

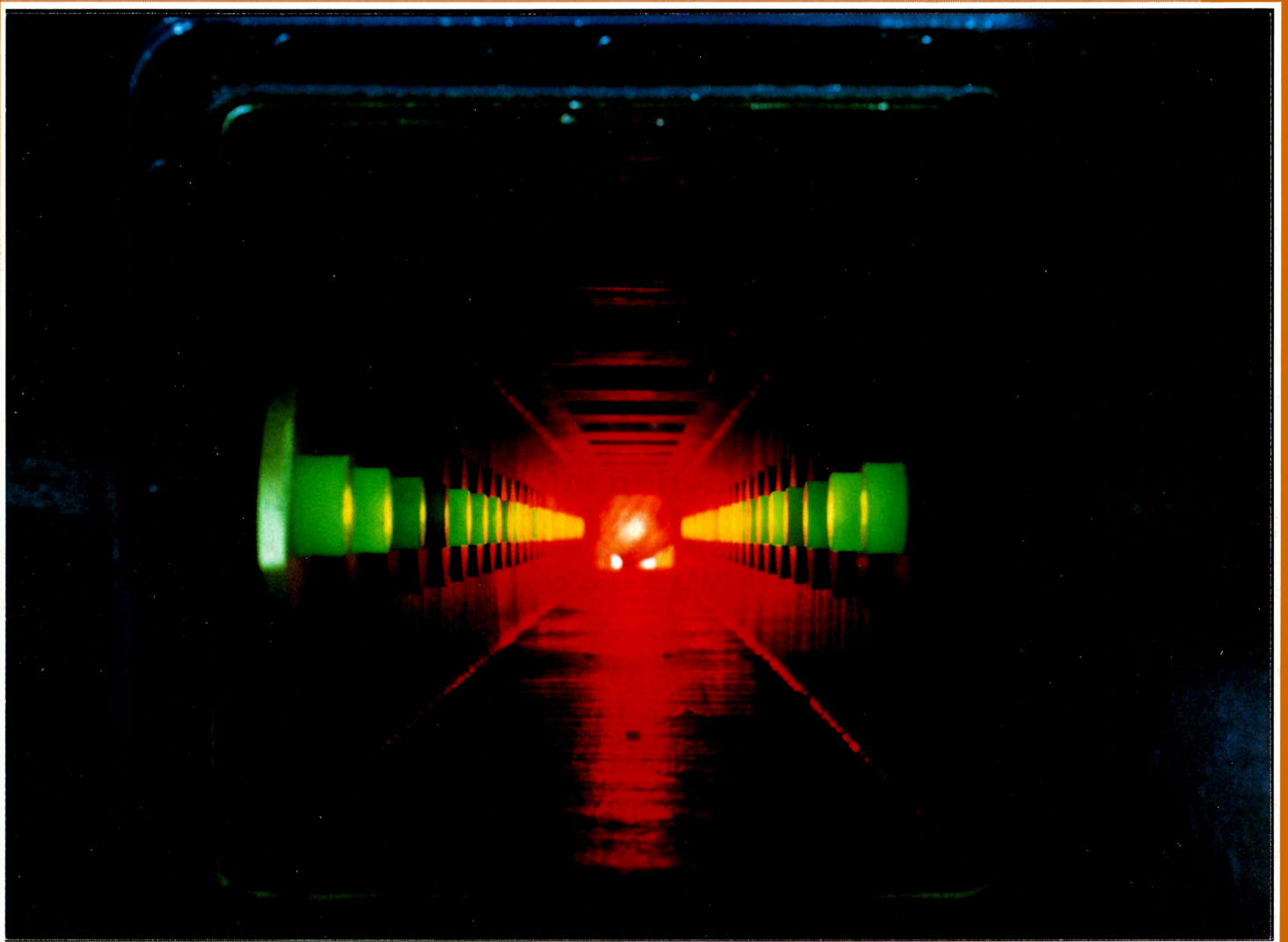
CERN COURIER

INTERNATIONAL JOURNAL OF HIGH ENERGY PHYSICS

VOLUME 36

7

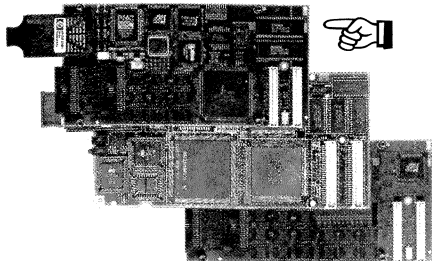
OCTOBER 1996



CES PRESENTS:

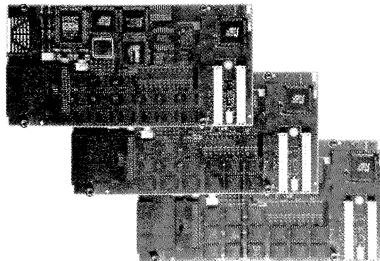
One more option in the PMC family for RTPC / RIO2 processor cards:

Communications



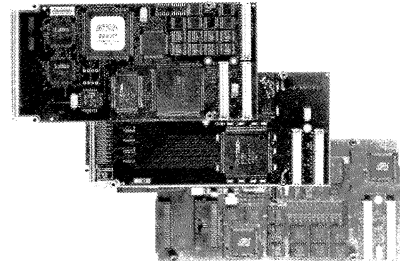
- ATM 8468
- FDDI 8466
- ETH 8477

Customer designed



- Flash ADCs
- Digital In/Out
-

Busses and Connections



- VSB 8464
- SCSI II 8465
- VIC2 8425

ATM 8468: 155 Mbits/s ATM PCI Mezzanine Card

- Easy to use: completely integrated in the CES RTPC / RIO2 Lynx development and target packages
- Low latency: 5 μ s
- High bandwidth:
 - 155 Mbits/s AAL5
 - 100 Mbits/s UDP or TCP/IP
- Low CPU load: independent PCI DMA channel
- High versatility:
 - Stand Alone C Library AAL5
 - Lynx-OS low level driver AAL5
 - Lynx-OS high level driver TCP/IP

