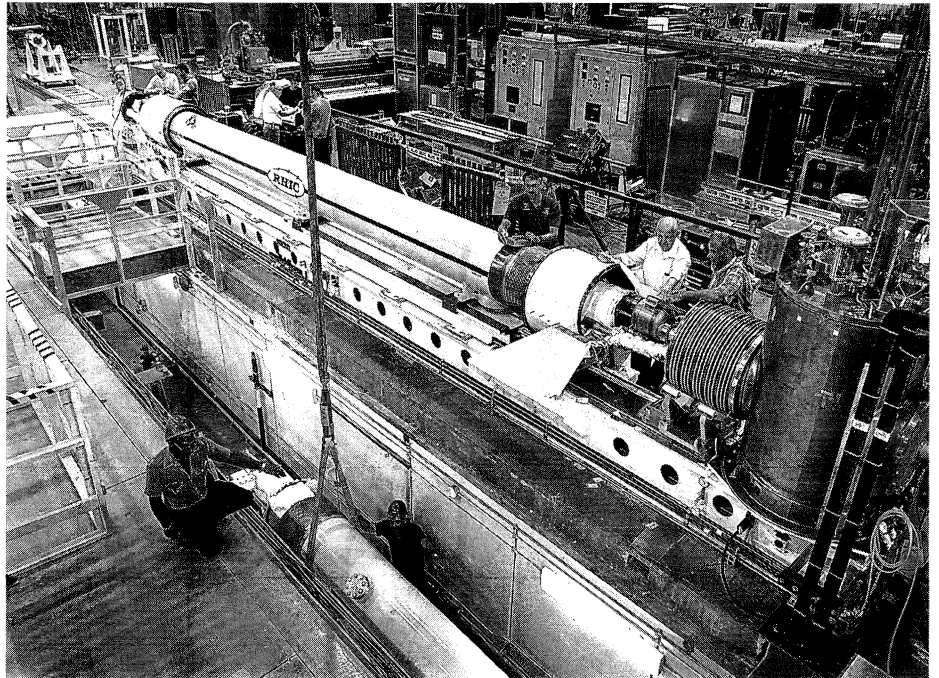
In SLAC experiment E-146, 25 GeV electrons passed through slim targets of carbon, aluminum, iron, gold, lead, tungsten and uranium — as well as a very thin gold target. After traversing the target, the electrons were deflected into a momentum-measuring wire chamber, while bremsstrahlung photons generated in the target continued downstream into a calorimeter made of bismuth germanate.

Led by Spencer Klein of UCSC, the collaboration developed a novel technique to do the experiment parasitically during normal operation of the SLC Stanford Linear Collider, using high energy photons created in the beam-defining slits at the end of the linear accelerator. These photons travel downstream past the SLC arcs and into the beam switchyard, where a copper target converts them into electrons and positrons. The electrons are captured and transported into End Station A; up to 100 electrons per pulse were obtained at energies between 400 MeV and 25 GeV. This technique can be used by future experiments requiring a high energy, low intensity beam.

The E-146 data confirm that the LPM effect exists. The magnitude of the suppression in dense media such as uranium is consistent with Migdal's prediction. Lighter targets such as carbon show little suppression. And the very thin gold target showed no LPM suppression at all, because the formation zone is longer than the target length.

Besides the theoretical interest, the LPM effect is relevant in a variety of physics areas, ranging from the design of calorimeters for the LHC to ultra high energy cosmic rays. Many

Prototype superconducting dipole for Brookhaven's RHIC heavy ion collider being tested on a stand using components on loan from the HERA electron-proton collider at the Hamburg DESY Laboratory.



nuclear effects, including the 'colour transparency' suppression of nuclear reactions, are closely related.

the magnets and their interconnections have called for a second test.

RHIC will use 1,740 superconducting magnets, 1,200 of which will be supplied by industry.

BROOKHAVEN HERA helps RHIC

Superconducting magnets for the second full cell of prototype magnets for Brookhaven's RHIC heavy ion collider have been tested on a stand using components on loan from the HERA electron-proton collider at the Hamburg DESY Laboratory.

Like RHIC, the HERA proton ring uses superconducting magnets to guide the particles round the ring. With HERA now operational, test equipment became available.

A full cell is the smallest string of magnets that can focus a beam vertically and horizontally as well as just bending it. Since the first RHIC full-cell test in 1990, modifications to

DESY QCD workshop

The traditional annual DESY Theory Workshop highlights a topical theory sector. The most recent was under the motto 'Quantum Chromo-Dynamics' - QCD, the field theory of quarks and gluons. The organizers, chaired by O. Nachtmann, had arranged a programme covering most aspects of current QCD research. This time the workshop was followed by a topical meeting on 'QCD at HERA', organized by J. Bartels, to look at the electron-proton scattering experiments now in operation at DESY's new HERA collider. An important DESY Theory Workshop tradition is for younger physicists to present their

At the recent DESY Theory Workshop, left to right, Gunter Wolf, A. Bartl, Otto Nachtmann (Photo P. Waloschek)



work in parallel sessions.

After a welcome by DESY Director Bjorn Wiik, reporting HERA's improving performance and encouraging joint theory-experiment efforts, the attention naturally focused on QCD in lepton-nucleon scattering.

Taking current issues in fixed-target measurements of the nucleon's quark structure, such as problems of the proton spin and violation of sum rules, as a starting point (E. Kabuss) the new results from HERA were presented (R. Yoshida, J. Gayler). The observed increase of the density of partons with small fractions (x) of the proton energy (October 1993, page 10) caused excitement due to its impact on 'QCD at small- x ', a topic now much under discussion (J. Kwiecinski, A. Mueller, M. Ryskin).

The standard evolution equations for parton branching processes are here insufficient and new equations with acronyms like BFKL and GLR (for their originators Balitzky-Fadin-Kuraev-Lipatov and Gribov-Levin-Ryskin) are now being investigated. It was questioned whether the HERA

data is a sign of 'BFKL-behaviour' or can be understood in more conventional ways using various parton density parametrizations, which were therefore examined in detail (A. Martin, J. Stirling, W.K. Tung, A. Vogt).

The increasing parton density at small x will ultimately lead to an 'overcrowding' in the proton and produce new phenomena, such as the fusion of two soft gluons into a more energetic one. The non-linear GLR equation attempts to describe this, but is debated by theorists together with the possibility for subregions in the proton with above-average gluon density, so-called 'hot spots' that might show up at HERA.

The discovery at HERA of 'rapidity gap' events with little visible forward energy (September 1993, page 6), and looking like diffractive scattering, is proposed by theorists as a new way to investigate the mysterious pomeron, introduced decades ago as a force mediator in elastic and diffractive scattering. Attempts to relate such phenomena with QCD

field theory in general and to HERA's new kinematic frontiers were considered (P. Landshoff, A. White, R. Kirschner, E. Verlinde, G. Ingelman). Small momentum transfer (Q^2) conditions also give insight to the colourful life of the photon, in terms of quark and gluon structure (G. Schuler).

The better known perturbative QCD effects in electron-positron, electron-proton and proton-antiproton collisions do nowadays provide high precision tools to test QCD parton emission processes and measure the fundamental strong coupling (α_s). Recent Fermilab Tevatron data (reported by G. Blazey) provide impressive examples, such as jet production rates in agreement with QCD over some ten orders of magnitude! Various ways to improve calculations and extract information from data were here considered in detail (S. Catani, W. van Neerven, B. Webber, B. Andersson, T. Boedeker, Yu. Dokshitzer, V. Khoze, J. Smith).

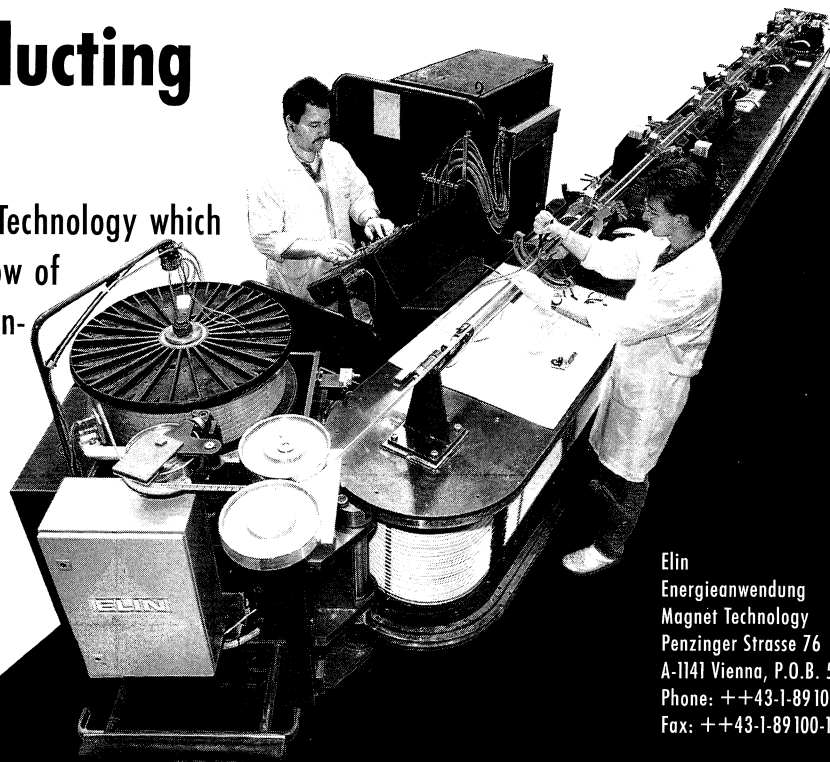
The lattice gauge theory approach to solve QCD in the strong coupling regime was another main workshop theme. This development has (according to C. Rebbi) gone from an initial period in the early 80s where new techniques had just been invented and 'gold nuggets' were easy to find, to the hard 'mining' work necessary today but made possible by an enormous development of calculational methods and computer power.

Progress on calculating the running coupling, the important heavy quark decay constants and other issues were reported (U. Wolff, S. Guesken, G. Schierholz). Other approaches to understand non-perturbative QCD, such as QCD sum rules along with vacuum structure in terms of various condensates, were also discussed (H.G. Dosch).

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: ++43-1-89100-3955
Fax: ++43-1-89100-154

Think Big Physics. Think Oxford.

Did you realise the scope of Oxford Instruments' commitment to the world of accelerator technology? We have the expertise to design and manufacture storage rings and components for applications big and small. Following our successful HELIOS compact synchrotron, operating at IBM, we are now building substantial parts of the accumulator ring for the DAΦNE project at INFN Frascati in Italy.

Our expertise is in the development of innovative solutions and the manufacture of:

- Complete accelerators (conventional and superconducting)
- Accelerator components and instrumentation
- Undulators and wigglers
- Control systems and instrumentation

Call or fax Will Clark at Oxford Instruments for a copy of our brochure "Accelerator Technology".

OXFORD

Oxford Instruments Accelerator Technology Group
Osney Mead, Oxon OX2 0DX, UK
Tel: +44 (0)865 269500, Fax: +44 (0)865 269502

Time-of-flight distribution of polarized very slow muons emitted from a solid argon layer for a flight path of 1 metre at the Swiss Paul Scherrer Institute. The very slow muons are accelerated in a two-stage system with the aluminium substrate held at a potential of 8kV. The peak at 317 ns corresponds to an initial muon kinetic energy of 10 eV; 1 eV muons appear at 332 ns, and 50 eV muons at 295 ns.

Under the heading 'nuclear chromodynamics' it was vigorously argued (S. Brodsky) that nuclei can change the QCD environment to produce interesting phenomena such as colour filtering to measure colour transparency and test the hypothesis of an intrinsic heavy flavour content in the proton.