Typical Applications

- ATM intelligent dispatcher RIO2 8061DA + up to 4 ATM 8468BA + embedded firmware
- ATM TCP/IP interface between host processors and a cluster of RIO2 interconnected by high speed transparent PCI/PCI link (VIC28425)

Ordering information

- ATM 8468BA: 155 Mbits/s ATM Fibre PMC (C Library included)
- AWL 31680A: ATM Lynx-OS low level driver for RTPC / RIO2
- AWL 33680A: ATM Lynx-OS high level driver for RTPC / RIO2 (TCP, UDP / IP)

Related Products

- RTPC 8067 family: PowerPC 604 based Real-Time VME Development Processor Board
- RIO2 8061 family: PowerPC 604 based Real-Time VME Target Processor Board

Contact CES directly or visit us on WWW at http://www.ces.ch/CES_info/Welcome.html

Your Real-Time Partner

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 EMail: ces@lancy.ces.ch
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



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

Guy Griffiths
Advertising Manager, USA
International Publishers Distributor
820 Town Center Drive
LANGHORNE PA 19047
Tel.: (215) 750-2642
Fax: (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, to request copies or to make address changes contact :

China

Dr. Qian Ke-Qin
Institute of High Energy Physics
P.O. Box 918, Beijing,
People's Republic of China

Germany

Gabriela Heessel or Monika Stuckenberg
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

Janice Voss
Creative Mailing Services
P.O. Box 1147
St. Charles, Illinois 60174
Tel.: 630-377-1589 / Fax: 630-377-1569

CERN COURIER is published monthly except January and August 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
Periodicals postage paid at St. Charles,
Illinois

ISSN 0304-288X

Volume 36
No. 7
October 1996

CERN COURIER

Covering current developments in high energy physics and related fields worldwide

Editor: Gordon Fraser CERN.COURIER@ CERN.CH
Production and Advertisements:

Micheline Falciola
Micheline_Falciola@macmail.cern.ch
Advisory Board: E.J.N. Wilson (Chairman), E. Lillestol,
M. Neubert, D. Treille; with L. Foà,
E.M. Rimmer

World Wide Web <http://www.cern.ch/CERN/Courier/>

1 Warsaw conference
James Gillies reports on major international meeting

8 Euroconference QCD
Quantum chromodynamics in the spotlight

9 A quarter century of hadron colliders
Looking back to the Intersecting Storage Rings

Physics monitor

13 SPACE: Gravitating towards physics
Physics experiments for orbit

13 BEAM EXTRACTION: LEAR and COSY
Peeling off particles slowly

14 HISTORY: Pauli heritage

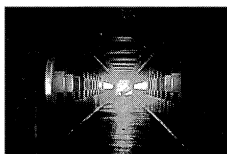
Around the Laboratories

18 CERN: Another step for LEP
End of 80.5 GeV per beam run

18 DESY: Upgrading H1
Plans for HERA detector

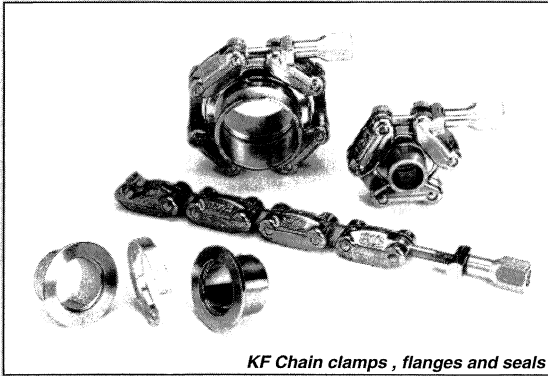
20 UPPSALA: Pelting pellets
New experiment at CELSIUS ring

22 People and things

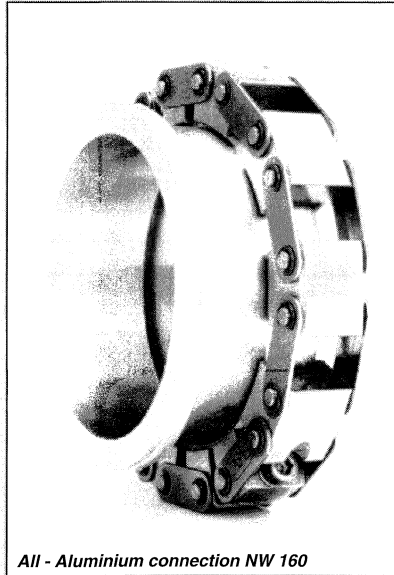


Cover photograph: An inner view of the optical fibre readout for the scintillating tile hadron calorimeter of the 7,000-tonne ATLAS detector for CERN's future LHC proton-proton collider. First full-size prototype ATLAS modules are now arriving at CERN (see page 24 - Photo CERN 4/7/1996).

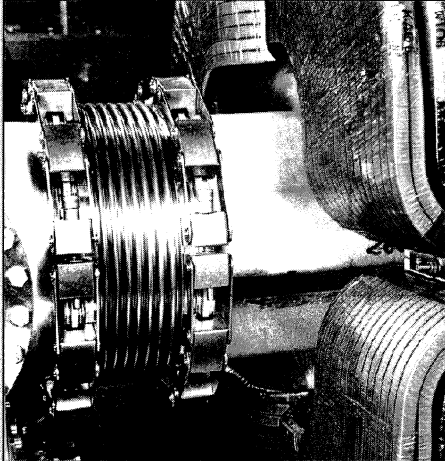
All - Aluminium Seals and Fittings for Accelerators



KF Chain clamps, flanges and seals



All - Aluminium connection NW 160



Picture: Courtesy of GSI Darmstadt
NW 250 connection w. Aluminium Seal and Chain Clamp

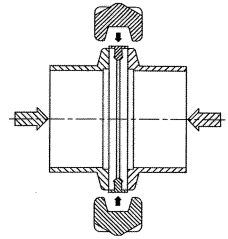
NEW: Ask for our free **GUIDE** to Aluminium Seals and Chain Clamps!

For clean, particle free vacuum with one or two bolt convenience, consider the ease of EVAC chain clamps, flanges and seals, bakeable to 150°C.

EVAC is your source for:
Quick Release Flange Couplings, Aluminium Seals and Fittings from KF NW16 to ISO NW800.

Customized Components for all applications including Medical Accelerators.

EVAC chain clamps provide for the rapid interconnection of two pipes, using tapered flanges. Intermediate seals centre the flanges forming a high vacuum connection.

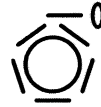


Applications:

- All kinds of Accelerators
- High Vacuum and UHV
- Process Technology
- Cryogenics
- Chemistry

Advantages:

- Time saving assembly
- High clamping force
- Equal distribution of tightening force
- Usable even where access is limited
- Especially suitable for metal seals
- Aluminium seals bakeable to 150°C



Quick - Release
Flange Couplings

EVAC AG

Fabrikstr. 16, CH-9470 Buchs (Switzerland)
Tel: +41 81 750 06 70, Fax: +41 81 750 06 79

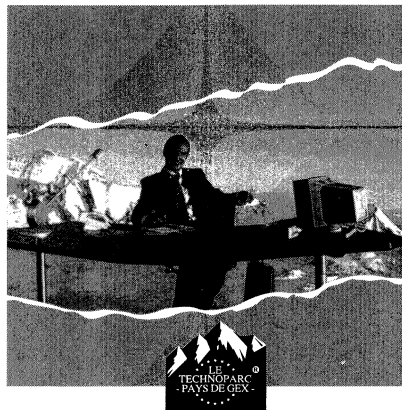
UNE HAUTE IDÉE DE L'ENTREPRISE

À 10 minutes de l'aéroport international de Genève, au carrefour des réseaux autoroutiers F/CH/D/I, près de deux gares TGV, à proximité du prestigieux CERN.

propose sur 40 hectares :
parcelles de terrains viabilisées (achats ou location)
bureaux
bâtiments mixtes
pépinière d'entreprises
services spécifiques d'assistance aux entreprises pour une implantation régionale et pour des relations avec le CERN.

CONTACT :
**SYNDICAT INTERCOMMUNAL
D'ACTIVITÉS DU PAYS DE GEX**
50, RUE GUSTAVE EIFFEL
F- 01630 SAINT-GENIS -POUILLY
Tél. (033 04) 50 42 20 00
Fax (033 04) 50 42 20 20

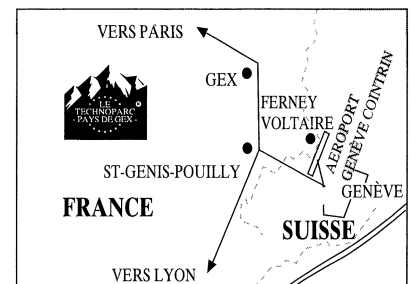
LE TECHNOPARC - PAYS DE GEX -



A GREAT BUSINESS IDEA

A Ten minutes' drive to Geneva International Airport, at the crossroads of the F/CH/D/I motorways, close to two TGV railway stations, right next to the prestigious CERN.

proposes 100 acres (40 ha) of site with :
pieces of equipped land (purchasing or renting)
offices spaces
activity buildings
incubator
specific assistance services to Firms for a regional establishment and for business relationships with CERN.



What you see here is a selection of replacement parts for your old turbo pump in corrosive gas technology.



Is your old turbo in corrosive gas and process technology just about to give up the technical ghost? Here you see the five models of our Turbo "C" series that are far more than mere replacements:

- Pump sizes with pumping speeds from 210–2200 l/s
- High flow rate and safe pumping of aggressive gases while saving fore-vacuum costs
- Hydrocarbon-free high vacuum
- Surfaces in contact with the gases protected against corrosion
- Final pressure 10^{-10} at 10 mbar fore-vacuum pressure
- Use of economical diaphragm pumps possible

And what's more, system, power and operating costs are minimal.

Of course, the models of the Turbo "C" series are not only "replacement parts", but can be used in all applications which require pumping of corrosive gases.