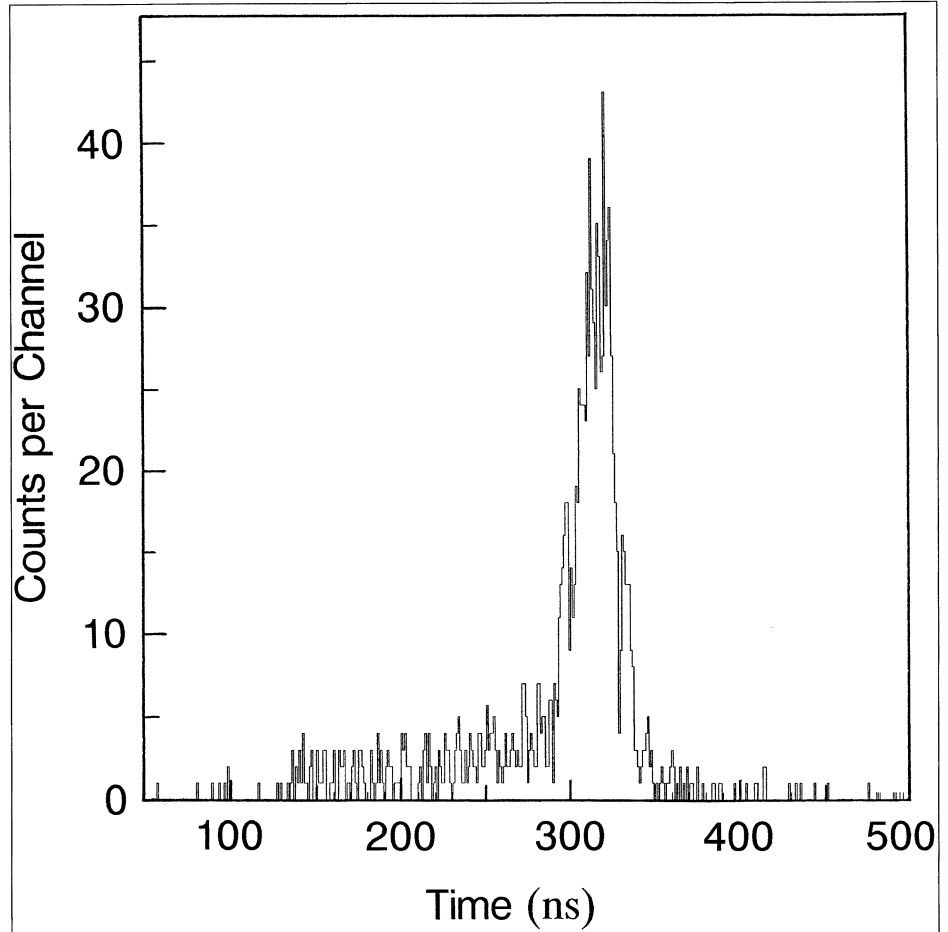
Altogether, it was made quite clear that QCD is well established and tested. Yet, "the problem of deeply inelastic scattering ... is [only] half solved" (to quote F. Wilczek at the Aachen 1992 QCD workshop) and open problems such as small-x and non-perturbative QCD will continue to attract much attention.

By Gunnar Ingelman (DESY)

PSI Very slow polarized muons

At the 'pion factory' of the Swiss Paul Scherrer Institute, a collaboration of PSI, Heidelberg and Zurich (ETH) headed by Elvezio Morenzoni has recently produced intense beams of positive muons which have kinetic energies as low as 10 eV and with complete polarization (spin orientation).

The new results were achieved at a surface muon channel, transporting positive muons from the decay of positive pions stopped at the surface of a pion production target. Surface muons with 4 MeV kinetic energy were transported by a conventional secondary beam channel and partially stopped in a moderator consisting of a layer of solidified noble gas deposited on a cold metallic substrate. The method is similar to



that widely used to produce very slow positrons (although the underlying physics may be different) - energetic positively charged particles slowed down in certain materials can be re-emitted with kinetic energies of just a few eV. This moderation technique was first applied to muons at the Canadian TRIUMF Laboratory in Vancouver in the late 1980s.

At PSI, it has now been shown that by using a solid argon or neon layer, the probability of converting a surface muon (kinetic energy 4 MeV) to a muon of a few eV can be made as 'large' as 10^{-4} and, most important, with the muon retaining its initial polarization.

This is an essential step towards the use of muons in a number of new applications. A solidified-gas modera-

tor inserted into a secondary surface muon beam can be used as the source of a tunable tertiary beam of polarized muons with energies between 10 eV and a few tens of keV.

PSI's new high-intensity beamline, which after completion of the current accelerator upgrade will deliver several hundred million surface muons per second, can give a source flux of about 10^4 very slow polarized muons per second.

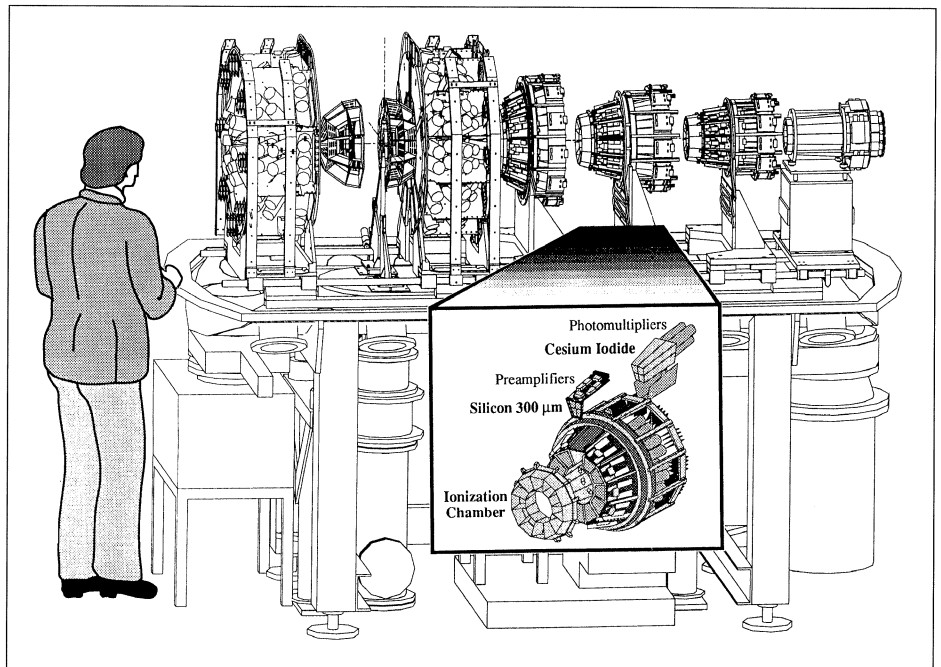
Such tertiary muon beams have a vast potential of applications in condensed-matter and particle physics. The muon spin rotation technique with secondary surface-muon beams is well established, and at PSI a large community of users applies it to investigations in solids,

Exploded view of the INDRA detector at the French GANIL Laboratory.

liquids and gases.

Because of the large penetration depth of the surface muons, the technique is presently limited to the study of bulk characteristics. However with the new tertiary muon beams, the penetration depth in matter can be varied between a few and a few thousand angstroms, extending the muon spin rotation technique (for the study of magnetism, defects, and diffusion) to surfaces and thin films.

Investigations on the muonium atom, a preferred object for studies of fundamental interactions and conservation laws, will also benefit.



GANIL INDRA and the hot nuclei

The formation and decay of hot nuclear systems formed in heavy ion collisions at intermediate energies is a major research axis at GANIL (Grand Accélérateur National d'Ions Lourds, Caen, France). The ultimate goal is to form highly excited nuclei at the "limit of stability".

In the past few years theoretical approaches predicted new decay modes for these nuclei, especially the possibility of a "sudden multifragmentation" of the nucleus, accompanied or not by a phase transition. The de-excitation of very hot nuclear systems is characterized by the emission of a large number of what are called in the trade "light charged particles" (in fact hydrogen and helium nuclei) and, to a less extent, heavier fragments.

Experimental studies require an event-by-event detection of all particles and fragments, with precise

measurements of their number, size (charge, mass), spatial distributions and energy. Physicists interested in studying the multifragmentation process at GANIL decided in 1989 to build INDRA.

This detector, which has to operate in a vacuum, covers about 90% of the space around the target. It can be described schematically as an ensemble of 336 cells arranged in 17 rings centred on the beam axis. The number and the size of cells on a ring depend upon its polar angle and have been chosen in order to have an approximately uniform counting rate. Charge identification (up to $Z = 50$) is achieved by energy measurements in two or three detection layers of increasing thickness: a low pressure gas-ionization chamber, 300 5m thick silicon detectors and cesium iodide scintillators thick enough to stop all particles. Hydrogen and helium isotopes are identified using pulse shape discrimination techniques on cesium iodide detector signals.

Building ionization chambers with a low energy threshold and almost complete solid angle coverage was a real challenge and is certainly the most original INDRA feature. The structures of the detector components used two different techniques - fibre-glass moulding or glued multilayer printed circuit boards. The anodes and cathodes of aluminized mylar foils were glued on the 1 mm thick walls of the structures and have to support a gas pressure of 70 mbars.

The second challenge was the huge dynamic range required for the electronics : 4000 to 1 for energy measurements in the silicon detectors (from 1 MeV to 4 GeV) with a 100 keV energy resolution. The electronics modules were designed and built by the INDRA collaboration laboratories, using mainly the new VXI Bus - an extension of the VME Bus for analog processing. This considerably reduced the number of modules by regrouping many functions in the same module (all func-

tions related to 24 cesium iodide scintillators could be stacked in one module). All electronics could also be placed close to the detector in the beam cave with full remote control (VXI/VME).

In Spring 1993 a first set of experiments with argon, xenon and gadolinium beams bombarding various targets was successfully run. These were designed to investigate the onset of multifragmentation as a function of the size of the nuclear system and the influences of electromagnetic forces and compression effects on the decay modes of the hot nuclear system formed during the collision.

GANIL-plus

The French GANIL heavy ion accelerator at Caen is to be upgraded by the GANIL-plus plan. Radioactive ions from GANIL collisions will be post-accelerated to provide radioactive beams of between 2 and 25 MeV per nucleon, opening up an important new range of physics studies.

CERN Accelerator School

The CERN Accelerator School (CAS) recently held its Advanced Accelerator Physics course in Greece on the island of Rhodes. Complementing the general course in Finland last year, this course was organized together with the University of Athens and NCSR.

Demokritos. Accelerator specialists from Europe, CIS, Japan and USA followed two weeks of "state-of-the-art" lectures designed to complete their education in the field.

Next year CAS, with the catholic University of Louvain, Belgium, is organizing a course on Cyclotrons, Linacs and their Applications, to be held from 28 April to 5 May at IBM's International Education Centre, La Hulpe, Belgium.

This is intended for staff in laboratories, university departments and hospitals where cyclotrons and linear accelerators have a practical application. Companies specializing in such equipment may also be interested. Participants should have at least a first-degree knowledge of physics, mathematics or engineering.

Further information from Mrs. S. von Wartburg, CERN Accelerator School, SL Division, 1211 Geneva, Switzerland, E-mail: CASBEL@CERNVM.CERN.CH Fax: + 41 22 7824836.

CAS is planning, with Vienna's Institut für Hochenergiephysik, an introductory course on accelerator physics, to be held from 19-30 September in Baden, Vienna.

This will mainly be of interest to staff in laboratories and university departments which use particle accelerators, and in manufacturing companies which specialize in equipment for accelerators. The course should be useful to designers and users of all types of particle accelerators, and to those working in related high technology fields. A second, complementary course on accelerator physics will be held in a year's time.

Further information and application forms from Mrs. S. von Wartburg, CERN Accelerator School, SL Division, 1211 Geneva, Switzerland, E-mail

CASAUS@CERNVM.CERN.CH, Fax: + 41 22 7824836.

Looking further forward to November, CAS and the US Particle Accelerator School, who normally would hold their next joint School in the US, have extended their partnership to include Japan. At a tripartite meeting at CERN it was decided to hold this school - "Frontiers of Accelerator Technology" - in the closest US State to Japan - Hawaii. The total cost should be less than the original venue on the US West Coast. The dates to reserve are 3-9 November. Details will be announced later and will include a limited number of scholarships.

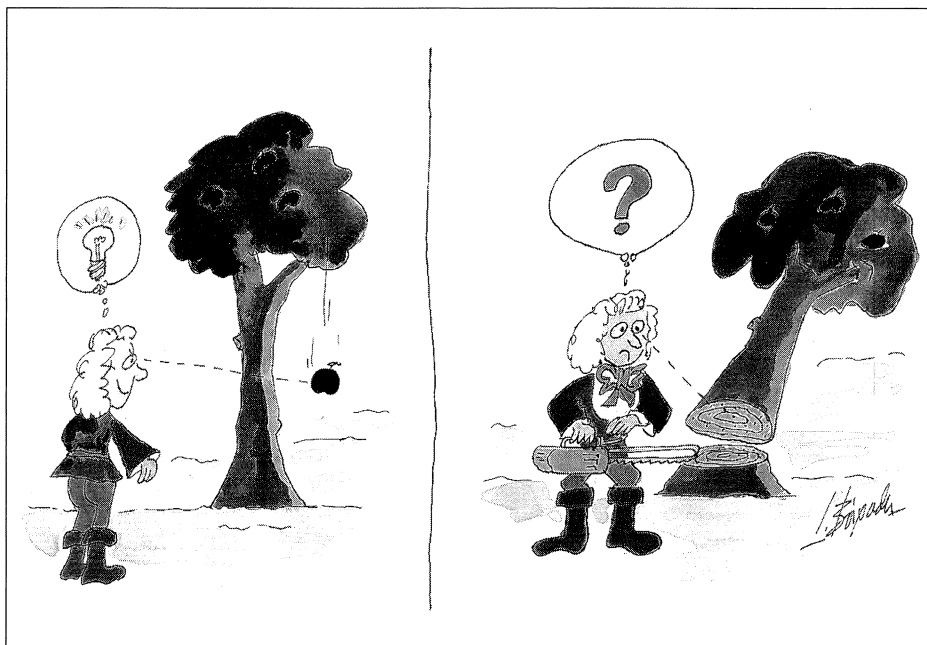
Physics monitor

CERN artist Georges Boixader's interpretation of Simon Hands' higgs explanation.