PM 800 159 PE

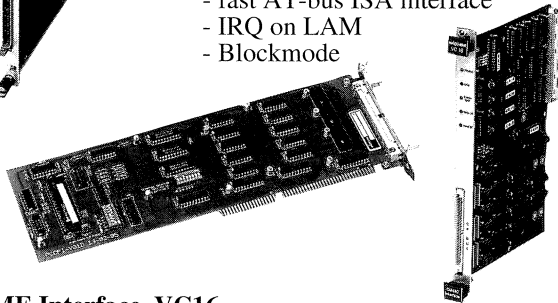
The Renaissance of CAMAC

CAMAC - VME - PC Link



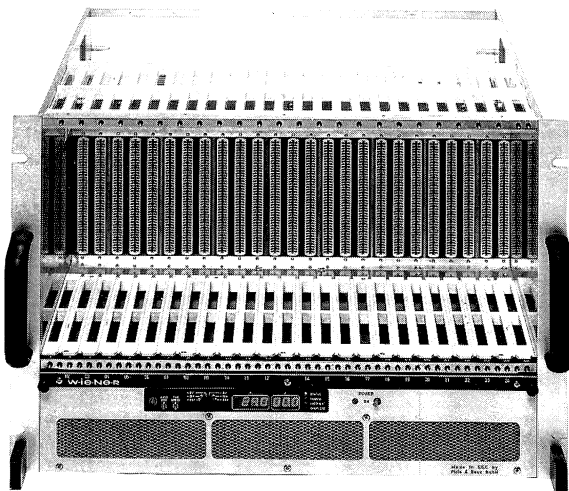
- Crate Controller CC16**
- double width CAMAC Module
 - 24 bit processing by 16 bit bus
 - net cable up to 200m possible

- PC Interface PC16-Turbo**
- serves up to 15 controllers CC16
 - fast AT-bus ISA interface
 - IRQ on LAM
 - Blockmode



VME Interface VC16

- 6U VME to CAMAC interface, module
- serves up to 15 controllers CC16
- A24 D16 access
- IRQ on LAM, programmable interrupt vector



Ultra high powered CAMAC Crate

- Up to 1600W output kept cool by 90% efficiency super low noise, proved excellent quality
- VHF switching power supply designed in Wiener-cavity-technology, mechanics and pin outs acc. to CERN spec.
- intelligent fan trays on request with remote control via CANbus, GPIB, High Speed CAENET

To avoid down times:

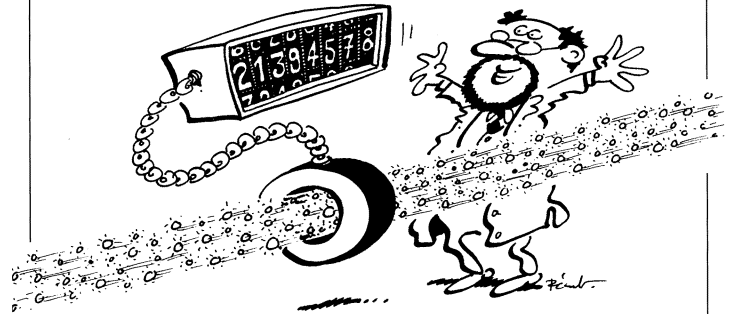


Plein & Baus GmbH, Germany
51399 Burscheid, Muellersbaum 20
Phone.: (49) 2174 6780 Fax.: (49) 2174 678 555
E-Mail: wiener @ pb. gl. eunet. de

Beam Charge Monitor

Measures :

- Single beam pulses with 3×10^6 e- resolution
 - Bunch lifetime in multi single bunch mode, instantly
 - Orbit current with 8nA rms resolution
 - Slow spills of several thousands micropulses
- Excellent absolute calibration



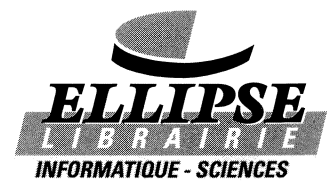
They all use it:

ASTRID, CESR, DAFNE, DELTA, ELSA, ESRF, LEP, SRRC
The Energy Amplifier, for absolute beam measurement
Even the Swiss Office of Metrology in Bern uses it
for its irradiation national primary standard.

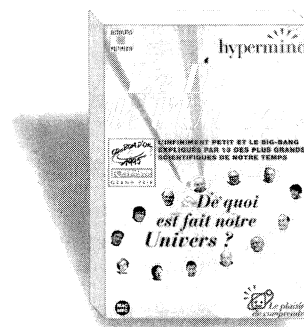
Precision Beam Instrumentation



Europe: Bergoz Tel.: +33-50.41.00.89
U.S.A.: GMW Tel.: (415) 802-8292
Japan: Repic Tel.: (03) 3918-5326



«Le défi de l'Univers»
Ce CD-Rom vous invite à partager l'une des plus formidables aventures scientifiques du 20^e siècle: le voyage dans l'infiniment petit, à la recherche de l'origine de l'univers. (Mac-PC)



FrS. 69.90

Envoi du bon de commande à Ellipse librairie, CP 1443, 1211 Genève 1

Nom/Société _____ nb. exemplaire _____

Adresse _____ NPA-Ville _____

Carte: Visa Eurocard _____ Echéance

No. carte:

Date/Signature _____ 5-défi

Serveur: <http://www.ellipse.ch> - E-mail: info@ellipse.ch
tél (022) 731 58 78 - fax (022) 738 36 48 - 14, rue Rousseau

Warsaw conference

Warsaw University's Auditorium Maximum provided the location for the parallel sessions of the 1996 Rochester conference.

In recent years, the biennial "Rochester" International Conference on High Energy Physics has been a festival of the Standard Model, the 20-year-old set of theories describing particles and forces. Despite early expectations to the contrary, the 28th in this prestigious series, held in Warsaw in July, turned out to be true to form.

In 1995, after many years of increasingly accurate measurements agreeing ever more precisely with Standard Model predictions, some small discrepancies appeared.

Theoreticians lost no time in invoking explanations involving physics beyond the Standard Model. The most popular of these is supersymmetry, a theory linking particles and forces which introduces a new "supersymmetric" partner for each ordinary particle. The atmosphere was charged with anticipation for new physics. But by the time the 1996 Rochester came around, most of the discrepancies had gone away, leaving the Standard Model healthier than it has been for some time.

The mood of the conference was captured by Gabriele Veneziano, head of CERN's Theory Division, with his concluding remarks that "The Standard Model's health, already excellent, keeps improving as it gets rid of a little cold, or a small headache." But adding the optimistic note that "Theoretical belief in supersymmetry appears really unshakable, and even contagious towards the experimentalists."

The Standard Model

The first hints that the Standard Model was on the road to recovery came in the parallel sessions when Ian Tomalin and Bruna Bertucci, both from CERN, presented new results



on the so-called R_b anomaly from the Aleph and L3 experiments respectively at CERN's Large Electron-Positron Collider, LEP. R_b is the fraction of quark-producing Z decays resulting in pairs of heavy b-quarks. Last year, results from LEP seemed to indicate that this happened far too often (October 1995, page 1). But supersymmetry provided an explanation. The idea was that the Z can decay into supersymmetric particles, which in turn decay to b-quarks.

The results presented by Tomalin and Bertucci are closer to the Standard Model than last year's measurement. The Aleph result matches precisely at 21.58%, but the new world average is still uncomfortably high at 21.78%. The general feeling in Warsaw was one of wait-and-see, but supersymmetry enthusiasts pointed out that the new world average is exactly what their model anticipates.

Andrzej Buras of Munich Technical University homed in on CP violation, the mechanism believed to be responsible for the apparent absence of antimatter in the Universe. He looked forward to the new precision measurement of direct CP violation expected soon from CERN's NA48 experiment.

Another precision experiment which is eagerly anticipated was introduced by Warsaw's Stefan Pokorski in his review of electroweak theory. A new experiment at Brookhaven will soon fix the anomalous magnetic moment of the muon with the unprecedented precision of 0.35 parts per million, 20 times better than CERN's classic measurement. This important quantity is a measure of the pointlikeness of muons, and provides a powerful test of electroweak theory.

The Warsaw conference was the first Rochester to welcome the top quark into the Standard Model's heaviest family of particles. Two

Conference Chairman Andrzej Wroblewski and CERN's Research Director Lorenzo Foà (left) admire conference coverage in Warsaw's newspapers

years ago in Glasgow, top was still unconfirmed. Now, it is perhaps the best measured quark of all, according to Rochester University's Paul Tipton, who pinpointed its mass at 175 ± 6 GeV with a production rate around 6.5 pb, a little higher than expected, but not inconsistent with theory. These measurements come from combined data from the CDF and D0 experiments at Fermilab's Tevatron proton-antiproton collider, and are derived from some 100 pb^{-1} of data corresponding to 500 top-antitop pairs for each experiment.

Scott Willenbrock of Illinois continued the top quark theme, looking forward to top physics to come. Since the top quark is so much heavier than the other quarks, he said, there must be something special about it. Top, for example, could have large CP violating decays, and might become the CP laboratory of the future. Top could even give hints of physics at the Planck scale where quantum mechanics and gravity meet. For example, one model of the Higgs symmetry breaking mechanism, thought to be responsible for mass, has a second minimum at the Planck energy. This model correctly puts the top mass at 173 ± 4 GeV, and predicts a Higgs boson mass of 135 ± 9 GeV.

The remaining quarks were covered by Rochester University's Lawrence Gibbons who presented a plethora of data on quark mixing. A cornerstone of the Standard Model is the Cabibbo-Kobayashi-Maskawa matrix, whose elements give the probabilities of one kind of quark turning into another. Several new measurements of oscillation frequencies in neutral B mesons are tightening the constraints on these matrix elements. Gibbons also presented the most accurate measurement to date of the mass



difference between long-lived and short-lived kaons made by the CPLEAR experiment at CERN. When combined with the experiment's studies of CP-violating kaon decays, the result carries the reassuring message that the combination of CP with time reversal symmetry, CPT, appears to be conserved.

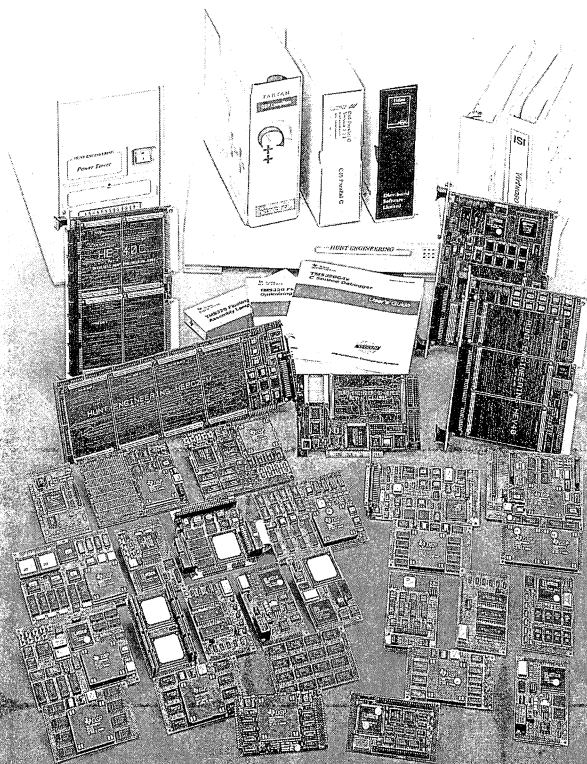
Alain Blondel of Ecole Polytechnique pointed out that with the top mass now measured, the Higgs mass is now the only unknown parameter in the Standard Model. Since the Higgs mass is highly sensitive to $\sin^2\theta_w$ (the weak mixing which links the two components of the electroweak force), that is where attention should turn, said Blondel. The SLD detector at Stanford's SLC electron-positron collider currently has the most precise measurement of $\sin^2\theta_w$ obtained by exploiting the 80% beam polarization obtainable at SLAC. Their value is 0.23061 ± 0.00047 , significantly

different from that obtained at LEP. The reasons for this discrepancy are not yet understood.