Hands on higgs

With the higgs particle one of the big unsolved mysteries of physics, last spring UK science minister William Waldegrave asked 'what is the higgs particle and why do we want to find it?', offering a bottle of vintage champagne to whoever could best answer this question in everyday language and on just one side of paper.

There were in fact four winning entries, all receiving Waldegrave champagne. The CERN Courier found the winning entry by Simon Hands, at the time a visitor in CERN's Theory Division, particularly enlightening, and asked Simon to develop his prizewinning entry.



Against the grain

The higgs particle is an undiscovered elementary particle, thought to be a vital piece of the closely-fitting jigsaw of particle physics. Like all particles, it has wave properties akin to those of ripples on the surface of a pond which has been disturbed: indeed, only when the ripples travel as a well-defined group it is sensible to speak of a particle at all.

Quantum mechanics naturally incorporates both particle and wave-like aspects of matter. In quantum language the analogue of the water surface which carries the waves is called a field. Each type of particle has its corresponding field. The higgs field is a particularly simple one - it has the same properties viewed from every direction, and in important

respects is indistinguishable from empty space. The particle-ripples associated with many other fields in particle physics spin on their axes, which clearly is not a property of empty space.

If the lowest energy state of the higgs field were one in which the field were zero, then the field would always interact the same way with all the other fields - physicists call such a state 'symmetric'.

However the laws which govern the behaviour of the higgs field dictate that even in its quiescent, ripple-less state the field is somehow "switched on", that is, it differs from zero. With the higgs switched on, pervading all of space and redefining its nature, the symmetry is destroyed: space is endowed with a "grain", like that of a plank of wood. The direction of the grain is undetectable, and only becomes important once the higgs' interactions with other particles are taken into account. Particles called vector bosons can travel with the grain, in which case they move easily over large distances and may be

observed as photons - particles of light. Against the grain, particle ranges are much shorter - these are the W or Z particles, the carriers of the weak nuclear force.

The higgs field enables us to view these apparently unrelated phenomena as two sides of the same coin; both may be described in terms of the properties of the same vector bosons.

When particles of matter such as electrons or quarks travel through the grain, they are constantly flipped "head-over-heels". This forces them to move more slowly than their natural speed, that of light, by making them heavy. Only the elusive neutrino seems (as far as we can tell) to spurn interaction with the higgs and remain massless. We believe the higgs field responsible for endowing virtually all the matter we know about with mass.

Like most analogies, the wood-grain one is persuasive but flawed: we should think of the grain not as defining a direction in everyday three dimensional space, but rather in

some abstract internal space populated by the various kinds of vector boson, electron and quark. In a world without the higgs, symmetry would reign supreme; photons, Ws and Zs would be indistinguishable, as would electrons and neutrinos, and "up" and "down" quarks (and therefore protons and neutrons). Thus the higgs indirectly gives structure to our world and makes it an interesting place.

The higgs' ability to fill space with its mysterious presence makes it a vital component in more ambitious theories of how the universe burst into existence out of some initial quantum fluctuation, and why the universe prefers to be filled with matter rather than antimatter - why there is something rather than nothing. To constrain these ideas more rigorously, and indeed to flesh out the whole picture, it is important to find the higgs particle.

There are unanswered questions: the higgs' very simplicity and versatility, beloved of theorists, makes it hard to pin down. How many higgs particles are there? Might it/they be made from still more elementary components? Most crucially, how heavy is it? Our current knowledge can only put its mass roughly between that of an iron atom and three times that of a uranium atom.

It is a completely new form of matter about whose nature we still have only vague hints and speculations, and its discovery is the most exciting prospect in contemporary particle physics.

By Simon Hands

Other higgs winners

Among the other winning entries, David Miller of London's University College introduced the higgs idea by imagining a cocktail party with Conservative Party workers uniformly distributed across the floor, all talking to their nearest neighbours, when suddenly ex-Prime Minister Margaret Thatcher enters. All in her immediate neighbourhood cluster around. As she moves across the room, she attracts those nearest to her, while the ones left behind return to their even spacing. Because of this surrounding knot she has more momentum for the same speed across the room, a political higgs effect.

Tom Kibble of London's Imperial College, who played a major role in the development of the higgs ideas in the mid-1960s (May 1993, page 22), was strong on spontaneous symmetry breaking. 'Spontaneous symmetry breaking is a ubiquitous phenomenon. For example a pencil balanced on its tip looks the same from every side - but when it falls it must do so in one particular direction, breaking the symmetry. The masses of the W and Z (and of the electron) arise through a similar mechanism. It is as though there are "pencils" throughout space, even in the vacuum.'

The remaining winners were Roger Cashmore of Oxford, and a joint entry by Mary and Ian Butterworth of London's Imperial College and Doris and Vigdor Teplitz of Southern Methodist University, Dallas, Texas.

New computing techniques in physics research

New techniques were highlighted by the "Third International Workshop on Software Engineering, Artificial Intelligence and Expert Systems for High Energy and Nuclear Physics" in Oberammergau, Bavaria, Germany, from October 4 to 8. It was the third workshop in the series; the first was held in Lyon in 1990 and the second at France-Telecom site near La Londe les Maures in 1992. This series of workshops covers a broad spectrum of problems.

New, highly sophisticated experiments demand new techniques in computing, in hardware as well as in software. Software Engineering Techniques could in principle satisfy the needs for forthcoming accelerator experiments. The growing complexity of detector systems demands new techniques in experimental error diagnosis and repair suggestions; Expert Systems seem to offer a way of assisting the experimental crew during data-taking. Evolutionary Algorithms could help resolve difficult optimization problems. Artificial Neural Networks are being adopted in the present generation of experiments. Special hardware is being implemented in trigger systems, software simulated networks are used for event classification in data analysis. The larger volumes of experimental data demand higher precision computation in theoretical physics; systematic procedures are being developed to compute higher order Feynman diagrams with the Techniques of Algebraic Manipulation.

Experts at the workshop included B. Botella (Constraint Logic Program-

TAKING CARE OF YOUR POWER

HOLEC H

Zero-flux measuring systems
made by Holec for high-precision measurement

ZERO-FLUX MEASURING SYSTEMS

- wide current range: up to 50,000 A
- analog and VME-bus output
- unequalled accuracy
- low power consumption
- true bipolar operation
- fully magnetically screened
- highly EMI protected
- without any temperature control devices
- high reliability: MTBF of 30 years

HOLEC H

Holec Systemen en Componenten, P.O. Box 23, 7550 AA Hengelo, The Netherlands,
tel.: +31.74.462850, fax: +31.74.464818

balzers

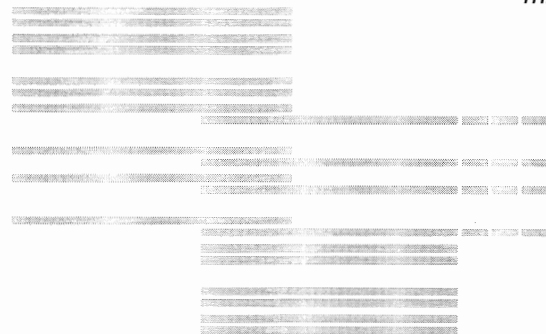
TPG 300
Vacuum controller
New combinations — wider choice!



New



1000 10⁻² 8·10⁻⁴ 10⁻⁹ 10⁻¹¹
mbar



Balzers Aktiengesellschaft
FL-9496 Balzers
Fürstentum Liechtenstein
Tel (075) 388 41 11
Fax (075) 388 54 14

K017e

ming), O. Kärmer-Fuhrmann (Software Engineering), F. Kursawe (Evolutionary Algorithms), and M. Lades and E. Littmann (Neural Networks).

The workshop was held under the auspices of the European Physical Society and the German Physical Society with financial support from the Bundesminister für Forschung und Technologie (BMFT), Bonn, the Centre National de la Recherche Scientifique (CNRS), Paris, the Deutsche Forschungsgemeinschaft (DFG), Bonn, the International Science Foundation, Washington DC, the Minister für Wissenschaft und Forschung of Nordrhein-Westfalen, the Village of Oberammergau, and the University of Wuppertal. The proceedings will be published by 'World Scientific'.

From Karl-Heinz Becks, Wuppertal, and Denis Perret-Gallix, LAPP Annecy

ELASTIC SCATTERING

How goes the Odderon?

Spurred by new measurements of total reaction rates and associated parameters by groups at CERN, DESY, and Fermilab, and with the scent of possible solutions to past controversies in the air, some 110 experimental and theoretical high-energy physicists gathered at Brown University (Providence, Rhode Island) for the fifth traditional 'Blois' Workshop on High-Energy Elastic and Diffractive Scattering.

Very much alive is the 'Odderon' - the extra effect to explain the difference between proton-proton and

proton-antiproton scattering.

Just when the weight of the new UA4.2 measurements at CERN (December 1993, page 14) suggested a rapid burial, a new calculation reported by theoreticians Lipatov et al. argued that if the Pomeron exists then the Odderon should also.

Everyone believes in some version of the Pomeron to drive elastic scattering, but the attendees clearly reserved judgement as to whether the exchange of the Lipatov Pomeron (built out of two pairs of (Reggeized) gluons), or of a more traditional 'soft' Pomeron (built of nonperturbative quark-gluon effects) are the best ways of representing the scattering of two protons at extremely high energies.

New experiments at the HERA electron-proton collider at DESY, Hamburg, gave more examples of the ubiquitous pointlike structure appearing in parton distributions, and Pomeron-like structure when the struck parton carries only a small fraction of momentum (the small-x region).

Theoreticians turned phenomenologists presented satisfying descriptions of the experiments, but no one can yet discuss with any confidence quark-gluon behaviour not tied to a perturbation approximation. These subjects will remain objects of passion and prejudice until either experimentalists can rule out (or in!) certain effects with sufficient precision to exclude theoretical creations; or until theoreticians can arrive at nonperturbative quark-gluon solutions. One should not hold one's breath in the expectation of either event happening in the immediate future; the Odderon and the Pomeron will return.

From H.M. Fried, Kyungsik Kang, C-I Tan

WORKSHOP

RICH people

When high energy particles travel through a transparent substance faster than the 'allowed' velocity of light, so-called Cherenkov radiation is emitted at an angle depending on the particle velocity, in much the same as a shock wave accompanies supersonic aircraft.

Knowing the momentum of the particle by tracking in the magnetic field, and measuring the Cherenkov angle of the emitted photons, the mass can be measured in a momentum range where no other technique is so useful.

This approach is called Ring Imaging Cherenkov (RICH) since the imaging of the radiation on a photosensitive plane perpendicular to the particle direction gives a ring whose radius increases with the particle velocity.

The technique was first suggested by A. Roberts in 1960, and the first prototype developed by J. Seguinot and T. Ypsilantis in 1977. Implementation is recent - SLD at Stanford (SLAC), Omega, CERES and Delphi at CERN.

To review the technique and look at future possibilities, a RICH workshop held last summer near Bari (Italy) examined -1) Status and prospects of running RICH devices; 2) New developments on photosensitive materials and detector systems; 3) Detector technology and electronics; 4) Pattern recognition techniques and data analysis for particle identification; 5) New concepts on the imaging of the Cherenkov light; 6) Proposals for future experiments.

After a historical survey by J. Seguinot, T. Ypsilantis gave a theoretical review of potential and limits. S. Swordy (Chicago) reviewed

WATERTIGHT

under high pressure



Series 03



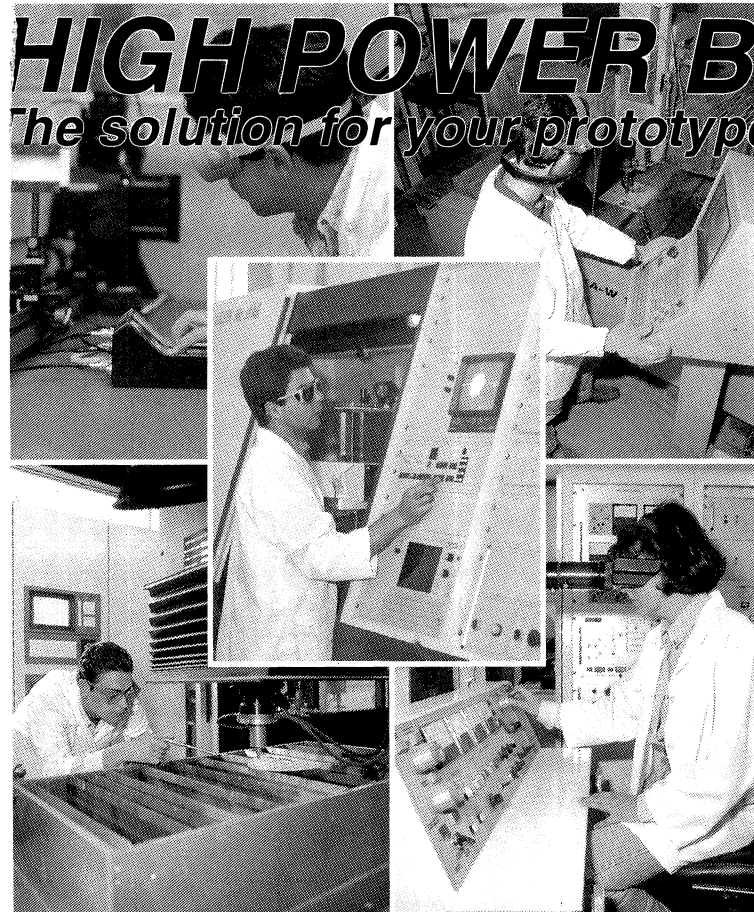
- Screwthread connector coupling system
- Watertight coupling is achieved by the compression of an O-ring guaranteeing the use under very high pressure (max. 60 bars)
- Connectors available as coaxial (50 Ω) or multipole version (2, 3 or 4 contacts). Max. AWG: 30 (stranded), 28 (solid)
- For use in limited space, maximum O.D.: 11.8 mm

LEMO SA P.O. Box 194 CH-1024 Ecublens Tel: 021/691.16.16 Fax: 021/691.16.26

2/94

HIGH POWER BEAM SERVICES

The solution for your prototypes and small batch Production
With Lasers, Electron Beam and Water Jet



Flexibility

Short time delivery

Feasibility analysis

What do we have?

- 2.5 kW CO₂ Laser with a 1.2x0.9m X-Y table CNC
- 900W Nd/YAG Laser with a CIM CNC
- 80W, 400Hz excimer laser with a high precision X-Y-θ table controlled by PC
- 7.5kW electron beam with a 0.8m³ vacuum chamber with a X-θ table
- 15kW electron beam equipment with a X-Y-θ table CNC controlled with a 1m³ vacuum chamber
- 3800 bar high pressure water jet pump with 1.3x2.0m X-Y table CNC

What can we perform?

special parts requiring precision and high quality:

- cutting
- welding
- surface hardening and alloying
- marking and engraving



instituto de soldadura e qualidade

CERN Courier, September 1993



Laboratório de Feixes de Elevada Densidade de Energia

Any enquiries regarding our services should be addressed to:
Mr. Dias Lopes

Address: Rua Francisco António da Silva 2780 Oeiras- PORTUGAL
E-Mail: dLopes@isq.pt Telf. (351)(1) 4429524/99 Fax:(351)(1) 4429799

A recent workshop near Bari (Italy) reviewed the Ring Imaging Cherenkov (RICH) technique. Picking up radiation on a photosensitive plane perpendicular to the particle direction gives a ring whose radius increases with the particle velocity. Combined with momentum measurements from tracking, this gives a useful means of particle identification.



applications in astrophysics and pointed to the wide potential of these devices.

The progress in detector technology was reflected in talks on the largest RICH systems: H.-W. Siebert (Heidelberg), O. Ullaland (CERN), J. Va'vra (SLAC) and P. Glassel (Heidelberg) reviewing the devices installed in Omega, Delphi, SLD and CERES respectively.

Since the heart of any RICH detector is the conversion of ultra-violet photons into electrons, the widest interest was in novel photosensitive materials. These are the technological starting point for future applications.

P. Miné (Ecole Polytechnique-Palaiseau) reviewed current photo-

sensitive materials and compared their properties with new compounds. A lot of R&D work has been carried out on solid photocathodes during the last few years since the pioneering study of G. Charpak, J. Seguinot and T. Ypsilantis on cesium iodide, still the best candidate to replace TMAE or TEA.

First results from solid photocathodes in large photodetectors were shown by several groups. The largest was reported by F. Piuz, for the RD26 Collaboration, using CsI evaporated on a 30x30 cm² cathode subdivided into 8x8 cm² pads: the number of photoelectrons and the angular resolution are promising. Although the quantum efficiency is not yet as good as the best evalua-

tions on small area samples in a controlled environment and using unpolarized UV light, the reports clearly showed the technological feasibility of solid CsI photocathodes in gas counters.

Among the results of great interest from the point of view of experimental technique is the measurement of a considerable photoelectron yield from a CsI photocathode into condensed xenon, krypton and argon, reported by D. Chen (Columbia). Analysis of CsI deposits on different substrates was illustrated by C. Coluzza (EPFL-Lausanne). Although it is still too early to evaluate these studies, they help understand the electron extraction process.

Provocative overviews of novel approaches for recognition of Cherenkov light patterns were presented by J. Baechler (Freiburg), A. Ljubicic Jr. (Zagreb), and J.I. Garcia-Perez (CERN). Physics results from RICH counters were presented by G. Vasileiadis (Athens) for NA35, by P. F. Honoré (Paris) for Delphi and by U. Muller (Mainz) for WA89. The idea of identifying long baseline neutrinos was illustrated by T. Ypsilantis, while M. Artuso (Syracuse) looked at the fast RICH for the CLEO upgrade at Cornell and G. Paic (Zagreb) reviewed the RICH detector proposed for particle identification in ALICE at LHC, based on the solid photocathode concept. J. Friese (Munich) presented a RICH system for HADES at GSI Darmstadt.

Held under the auspices of the major Italian research agencies: INFN, INFM and GNCP-CNR, the conference was also supported by the University and Physics Department of Bari. The Proceedings will be published as a special issue of Nuclear Instruments and Methods.

Industry and spinoff

This year, the CERN Courier plans to highlight the increasingly important area of technology transfer and industrial spinoff from high energy physics.

CERN ESPRIT de corps

Skills in applied data processing are one of the important spin-offs of the CERN experimental particle physics programme. CERN's expertise in this area is being shared in three research and development projects in the framework of ESPRIT - the European Strategic Programme for Research and Development in Information Technology - where CERN is a major partner.

The ESPRIT programme was established by the European Community in 1984 and is active in four Framework Programmes, the fourth such programme having been agreed in June 1993.

ESPRIT was set up with the following objectives:

- to provide European information technology industry with the basic technologies to meet the competitive requirements of the 1990s;
- to promote European industrial co-operation in pre-competitive R&D in information technology;
- to pave the way for internationally accepted standards.

A major aim of the fourth Framework Programme is to make maximum use of the resources available, increase the economic spin-offs and thus help make European industry more competitive. It will also try to improve co-ordination of the European Community states' participation in major international projects and with the research conducted by various European organizations



CERN is a major partner in three European ESPRIT projects using a General Purpose Multiple Instruction Multiple Data (GPMIMD) computer based on the European developed 'transputer' - a singlechip computer incorporating four bi-directional high speed serial links. In this work the T9000 from INMOS/SGS Thomson forms an ideal basic building block for a parallel computer.

including CERN and the European Space Agency.

With advances in accelerator technology and more stringent demands on the experimental front - usually for more data more quickly - data acquisition and handling constantly threaten to bottleneck particle physics. Bearing in mind that the planned LHC proton collider in the LEP tunnel aims for thousand-fold increases in collision rates, parallel processing is an obvious route for the future. In parallel processing, computing modules carry out their allotted tasks at the same time, rather than sequentially as in more traditional computing solutions.

An analogy, quoted by 1982 physics Nobellist Kenneth Wilson of Cornell, is a hypothetical array of parallel desks for optimizing airport checkin, with one clerk checking tickets, another weighing and ticketing baggage, another handling seat allocation, etc., rather than a single clerk doing all these activities one after another.

The importance of massively parallel processing was underlined in the recent European Community study group, chaired by Carlo Rubbia (March 1991, page 19), and the subsequent establishment of a parallel processing steering group to attend to the rapidly evolving special needs of high energy physics (October 1992, page 20).

The three ESPRIT projects envisage using General Purpose Multiple Instruction Multiple Data (GPMIMD) computers, two based on transputers and one on Sparc microprocessor technology, all with fast interconnections building on work carried out in previous ESPRIT projects.

The first project GPMIMD-1 (P5404) uses a GPMIMD computer based on the European developed 'transputer' - a single-chip computer incorporating four bi-directional high speed serial links. The T9000 from INMOS/SGS Thomson, together with the INMOS C104 communications routing chip forms an ideal basic building block for a parallel computer,

especially for real time needs. The machine will be constructed by Parsys (UK) and Telmat (F).

Major hardware tasks for CERN in this particular project are the development of an interface between these parallel processing components and the existing technology standards VME and HiPPI (a High Performance Parallel Interface). The development of an optical fibre link capable of operating over 250 metres will permit geographically distributed Transputer systems.

There are immediate applications for particle physics. Transputers have recently been used for data acquisition and on-line event reconstruction for the CPLEAR experiment at CERN's LEAR low energy antiproton ring. There is particular interest in running the experiment's large FORTRAN programming codes on-line, in parallel.

CERN is the leading partner in a second ESPRIT GPMIMD project, GPMIMD-2, using the CS-2 high

performance parallel computer, based on Sparc chips, and developed by the PCI consortium of Meiko (UK), Parsys (UK) and Telmat (France), in collaboration with CERFACS (Centre Européen de Recherche et Formation Avancée en Calcul Scientifique, Toulouse) and major meteorological centres in France, Germany and the UK.

In this project, CERN is developing applications for data analysis, event reconstruction, and simulation, while the other partners develop large computer programs for meteorology.

The third particle-physics-linked ESPRIT project is HARMONY, which aims to develop the CHORUS operating system for real-time use. CHORUS developments will be used in computing for Positron Emission Tomography (PET). In the wake of George Charpak's invention of rapid electronic detection techniques, PET is another of the big particle physics spin-off successes (April 1993, page 1). Positrons (from neutron-deficient,

positron-emitting isotopes) annihilate with organic electrons, producing a characteristic back-to-back pair of photons. Monitoring these particles provides a rapid three-dimensional scan for medical diagnosis.

CERN's contribution to HARMONY aims to develop a complete PET data acquisition system, based on transputers, giving image reconstruction in real time. As well as serving for routine medical diagnosis, this technology could be used in medical research, for example to study how the brain works. With CERN in this PET work are Lausanne University's Nuclear Physics Institute and the Geneva Cantonal Hospital.

Postdoc Position

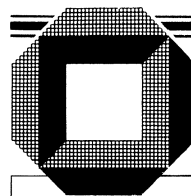
At the National Institute for Nuclear Physics and High Energy Physics (NIKHEF) the Pulse Stretcher/Storage Ring AmPS recently came into operation. This facility provides high duty-factor electron beams for coincidence experiments in the energy range 250-750 MeV. The research program at AmPS includes studies of short-range correlations in nuclei, the physics of the Δ -resonance and internal target physics.

Recently the European 'Human Capital Mobility' Program has given support to formation of an international network of physics laboratories aiming at studying bound nucleon properties using both electron and photon beams. NIKHEF acts as the coordinating group of this network, (also including groups from Edinburgh, Gent, Glasgow, Göttingen and Lund) and as such is inviting applicants for

a postdoc position. The successful applicant will play a central role in the network and carry out comparative studies using the high-duty factor beams of AmPS and of MAXLAB in Lund (Sweden). He/she will be based in Amsterdam and Gent (Belgium) for approximately one year at each location.

Applicants should have a PhD in experimental nuclear physics. Experience with electron and/or photon induced experiments would be an advantage. Letters of application supported by a full CV should be sent to: Mr. T. van Egdorn, Personnel Department NIKHEF, PO Box 41882, 1009 DB Amsterdam, the Netherlands. Information on this position can be obtained from Dr. G. van der Steenhoven, tel. 31-20-5922142 or by E-mail:gerard@nikhef.nl.

NIKHEF



**UNIVERSITÄT
KARLSRUHE**

Am Institut für Experimentelle Kernphysik der Universität Karlsruhe ist eine

C-3 Professur für Teilchen-Astrophysik

zu besetzen.

Bewerberinnen oder Bewerber sollten Erfahrungen bei der Entwicklung und dem Bau grösserer Teilchendetektoren in einem der Fächer Astrophysik, Kernphysik oder Elementarteilchenphysik besitzen. In enger Zusammenarbeit mit dem Kernforschungszentrum Karlsruhe bestehen ausgezeichnete Forschungsmöglichkeiten im Bereich der Neutrinophysik (Experiment KARMEN) und der Höhenstrahlphysik bei sehr hohen Energien (Experiment KASCADE). Zu den Lehraufgaben gehört die Beteiligung an der Physikausbildung auch für Studierende anderer naturwissenschaftlicher und ingenieur-wissenschaftlicher Fachrichtungen.