Blondel also had the task of presenting the final Z results from LEP representing seven years of painstaking precision analysis, and the current state of play with the W, the Z's charged partner. LEP's final value for the Z mass is 91.1863 ± 0.0020 GeV. Fermilab currently has the best measurement of the W mass at 80.356 ± 0.125 GeV. The LEP2 value from the first few days of running stands at 80.3 GeV, with an uncertainty of half a GeV.

Summarizing Standard Model physics, Gabriele Veneziano drew attention to the remaining excursions from the Standard Model. R_b is still significantly removed from the prediction, despite the new data. There are substantial differences between SLD and LEP values of $\sin^2\theta_w$, and the b-quark coupling parameter, A_b , is uncomfortably far

HUNT ENGINEERING



Parallel DSP Solutions

HUNT ENGINEERING are coming to Cern!

See us 8th-11th October 1996
'Britain at Cern'

- Modular Solutions for Parallel and Multi DSP Systems
- Development tools and systems for TMS320C4x
- Data Acquisition Systems
- High Speed Data Processing and Storage

HUNT ENGINEERING

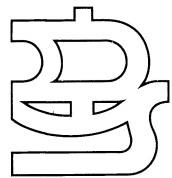
Chestnut Court, Burton Row,
Brent Knoll, Somerset TA9 4BP
UK

Phone (+44) 1278 760188

Fax (+44) 1278 760199

Email sales@hunteng.demon.co.uk

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



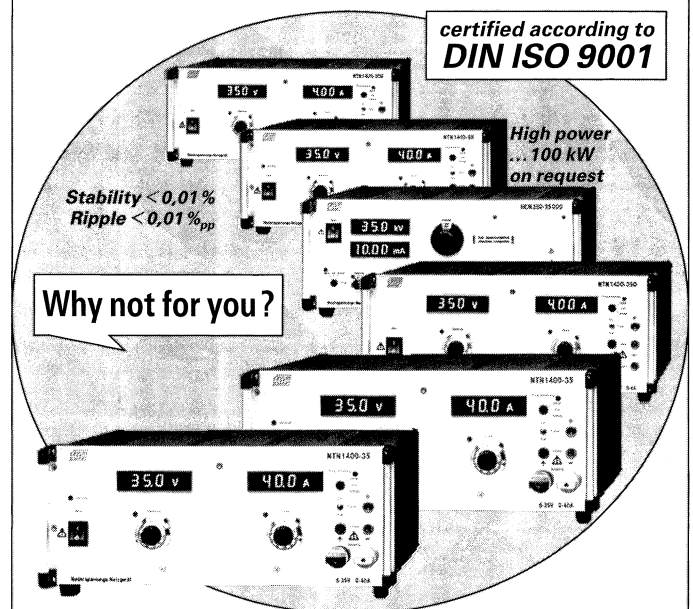
lannoo

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

fug

High And Low Voltage Power Supplies

High Stability + Low Ripple
Many standard types ex stock



F.u.G. Elektronik GmbH · Florianstr. 2 · D-83024 Rosenheim
Tel. ..49 (0) 8031/2851-0 · Fax ..49 (0) 8031/81099

Warsaw old town square provided a pleasant place for conference goers to relax after a hard day's work.



from the Standard Model prediction, he said. Putting all of the new Standard Model measurements into the equations yields a current best guess of the Higgs mass at 150 GeV, beyond the reach of LEP2 but comfortably within range of CERN's LHC proton-proton collider.

A fine thread of glue

Monday morning's plenary session was held together by glue. CERN's Rolf Landua presented the work of the "spectroscopy detectives" hunting down exotic particles. The existence of a particle made entirely from gluons, a glueball, said Landua, is now established, but it is not yet clear whether it is the $f_0(1720)$ found at SLAC in the 1980s, or the $f_0(1500)$ revealed by the Crystal Barrel experiment at CERN's LEAR antiproton ring last year. Further investigations are needed. The real glueball should also be found in J/psi decays, but it should not appear in two-photon physics since gluons

don't couple to photons. With LEAR closing down at the end of 1996, the immediate future of glueball searches will move to Beijing, where the BES experiment studies J/psi decays.

Sergey Levonian of Ecole Polytechnique and Halina Abramowicz of Tel Aviv both drew attention to the Pomeron, a mathematical entity invoked some thirty years ago to describe elastic scattering phenomena, and once again in the spotlight. If the Pomeron has a high gluon content, it could help to explain effects seen at the HERA electron-proton collider in Hamburg. HERA also reveals the structure function of the proton at low momentum fraction. The structure function measures the momentum distribution of the proton's constituents. According to George Sterman of the State University of New York, a rise was not unexpected by quark-gluon theory, but more work is needed to understand the observed effect fully. Further Pomeron studies will also "provide important input for the next generation of colliders", according to

Abramowicz. But is the Pomeron real, or is it purely a mathematical tool? By the next Rochester, Abramowicz and Levonian agreed, perhaps we will know the answer.

Levonian also spoke of jet multiplicities, an area where experiment and theory have been uncomfortably far apart for some time. Theory says that the ratio of multiplicity in gluon jets to that in quark jets should be around 1.8, whereas experiments have suggested a value closer to 1.2. A new analysis by OPAL at LEP, however, gives an experimental value around 1.6, consistent with the theoretical prediction.