Die Fakultät für Physik ist bemüht, den Frauenanteil zu erhöhen, und ermutigt daher besonders Frauen, sich zu bewerben.

Habilitation oder gleichwertige Qualifikation werden vorausgesetzt. Bewerbungen mit den üblichen Unterlagen werden bis zum 31.3.1994 erbeten an den Dekan der Fakultät für Physik, Universität Karlsruhe, Postfach 6980, 76 128 Karlsruhe.

EXPERIMENTAL NUCLEAR PHYSICS The Ohio State University

FACULTY POSITION : The Department of Physics invites applications for a tenure track Assistant Professor position in experimental nuclear physics. The successful candidate, who should be capable of establishing an independent research program, would join an existing nuclear group. The present OSU group is comprised of three faculty members working typically with three postdoctoral fellows and about fifteen graduate students. Topics of current study include nuclear astrophysics, relativistic heavy ions, and spin variables in intermediate-energy charge exchange reactions. We are particularly interested in identifying strong candidates who would be able to augment our recent move into relativistic heavy-ion physics at such facilities as CERN and RHIC, but would encourage candidates in other subfields as well. A commitment to teaching is also required.

Applicants should send their curriculum vitae and arrange for at least three persons who can provide a candid professional evaluation to submit references to :

Professor Evan Sugarbaker
Chair of the Search Committee
The Ohio State University
Department of Physics,
COLUMBUS / OH 43210-1106

Pending final administrative approval, the department hopes to fill this vacancy as early as Autumn, 1994. For fullest consideration, applications should be received by April 1, 1994.

The Ohio State University is an Equal Opportunity/Affirmative Action Employer. Qualified women, minorities, Vietnam-era Veterans, disabled veterans and individuals with disabilities are encouraged to apply.

FACULTY POSITION HIGH-ENERGY THEORY

INDIANA UNIVERSITY

Applications are invited for a faculty position at the junior or senior level in high-energy theoretical physics, available September 1, 1994. We seek outstanding candidates in any area of high-energy theoretical physics who can demonstrate the ability to establish a vigorous research program and who have overlapping interests with the Indiana theory group. Each application should include a curriculum vitae, a description of research interests and accomplishments, and a list of publications. Candidates should also have at least three letters of reference sent to : High-Energy Search Committee, Swain Hall West, Physics Department, Indiana University, Bloomington, IN 47405.

Applications received before January 31, 1994 may receive preference.

Indiana University is an Equal Opportunity/Affirmative Action Employer.

UNIVERSITY OF COPENHAGEN

Niels Bohr Institute for

Astronomy, Physics and Geophysics

Associate Professorship in Experimental Nuclear Physics

A position as associate professor (lektor) in experimental nuclear physics at the Niels Bohr Institute for Astronomy, Physics and Geophysics (NBIfAFG) will be open from March 1, 1994.

Experimental nuclear physics research at the NBIfAFG is conducted in part at the tandem laboratory of the Institute, in part in laboratories throughout the world including CERN and Brookhaven National Laboratory. One group studies highspin physics and is deeply involved in the development and use of large solid angle high resolution gamma detectors, such as NORDBALL and EUROBALL. The NORDBALL system is in operation at the institute's tandem laboratory. A second group is engaged in experiments concerning isovector giant resonances, in particular the role of delta resonance excitation. The third group has started experimental research in high energy heavy ion physics at the Brookhaven AGS (experiment E866) and is planning for programs at RHIC (Brookhaven) and LHC at CERN.

The chosen candidate is expected to take on a leading role in experimental research in one of the areas given above and must have documented experience in building up complex experiments. The chosen candidate is expected to participate in the University teaching program at all levels and in particular to contribute towards a new course in modern experimental nuclear physics at the graduate level. The language of undergraduate instruction is Danish, but English will be accepted for the first two years of the appointment.

Applications should include a *curriculum vitae*, a complete list of publications, copies of scientific publications, and further documentation which the applicant wishes to have considered, as well as a brief outline of proposed research. Information about teaching experience should also be enclosed. The material should be submitted in triplicate and should contain a full listing of the items submitted. After evaluation of the applicants' qualifications by a specially appointed Evaluation Committee, its report will be sent to all applicants. The Evaluation Committee may ask for supplementary material, which the applicant then must provide in the requested number of copies. Information about research plans, facilities and staff may be obtained from the Director, Professor Ole Hansen, Niels Bohr Institute for Astronomy, Physics and Geophysics, Blegdamsvej 17, DK-2100 Copenhagen Ø, Denmark; telephone : +45 35325292, fax : +45 35431087, E-mail oleh@nbi.dk. The position will be under a continuing contract as agreed between the Confederation of Professional Unions and the Ministry of Education. The annual salary depends on seniority and ends at a maximum of 326,558 DKK. Applications should be made to the Rector of the University of Copenhagen, written in English, and mailed to the Faculty of Science, Panum Institute, Blegdamsvej 3, DK-2200 Copenhagen N, Denmark. Applications, in order to be considered, must have been received by the Faculty of Science no later than March 1, 1994.

People and things

At the official dinner of CERN Council on 16 December, outgoing Director General Carlo Rubbia received the Cross of Commander of the Polish Order of Merit from Polish Ambassador Ludvik Dembinski.

(Photo CERN HI39.12.1993)

CERN elections and appointments

New elections and appointments voted at the December meeting of CERN Council include Hermann Strub (Germany) as Council Vice-President for one year. New members of the Scientific Policy Committee are Hans Specht, Andreij Wroblewski and Abraham Seiden. At CERN, Gabriele Veneziano takes over as Head of Theory Division from John Ellis.

UK awards

In this year's UK Institute of Physics major awards, Paul Williams, Director of the Rutherford Appleton Laboratory, receives the Glazebrook prize for his contributions to the organization and development of UK science.

Chris Damerell, also from Rutherford Appleton, receives the Duddell prize for his work in the development of a mosaic of charged-coupled devices for precision tracking in an experiment at SLAC, Stanford, which recently produced its first physics (June 1993, page 9).

Wolfgang Paul 1913-1993

Just several months after celebrating his 80th birthday, Wolfgang Paul, Professor Emeritus at the University of Bonn, Germany, former director at KFA Jülich, CERN and DESY, and 1989 Nobel prizewinner for the development of the ion trap technique, died on 7 December.

He was one of the founding fathers of the German and European renaissance of basic physics after World War II. In 1954, with European science in ruins, he launched the construction of a 500 MeV electron synchrotron at Bonn, the first machine in Europe to use the strong



focusing technique, and went on to push for a major German particle physics centre, leading to the establishment of the DESY Laboratory in Hamburg in 1959. In the early 1960s he took over from Willibald Jentschke as Director of DESY, where he was later President of the Scientific Council.

At CERN from 1964-7, he was initially joint Head of Nuclear Physics Division, then Director of Physics I Department. In 1974 he was Chairman of ECFA, the European Committee for Future Accelerators, and from

1975-7 served as Chairman of CERN's Scientific Policy Committee. He was a longstanding member of the German delegation to CERN Council.

In 1989 Wolfgang Paul and Hans Dehmelt shared the Nobel Physics Prize for their development of ion trapping techniques with Norman Ramsey (who was honoured for his invention of the separated oscillatory

Wolfgang Paul soon after his arrival at CERN in 1964. On the right is Viktor Weisskopf.





TRIUMF

MEBON RESEARCH FACILITY
University of Alberta
Simon Fraser University
University of Victoria
University of British Columbia
Competition # 677-113

Accelerator Physicist

TRIUMF has an opening for a Physicist or Engineering Physicist to work as a Research Scientist participating in the design and evaluation of magnet lattices for synchrotrons and storage rings. Research Scientist appointments are permanent staff positions. The initial appointment would be for a period of two years.

Candidates should have a Ph.D. or equivalent in Physics or Engineering, good theoretical abilities, familiarity with particle beam dynamics and experience with modern orbit codes.

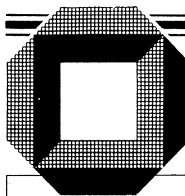
Salary will depend on qualifications and experience.

Please send application with curriculum vitae, a list of publications and the names of three referees to: **TRIUMF Personnel (Comp. #677-113), 4004 Wesbrook Mall, Vancouver, B.C. CANADA V6T 2A3.**

Closing date of applications is **February 28, 1994.**

We offer equal employment opportunities to qualified male and female applicants.

In accordance with Canadian immigration requirements, this advertisement is directed first to Canadian citizens and permanent residents.



UNIVERSITÄT KARLSRUHE

An der Fakultät für Physik ist eine Professur (C3) für Theoretische Teilchenphysik

nach dem Hochschulsonderprogramm II des Landes Baden-Württemberg zu besetzen (Höchstalter bei der Ernennung 45 Jahre).

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 ist bemüht, den Frauenanteil zu erhöhen und ermutigt daher besonders Frauen, sich zu bewerben.

Bewerbungen und Unterlagen über die bisherige Forschungs- und Lehrtätigkeit sowie Sonderdrucke der wichtigsten Publikationen werden bis zum **31. März 1994** erbeten an den Dekan der Fakultät für Physik, Universität Karlsruhe (TH), Postfach 69 80, 76 128 Karlsruhe.

The Max-Planck-Institut für Physik, München, offers the position of an experimental physicist (Ph.D.)

with experience in high-energy particle physics. The applicant is expected to participate in the preparation and execution of the NA49 experiment to investigate lead-nucleus collisions at the SPS of CERN. In particular, his/her work will concentrate on the data acquisition system.

The contract will initially be limited to two years with the possibility of an extension.

Applications, together with a curriculum vitae, a list of publications and two references, should be sent as soon as possible to

Prof. N. Schmitz
Max-Planck-Institut für Physik
Föhringer Ring 6
80805 München
Germany

Department of Physics STANFORD UNIVERSITY

The Department of Physics at Stanford University seeks to make a junior level, tenure-track appointment in the field of Experimental Particle Physics. In exceptional circumstances, a tenure level appointment may be possible. It is likely that an additional position in the field will be available in the near future.

The Department pursues research in fundamental physics and maintains a strong teaching program at all levels.

Candidates will be expected to have demonstrated originality and the ability to carry out an independent research program, along with a commitment to teaching.

Stanford University actively seeks applications from women and minority candidates and is an affirmative-action employer.

Interested applicants should send their curriculum vitae and bibliography plus the names of at least three references to :

Professor Stanley G. Wojcicki
Department of Physics
Stanford University
Stanford CA 94305-4060

The deadline for the applications will be April 1, 1994.

fields method and its use in the hydrogen maser and atomic clocks).

Eduardo Caianiello 1921-93

Eduardo Caianiello, one of the most distinguished personalities in Italian physics, died in Naples on 22 October aged 72. His life was dominated by science, with a wide range of interests but always devoted to fundamental problems. His contributions to quantum field theory, in particular to the analysis of Feynman graphs using permanents and determinants were hailed as revelations of beauty and clarity. His pioneering work in neural networks (Caianiello's equations) already belongs to the literature of the field. He died while completing with his coworkers a study of the implications of the hypothesis of the proper maximal acceleration of a massive particle.

A tireless organizer, he founded and promoted many Italian institutions, the last being the International Institute for Advanced Studies (IIASS) in Vietri sul Mare which hosts important international meetings and is active in neural network research.

With him we lose a protagonist and a witness of one of the most exciting and rich periods in modern physics. Those who had the privilege of knowing him were aware of his deep wisdom and humanity. He embodied the soul of his land to which he was always faithful and linked by profound love.

From Sergio Fubini, Alberto Giovannini and Maria Marinaro.

Eduardo Caianiello 1921-93

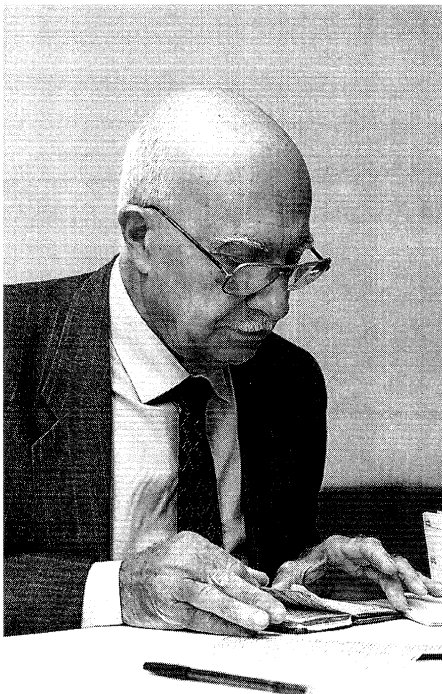
Chinese commemoration

On 16 October, a seminar commemorated the 80th anniversary of the birth of Chinese nuclear research pioneer Qian Sanqiang, who died in 1992. Qian returned from France, where he had been the student of the Joliot-Curies, in 1948 to found the Chinese Academy of Sciences Institute of Atomic Energy.

Oxford orders

The Accelerator Technology Group of Oxford Instruments has a contract to provide the 550 MeV 32-metre accumulator ring for the DAPHNE project at Frascati. This follows Oxford's involvement in the construction of the HELIOS compact superconducting synchrotron for IBM.

Meanwhile Oxford has shipped a large cold iron quadrupole



Chinese nuclear research pioneer Qian Sanqiang with CERN Executive Director General John Adams at CERN in 1978 (Photo CERN 284.6.78)



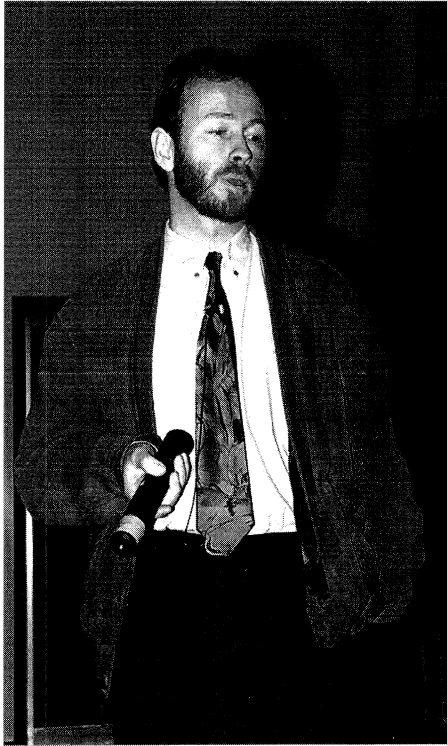
spectrometer magnet for the CEBAF electron machine complex nearing completion at Newport News, Virginia. It will be used for CEBAF's High Momentum Spectrometer in Experimental Hall C.

Reviews of Modern Physics

From January 1, particle physics will be represented in Reviews of Modern Physics by two Associate Editors. Persis Drell of Cornell and William J. Marciano of Brookhaven succeed Chris Quigg of Fermilab, who has served since 1981 as Associate Editor for high energy physics, particles, and fields. Reviews of Modern Physics seeks to present comprehensive, scholarly reviews of topics of interest to a broad range of physicists. The editor and associate editors strongly encourage prospective authors to correspond with them before submitting.

Søren Pape Møller of Aarhus, Denmark, gave the 1993 John Adams Memorial Lecture at CERN in November. In his talk he showed how tiny crystals can do the work of huge magnets to bend particle beams. The John Adams Memorial Lecture is traditionally given by a young physicist around the anniversary of the startup of the PS, CERN's first major machine, in 1959.

(Photo CERN 49.11.93)



Zeuthen, R. Sosnowski of Warsaw, S. Yamada of Tokyo, and Zhi Peng Zheng of Beijing. This membership was elected at Nara last September for a term of three years.

Beam Instrumentation Workshop

The fifth annual Beam Instrumentation Workshop was hosted in Santa Fe, New Mexico, by Los Alamos National Laboratory from 20-23 October. Approximately 120 participants and 15 vendors participated in an agenda that included 25 invited and contributed talks and 30 poster presentations. The next workshop will be held in Vancouver, BC, in October 1994, and will be hosted by TRIUMF. At the Santa Fe workshop the Faraday Cup prize was awarded to Ralph Fiorito and Donald Rule of the US Naval Surface Warfare Center for their development of electron beam emittance measurement techniques using optical transition radiation. The prize is \$5000 and is sponsored by the Bergoz company.

IUPAP Commission

The International Union of Pure and Applied Physics (IUPAP) Commission on Particles and Fields is now chaired by Jean Sacton of Brussels, with G. Mourier of Thomas Tubes Electroniques as Vice Chairman and Barry Barish of Caltech as Secretary. Members are A. Astbury of Victoria, Canada, N. Cabibbo of Rome, V. Kadyshesky of Dubna, P. Kalmus of London, J. Peoples of Fermilab, V. Savrin of Moscow, P. Söding of

Italian Minister for Universities and Research Umberto Colombo formally opens the 'Italy at CERN' industrial exhibition on 30 November, watched by, left to right, CERN Director General Carlo Rubbia, Franco Muscara of the Istituto Nazionale per il Commercio Estero (ICE), Italian scientific attaché in Geneva Claudio Orzalesi, Andriano Massone of ICE who was in charge of the exhibition, and Aldo Bracciani of ICE who was in charge of the stands.



Wolfgang Schnell (right) of CERN receives his honorary Doctor of Science degree from Bodo Baschek, Dean of the Faculty of Science at Heidelberg University. The title of his subsequent lecture was 'New technologies for electron-positron collisions in the TeV region' (see page 7).



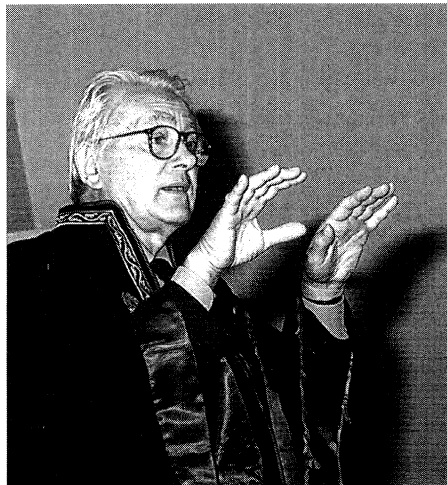
Meetings

The Lake Louise Winter Institute Particle Physics and Cosmology will be held at Lake Louise, AB, Canada, from 20-26 February. Information from The Secretary, Lake Louise Winter Institute, Department of Physics, University of Alberta, Edmonton, AB Canada, T6G 2J1

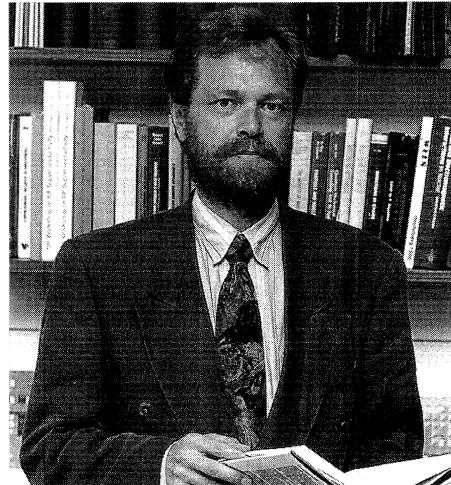
President of the Chinese Academy of Sciences Zhou Guang-Zhao visited CERN on 5 November.
(Photo CERN HI15.11.93)



Recently 1992 Nobel Physics prizewinner Georges Charpak was awarded a doctorate Honoris Causa by the University of Thessaloniki, Greece.



Leading accelerator specialist Thomas Weiland of Darmstadt's Technische Hochschule has been elected a Member of the Mainz Academy of Science and Literature.



Internet llwi@phys.ualberta.ca Fax 403 492-3408, Phone 403 492-1052

The International Conference on "Hypernuclear and Strange Particle Physics" will be held in Vancouver, BC, Canada, on the UBC campus, from 4-8 July. This is the next in a series of conferences previously held at Heidelberg (1982), Brookhaven (1985), Padova (1988) and Shimoda (1991) to discuss recent developments concerning Hypernuclear and Strange Particle Physics. This conference is being organized by TRIUMF. Any further inquiries and correspondence about the conference should be directed to: HYP94, TRIUMF, 4004 Wesbrook Mall, Vancouver, B.C., CANADA V6T 2A3
E-Mail: INTERNET: HYP94@TRIUMF.CA HEPNET: ERICH::HYP94 fax: (604)-224-6910 Phone: (604)-222-1047. You may also sign onto an anonymous FTP: "FTP TRIUMF.CA" and look in subdirectory HYP94 for additional information that we shall be inserting from time to time. You will be asked to enter your full account name as a password.

An Advanced Study Institute on Techniques and Concepts of High Energy Physics will take place from June 16-27, sponsored by: NATO Advanced Study Institutes Program, US Department of Energy, US National Science Foundation, Fermilab, and the University of Rochester in St. Croix, U.S. Virgin Islands. Further information from C. Jones, Dept. of Physics & Astronomy, (ASI-94) University of Rochester, Rochester NY 14627 USA, e-mail CONNIE@PAS.ROCHESTER.EDU Attendance is limited to about 60 advanced graduate students and recent PhD recipients.

The Fourth Annual Conference on Electronics for Future Colliders will be held at LeCroy Corporation HQ on 11-12 May. Further information from George Blamar, LeCroy Corporation, 700 Chestnut Ridge Road, Chestnut Ridge, NY 10977-6499. Phone (914) 578-6012, fax (914) 578-5984.

The next Workshop on Phenomenological Strong Interaction

Theory, Hadrons 94, will be held from 7-11 September. Further information from Mrs. G. Bugrij, Hadrons, Bogoliubov Institute for Theoretical Physics, Kiev 143, Ukraine. Fax +7-044-2665998, e-mail ABUGRIJ@GLUK.APC.ORG

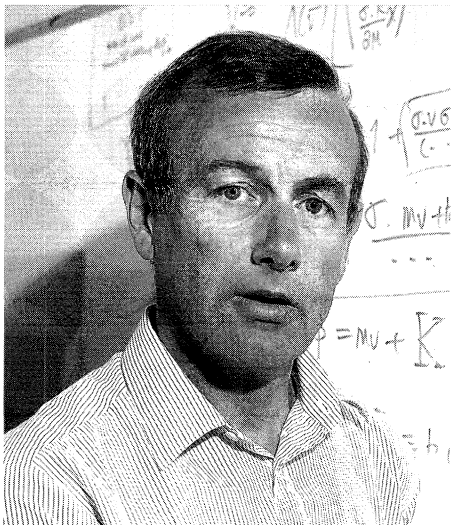
A summer school on hadronic aspects of collider physics will be held at Zuoz (Engadine) Switzerland, from 23 - 31 August organized by the Paul Scherrer Institute (PSI), Villigen.

Requests for registration should be sent to Mrs. C. Kunz (secretary) PSI, 5232 Villigen-PSI, Switzerland, Telephone + 41-56-994223, Fax +41-56-993294, e-mail: CKUNZ@cageir5a.bitnet before June 18.

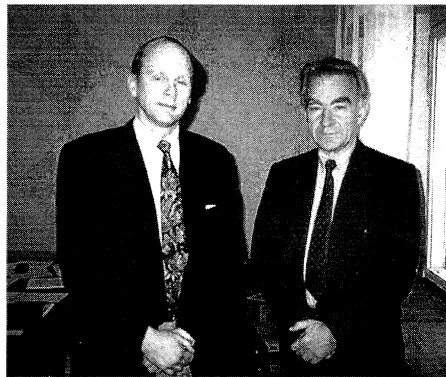
1994 European School of of High-Energy Physics (formerly CERN-JINR School of Physics)

The 1994 European School of High-Energy Physics will take place from 29 August to 11 September at the Grand Hotel Cocumella, Sant'Agnello, near Sorrento, Italy. The topics covered will include Field

In December, Frank Close of the UK Rutherford Appleton Laboratory gave the traditional Christmas lectures at the Royal Institution, London. His subject was 'the Sixth Sense' - how scientific ingenuity and new technology extend our awareness to reveal a 'hidden' Universe. Meanwhile the widely admired illustrated book 'The Particle Explosion' by Frank Close, Michael Marten and Christine Sutton is now available in paperback (Oxford University Press - ISBN 0-19-853999-1)

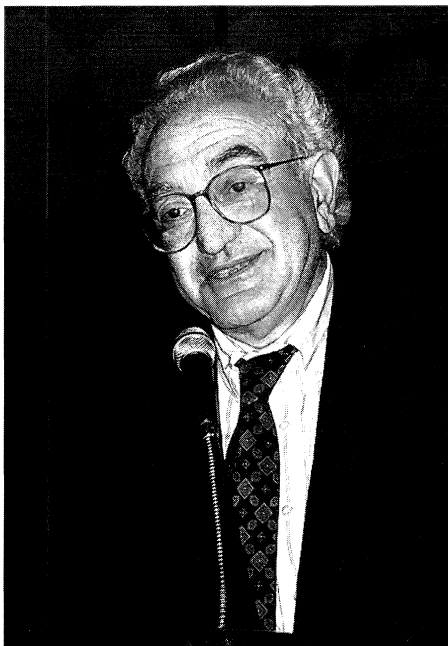


Lars Brink (left) Chairman of Nordita, Copenhagen, with Leonid Keldysh, Director of Moscow's Lebedev Institute, at the first meeting of the governing board of Moscow's new International Centre for Fundamental Physics. The new centre aims to safeguard Russia's impressive heritage in physics in difficult times and at the same time to promote Russian participation in world science.