Gluons could also account for last year's excess of high transverse momentum jets seen by Fermilab's CDF experiment, according to Raymond Brock of Michigan State. The other Tevatron experiment, D0, did not see the same effect, which led Brock to ask whether the two experiments data sets were inconsistent, or whether it was the models used to interpret the data which were at variance. His conclusion was that it is the models, and that we need to know more about the gluon distribution inside the proton before we can reliably interpret phenomena such as CDF's jets. What at first appeared to be a crack in the Standard Model turns out to be just a lack of information needed to interpret the data.

The thread of glue reached its end with Warsaw's Jan Nassalski who pondered the question of "Why nature has chosen such a complex way to say one half." He was considering the spin of the proton, a spin-half particle whose spin was once thought to be due to the quarks inside. Now we know that the story is not so simple, the spin comes partly from intrinsic angular momentum, partly from the quarks,

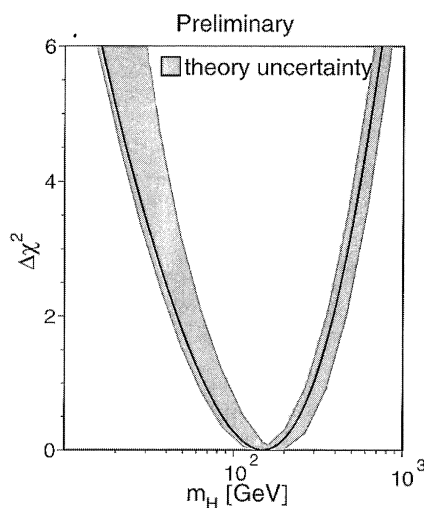
The latest Standard Model results show that the most likely place to find the Higgs particle, responsible for electroweak symmetry breaking, is at 150 GeV.

but mostly, it appears, from gluons. HERA's Hermes experiment, and perhaps the proposed COMPASS spectrometer at CERN, will soon measure the gluon contribution directly, by studying J/psi production in lepton-proton scattering.

New Physics

Kenneth Lane of Boston, emboldened by the new R_b measurements from LEP, provided a refreshing and entertaining alternative to supersymmetry, for which, he says, there is not one scrap of evidence. Quoting Emily Dickinson "Faith is a fine invention when gentlemen can see, but microscopes are prudent in an emergency", Lane's clarion call was look for evidence of alternative theories too. Graham Ross of Oxford, on the other hand, spoke for the majority when he urged experiments to go out and find supersymmetry. Time will tell who, if either, turns out to be correct!

Peter Maettig of Dortmund in his talk on new particle searches chose not to take up Kenneth Lane's call, but to concentrate instead on Higgs and supersymmetry. Last year, when LEP took its first step up in energy, there was excitement in the Aleph camp when a number of curious events were detected. These each had four jets of particles with a combined mass around 105 GeV (January, page 1). At the time, Aleph claimed that although these events could be explained by the Standard Model, they could also be new physics. But now with data from the other LEP experiments analysed, and new data from the 1996 LEP run, it looks like these are just Standard Model events after all. On the supersymmetry front, candidate events exist at both Fermilab and LEP2, but



for the time being at least, the Standard Model can account for them all.

Reinhard Stock of Frankfurt summarized the results of the recent Quark Matter conference, held in Heidelberg (July, page 1), and said that the "Lead beam SPS programme is on the verge of a breakthrough." He looked forward to the continuing programme at the SPS, and the upcoming programmes at Brookhaven's RHIC collider and the LHC for this breakthrough to be realized.

At the more speculative level, CERN's Sergio Ferrara summarized recent developments in superstring theory where much progress is being made to demonstrate the equivalence of different candidate theories.

Strong Coupling Constant and Heavy Flavours

Michael Schmelling from the Max Planck Institute in Heidelberg pointed out that α_s , the strong interaction coupling constant, is the least well known of all Standard Model coupling constants, but measurements are beginning to converge. Measurements are made at energies ranging

from 1 to 133 GeV and since α_s varies with energy, they are all extrapolated to the Z-mass (91 GeV) for comparison. Measurements from deep inelastic scattering which used to be low, and values from electroweak interactions, which used to be high, are now coming into line, giving a new global average of 0.118 ± 0.003 consistent with theoretical calculations presented by Southampton's Jonathan Flynn.

Jeff Richman of the University of California at Santa Barbara discussed heavy quark decays. Nearly all measurements are in good agreement with Heavy Quark Effective Theory which makes things easier to calculate by assuming that heavy quarks are extremely heavy. The exception is the lifetime of the Λ_b baryon, which appears to be significantly lower than expected. Guido Martinelli of Rome threw some light on this in his discussion of theoretical aspects of heavy flavour physics. In reality, he said, the quark masses are not all large, and much effort is being made to understand the so-called power corrections which account for this. According to Martinelli, the Λ_b discrepancy between experiment and theory arises from just such a power correction.

Neutrinos and Cosmology

Tokyo's Yoichiro Suzuki summed up the neutrino sector concentrating on experiments which could show evidence for oscillations, neutrinos changing from one type to another. All of the five solar neutrino experiments detect fewer solar neutrinos than the standard solar model expects. The new super Kamiokande detector, some 30 times larger (by mass) than its predecessor

Andrzej Wróblewski and Yoshio Yamaguchi share a joke between sessions.



started taking data in April, and so far seems to see the same effect (July, page 22). In atmospheric neutrinos originating from cosmic rays, the ratio of muon to electron type neutrinos is not what is expected. Both these phenomena could be explained if neutrinos have a mass, which would allow them to oscillate.