Susannah_Tracy@dgmail.cern.ch
 Telex: 419000 cer ch Telephone: + 41 22 767 2724 Telefax: + 41 22 782 3011. The closing date for applications is 31 March 1994.

Theory, Radiative Corrections, QCD, the Standard Model and Beyond, CP Violation, Results from Colliders, and Astrophysics/Cosmology. Further information from: Miss S.M. Tracy, School of Physics, CERN - DG-DI, 1211 Geneva 23, Switzerland. E-mail:



26 December marked the 60th birthday of Anatoli Efremov (above) of the Bogoliubov Theoretical Laboratory, Dubna.

Nicola N. Khuri (left) recently celebrated his 60th birthday. Khuri, Professor of Theoretical Physics at Rockefeller University, New York, predicted (with T. Kinoshita) that the real part of the proton-(anti)proton scattering amplitude becomes positive at high energies if reaction rates rise (see December 1993, page 14). (Photo Schu Martin)

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)
J. Cooper, J. Holt
- GSI Darmstadt, (Germany)
G. Siebert
- INFN, (Italy)
A. Pascolini
- IHEP, Beijing, (China)
Qi Nading
- JINR Dubna, (Russia)
B. Starchenko
- KEK National Laboratory, (Japan)
S. Iwata
- Lawrence Berkeley Laboratory, (USA)
B. Feinberg
- Los Alamos National Laboratory, (USA)
C. Hoffmann
- Novosibirsk, Institute, (Russia)
V. Balakin
- Orsay Laboratory, (France)
Anne-Marie Lutz
- PSI Laboratory, (Switzerland)
R. Frosch
- Rutherford Appleton Laboratory, (UK)
Jacky Hutchinson
- Saclay Laboratory, (France)
Elisabeth Locci
- IHEP, Serpukhov, (Russia)
Yu. Ryabov
- Stanford Linear Accelerator Center, (USA)
M. Riordan
- TRIUMF Laboratory, (Canada)
M. K. Craddock



Pierre Auger (left) at CERN's 30th anniversary in September 1984 with Edoardo Amaldi. In the early 1950s, the two men, respectively as head of UNESCO's Exact Sciences Department and Secretary General of the fledgling international organization, played vital roles in the establishment of CERN. Seen between them is Denis de Rougemont (1906-1985) who as founder of the European Cultural Centre helped make the CERN idea a reality, while on the right is Jean Mussard, Auger's assistant at UNESCO.

(Photo CERN 88.9.84)

formidable skills were widely sought, for example in national committees in broadcasting and literature as well as science, while on an international level he was a member of a UN group on the application of science and technology for development.

Pierre Auger 1899-1993

Distinguished French scientist and statesman Pierre Auger died on 24 December, aged 94. Rarely has one man been able to contribute so much to science and to scientific administration on both national and international levels.

In 1925, before completing his doctorate, he discovered the famous multiple cloud chamber electron tracks which showed that X-rays could eject several electrons from a single atom. The main photoelectric electron was accompanied by characteristic 'Auger electrons' from an atomic reorganization. In 1932 he carried out pioneer studies of neutron production from beryllium bombarded by alpha particles. Subsequently turning to cosmic rays, his physics research career was crowned in 1938 by the discovery of the large cosmic ray showers resulting from primary interactions high in the atmosphere each producing hundreds of millions of secondaries extending over hundreds of metres on the ground.

After founding the documentation service of the Centre nationale de la recherche scientifique (CNRS), at the outbreak of the Second World War he went to Montreal to work with the

Anglo-French atomic energy team, subsequently moving to the French Scientific Mission in London.

After the war, he was Director of Higher Education in France (where he helped establish new national technical institutes) and a founder member, with Frédéric Joliot-Curie, of the Atomic Energy Commission. In 1948 he became head of UNESCO's Exact Sciences Department. In a 1950 UNESCO Conference in Florence, Isidor Rabi proposed that UNESCO should 'assist and encourage... regional centres and laboratories... to increase... international collaboration of scientists'.

Auger made this 'Rabi resolution' a reality. He worked tirelessly, travelling around Europe for high-level meetings. His good contacts made these meetings especially fruitful, while his far-sightedness ensured that CERN's government had the correct international flavour. At a UNESCO meeting in 1952 the provisional 'Conseil Européen pour la Recherche Nucléaire' (a title subsequently discarded but which gave the acronym CERN) was set up.

In the late 1950s, at the same time as being CNRS Research Director, he became involved in space research, first on the national level, then as Director General of the European Space Research Organization (ESRO) from 1962-67. Auger's

World Wide Web

The next San Miniato meeting (1st San Miniato Topical Seminar on World Wide Web and Beyond in Physics Research and Applications) will take place from 14-18 March in San Miniato (Pisa), Tuscany. The meeting is organized jointly by F.-L. Navarra of the University of Bologna [vaxbo::KAOS, KAOS@bo.infn.it], P.G. Pelfer of the University of Florence [vaxfi::TOP93, TOP93@fi.infn.it] and R. Cailliau of CERN [cailliau@www1.cern.ch]. The Seminar will start with the discussion of the present status and of the perspective impact of World Wide Web in several areas connected with physics research and applications: high-energy and underground physics, nuclear medicine, astrophysics, molecular biology, meteorology. Advanced computing techniques in high energy physics and biology will also be discussed. Some projects, detectors and experimental results will be presented with emphasis on new and non conventional computing techniques and algorithms.

Powered Crates

Further to all our **CERN approved CERN-Spec. Crates**
NIM-, CAMAC-, FAST BUS-, VMEbus 422/430

Wes-Crates supplies other Crates based upon these Systems.

Some applications with our well known, extremely low noise and ripple, and electromagnetic shielded FAST BUS-Power Supplies:

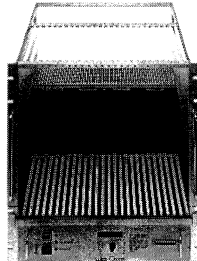
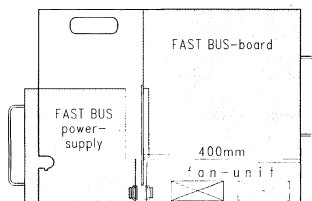
Power Supply Spec.:

Input voltage: 3-phase, 400 V - 50 Hz / 200 V - 60 Hz
Neutral line-load < 2A.

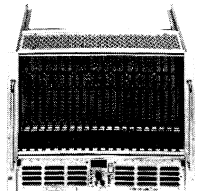
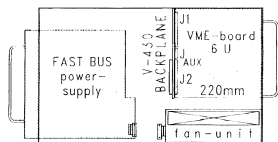
Output power: Up to 3.500 W.

Output modules: -2 V - 50/100/150 A. +5V/-5,2 V - 75/150/200/300 A. +12 V/-12 V - 10/25/40 A. +15/-15 V - 10 A/25 A/35 A.
Other voltage/current outputs on request.

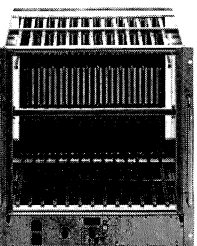
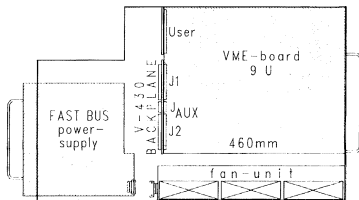
Output protection: Global Trip-Off of all voltage within 5msec. at any bad status, overload, overvoltage, overheat, line error and switch-off mains.
(Outputs discharged with crowbars).



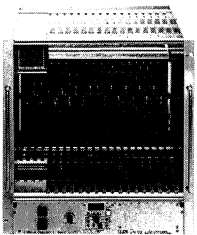
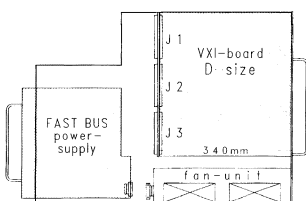
FASTBUS-Crate acc. to CERN-Spec. F6852.
Tested and accepted by **CERN Electronic Pool.**



VMEbus-Crate with +5 V, -5 V, +9 V, +12 V, -12 V.
For supply of linear voltage regulators for external amplifiers.



VMEbus-Crate with +5 V, -5,2 V, -2 V, +12 V, -12 V. Slot 1-4 for standard VMEbus-boards, slot 5-21 for big size 9U x 460 mm.



VXIbus-Crate with +5 V, -5,2 V, -2 V, +12 V, -12 V

Every **CERN-Spec.** so far has given rise to a **CERN-approved Crate** from:

Custom Crates and Power Supplies
WES-Crates is flexible because of modular systems for crates and power supplies.

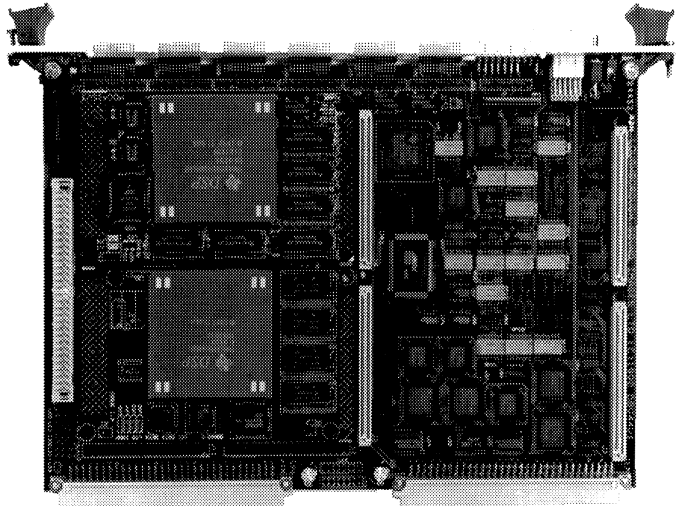
Wes-Crates

Wes-Crates GmbH
Pattburger Bogen 33
D-24955 Harrislee/Flensburg
Germany

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

Your contact in Geneva: HiTech Systems Sa, Abenue Wendt 16,
1203 Geneva, Tel.: 022 / 344 77 88, Fax: 022 / 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

DSP Solutions for VMEbus

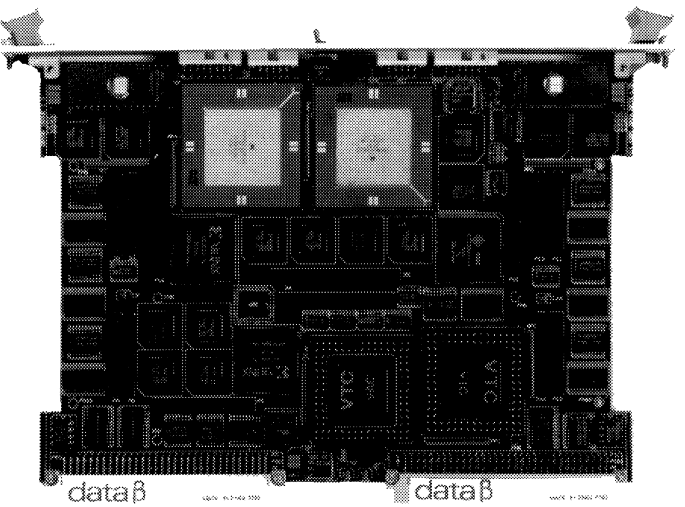


Hardware

Wide range of DSP boards using
DSP96002
TMS320C40
... and others
High speed analog I/O

Software

Workstation & PC based Development Tools
Extensive DSP Libraries



Applications

Data Acquisition
Digital Control
Frequency Analysis

The Company

Loughborough Sound Images is the leading European manufacturer of DSP solutions for VMEbus and other standard bus systems.
LSI is already an established supplier to High Energy Research facilities.

Call now for further information



**Loughborough
Sound Images Limited**

The Technology Centre Epinal Way
Loughborough Leicestershire LE11 0QE England
Tel: +44 (0)509 231843 Fax: +44 (0)509 262433

INCORPORATING
dataβ

The DSP Company

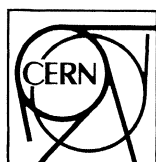
Experimental Particle Physicist

The Lawrence Berkeley Laboratory is seeking an outstanding experimentalist in particle physics for a position as a Divisional Fellow. The term of the position is up to five years, with expectation that the Fellow's professional accomplishments may lead to promotion as a Senior Scientist. Applicants should have demonstrated excellence in experimental particle physics research.

The Divisional Fellow will be expected to contribute substantial original research to one of the ongoing or prospective high-energy programs in the LBL Physics Division. These include experiments with the Tevatron Collider, the SLAC B-factory, and the LHC at CERN. Monthly salary range is \$3855-\$6750.

Please send inquiries, with a professional resume, list of publications, and names of four references to: **Dr. Robert Cahn, Director, Physics Division, Lawrence Berkeley Laboratory, c/o Mary Anne Holman, Staffing Office, Box # JCEC2044, One Cyclotron Road, Bldg. 938A, Berkeley, CA 94720.** Applications should be received before March 15, 1994. Equal Opportunity Employer.

 **LAWRENCE BERKELEY LABORATORY**
UNIVERSITY OF CALIFORNIA
U.S. Department of Energy



GENEVE, SUISSE
GENEVA, SWITZERLAND

ORGANISATION EUROPÉENNE POUR LA RECHERCHE NUCLÉAIRE
EUROPEAN ORGANIZATION FOR NUCLEAR RESEARCH

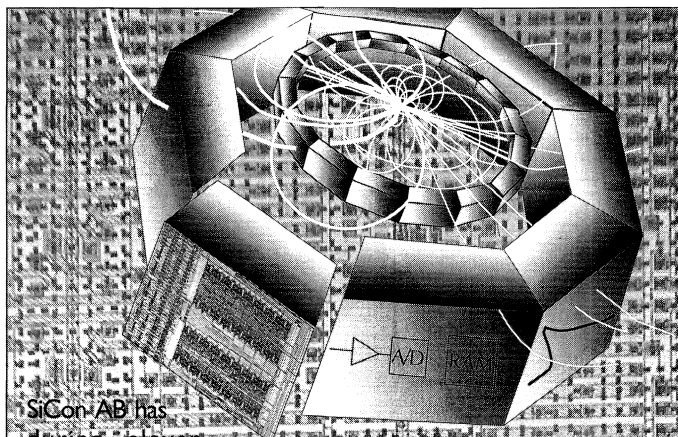
Laboratoire Européen pour la Physique des Particules
European Laboratory for Particle Physics

COURRIER CERN

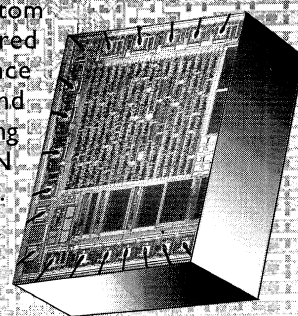
Le Courrier CERN offre à un jeune physicien de langue maternelle française, capable de traduire de l'anglais en français, la possibilité de collaborer occasionnellement à des travaux de traduction d'articles du Courrier CERN.

Des offres écrites avec des traductions de textes déjà effectuées sont à présenter au rédacteur du Courrier CERN,

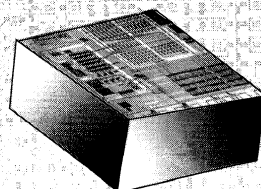
Gordon Fraser
Rédacteur
Courrier CERN
CH -1211 Genève 23 (Suisse)



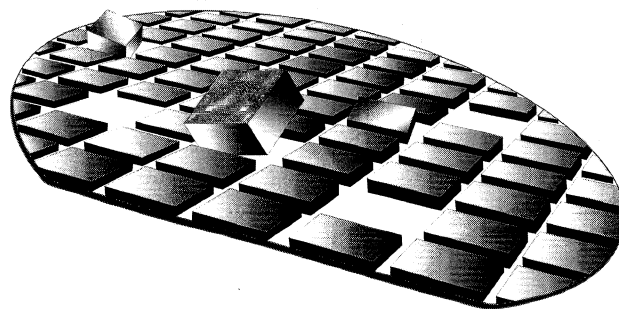
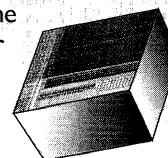
SiCon AB has during eleven years worked with design of custom integrated circuits. We have more than forty manyears of experience in analog/digital full custom design. We have delivered several high performance circuits to industries and research institutions, among others SAAB and CERN (RD6, WA98 and Fermi). SiCon AB works totally independant of vendors, which is possible by using a state of the art CAD-system and by having agreements with a number of producers in Europe, USA, Korea and Japan.



SiCon AB can offer a complete range of services, from consultations in semiconductor physics to delivery of fully tested custom integrated circuits. We have experience in shapers, A/D-conversion, readout buffers and derandomizers.



Call or write today and discuss with our engineers about the possibility of realising your electronics in custom integrated circuits.

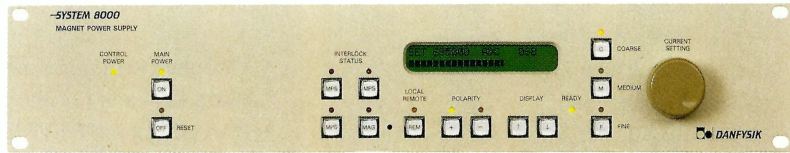


SILICON CONSTRUCTION AB

Teknikringen 2 Telefon: +46 13 21 27 21
S - 583 30 Linköping Telefax: +46 13 21 27 19
Sweden e-mail: sicon@sicon.se

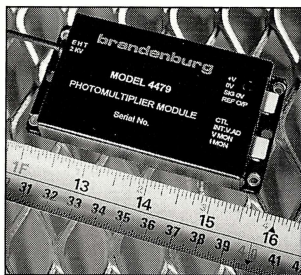
If you're looking for the highest performance – precision magnet power supply, with ultimate stability class rating – and inbuilt service “spotting” procedures, you can't afford not to use system 8000.

- Current range from 50 A to 10.000 A
- Power range from 1 kW to 1 MW
- Stability classes: 0.1, 1 and 10 ppm
- Linear, switchmode or SCR technology
- Low noise and high efficiency
- Standardized modular construction
- RS232C/422, IEEE488 or custom built interfaces



DANFYSIK Probably the best magnet power supply technology you can buy...

DANFYSIK A/S · Møllehaven 31 · DK-4040 Jyllinge · Denmark · Tel.: +45 46 78 81 50 · Fax: +45 46 73 15 51
 In USA: GMW Associates · Tel.: (415) 368-4884 · Fax: (415) 368-0816



The World's smallest and most cost effective Photomultiplier Module is part of a big range!

The latest addition to Brandenburg's photomultiplier power supply range, Model 4479, delivers up to 2W with 4mV pk-pk across the range up to 2kV - all from a device only 15mm high. The 4479 module range includes 48 products with current and voltage monitoring as standard. For details of this and all the other pm products call us on **44 (0) 384 393737**, or fax **44 (0) 384 441308**.

MODEL	RATING	OUT PUT		INPUT	FEATURES
568	3W	300V, 10mA	6KV, 500µA	2V-12VDC	<ul style="list-style-type: none"> ■ Floating short circuit protected output ■ Output voltage proportional to input ■ PCB mountable and fully encapsulated ■ Input/output isolation > 3KV
2478	10W	1KV, 10mA	2KV, 5mA	24VDC	<ul style="list-style-type: none"> ■ Output adjustable 20-100% UF nominal ■ Ripple 5mV pk-pk ■ Good line and load regulation ■ Remote programming ■ Positive and negative versions
2479	7W	1.7KV, 4mA	3.5KV, 2mA	24VDC	<ul style="list-style-type: none"> ■ Output adjustable 20-100% UF nominal ■ Ripple 5mV pk-pk ■ Good line and load regulation ■ Remote programming ■ Positive and negative versions
3479	1.7W	300V, 2mA	1.7KV, 1mA	12, 24VDC	<ul style="list-style-type: none"> ■ Remote control (> 10VDC) ■ Excellent line and load regulation ■ Low ripple and tempco ■ PCB or chassis mountable
NEW 4479	2W	300V, 3mA	2KV, 1mA	12, 24VDC	<ul style="list-style-type: none"> ■ 15mm high ■ Current and voltage monitor as standard ■ PCB or flying lead versions ■ Ripple 4mV pk-pk ■ Low tempco and fixed output

High Street, Wollaston, Stourbridge, West Midlands DY8 4PG England

brandenburg

DENMARK	GERMANY	HOLLAND	FRANCE	FINLAND	USA	ITALY
0 4288 3833	0 421 555179	0 76 78 49 11	0 1 45 471595	(9) 0 7775733	508 881 7434	0 2 24 88 971

CES PRESENTS:

The VMDIS 8004 : a new VME / VSB Display and Diagnostic Module, essential to monitor the backplane activity and measure the performance of modern VME / VSB systems at over 80 Mbytes/s

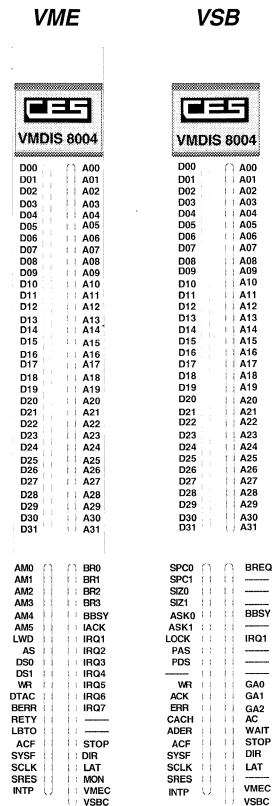
- Switch selectable VME or VSB Display
- VME mode displays :
 - Address Lines, including A64
 - Data Lines, including D64
 - Address Modifier Lines
 - Control Lines
- VSB mode displays :
 - Address Lines
 - Data Lines
 - Control Lines
- Direct, Latched or Monitor display modes
- Control and Status registers accessible over VME through a VME Slave interface
- High-Speed Slot 1 functions
- VSB Central Arbitrer
- Block transfer counter and Cycle duration timer
- Delay between DS and DTACK programmable in monitoring mode
- VME interrupter, activated by front-panel push-button or external signal (NIM/TTL)
- VME SYSRESET, activated by front-panel push-button or external signal (NIM/TTL)
- VME SYSRESET can be generated in response to software request

The VMDIS 8004 is an extension of the VMDIS 8003 Display and Diagnostic Module, providing additional visual and computer controlled test features. Among these features:

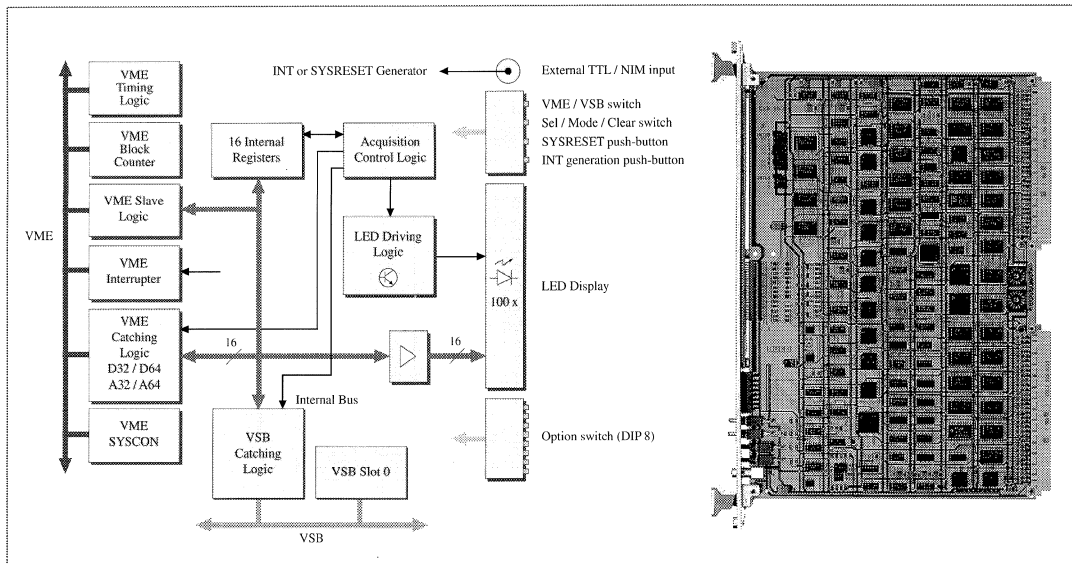
- Designed to monitor modern VME systems using D64 and / or the VSB bus.
- Provides extended VME test features when booting a VME based microprocessor system. All data, address and control lines of the VME and VSB busses are latched in a set of registers which can be read back over the VME bus.
- Generates VME interrupts on programmable levels under manual control. This feature is extremely useful when debugging software requiring interrupt handling.

Performance measurement section

- The VMDIS 8004 can count the number of VME cycles which respond to selected criteria. This feature is of great help when debugging DMA transfers.
- It is also equipped with timing logic which measures the duration of VME cycles.



If you liked the VMDIS 8003, you will love the VMDIS 8004



CES, at the leading edge in system conception

For any additional information about this product or our complete VIC, VME, CAMAC and FASTBUS line, do not hesitate to contact us.

CES Geneva, Switzerland Tel: +41-22 792 57 45 Fax: +41-22 792 57 48
 CES.D Germany Tel: +49-60 55 4023 Fax: +49-60 55 82 210
 CES Creative Electronic Systems SA, 70 Route du Pont-Butin, P.O. Box 107
 CH-1213 PETIT-LANCY 1 SWITZERLAND