The Los Alamos Liquid Scintillator Neutrino Detector experiment, LSND, still claims to see evidence for oscillations, finding candidate electron-neutrino events in a muon-neutrino beam. But a similar experiment, the Karlsruhe Rutherford intermediate Energy Neutrino experiment, KARMEN, at the Rutherford Appleton Laboratory in Britain, has so far not seen any evidence for this effect. The controversy will probably continue until long baseline experiments, such as that which will send a neutrino beam from the Japanese KEK laboratory to super Kamiokande 250 km away, and the NuMI project at Fermilab (September, page 20) start to take data. The theory of neutrino masses was presented by Alexei Smirnov of the International Centre for Theoretical Physics in Trieste who looks forward to new results which will put the "huge edifice" of theory on more solid foundations.

Saclay's Michel Spiro summed up the emerging field of particle astrophysics, dividing his presentation into

three: the dark side, the monster side, and the opposite side of the Universe. The dark side is characterised by the search for dark matter. WIMPS, MACHOS, or a combination of both? WIMP stands for Weakly Interacting Massive Particle, perhaps the anticipated supersymmetric particles, but so far there's no evidence that they exist. MACHOs, MASSive Compact Halo Objects, on the other hand, do seem to exist. Two candidates have been found by gravitational lensing. The monster side of the Universe is manifest on Earth in the form of high energy cosmic rays which come from active galactic nuclei. Could these be Black holes with a mass between one and a hundred million times that of the sun? The opposite side of the Universe could only be antimatter. Are there antistars and antigalaxies out there? The AntiMatter Spectrometer, AMS, will start to look when it first flies aboard the space shuttle in 1998, and then on the space station from 2001 (November 1995, page 8). The terrestrial antimatter highlight was the detection of antihydrogen at CERN in 1995 (March 1996, page 1) paving the way for new experiments to study spectral and gravitational effects.

Robert Scherrer of Ohio State concentrated on two recent measurements of the abundance of primordial deuterium which differ by a factor of

10, and could have profound implications for the Universe. If the lower result is correct, then our current understanding of big bang nucleosynthesis could be in trouble. But it is too early to say which measurement is right. The analysis involves observing spectra from quasars seen through clouds of space dust, and the interpretation could be influenced by the presence of other material in the way.

Future Detectors and Accelerators

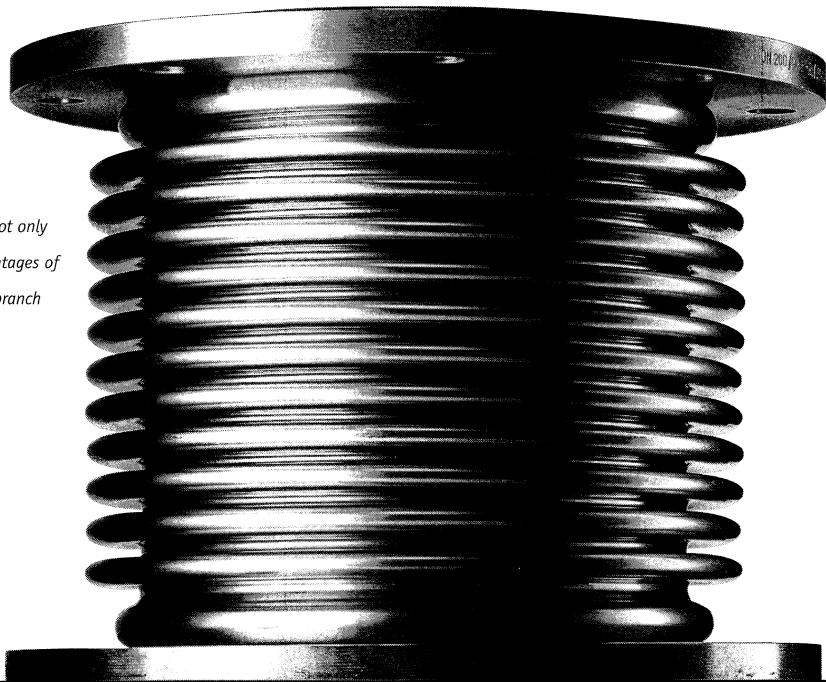
Enzo Iarocci of Frascati gave a comprehensive overview of the advances which have been made in the field of detectors from innovative upgrades being prepared for the Tevatron's detectors, to completely new devices at Stanford and CERN. Smaller, faster, radiation-harder was the message delegates took away with them, almost paraphrasing the motto of the Olympic games, taking place in Atlanta at the same time as the conference. Compact, fast and radiation hard detectors are needed to handle the LHC's unprecedented 800 MHz proton-proton collision rate.

In his talk on future accelerators, Brookhaven's Robert Palmer, concentrated on the speculative area of muon colliders. The idea for such machines dates back to the 1960s, but serious work only began this decade, when it became clear that LEP was likely to be the last big circular electron-positron collider. Muons seemed to present an attractive alternative, but the main problem is that they don't live very long, and would average just 1000 orbits before decaying. By comparison, LEP's beams complete over 11000 orbits a second, and are stored in the machine for several hours. A muon collider would have

APPLICATION UNDER THE HARDEST CONDITIONS. AND ALWAYS SPLENDID IN FORM.

Year after year in use under the hardest conditions and as flexible as on the first day. Not everyone can make such a claim. But then we have equipped our expansion joints with special bellows. Instead of one single ply they consist of many thin single plies. That makes them highly flexible and absolutely reliable. But it is also due to the know-how and the perfected engineering we have. That is why we only hear from you after many years of operation when you are planning once more.

*The multi-ply bellows of HYDRA compensators not only give advantages of safety, they also have advantages of economy. By the way: We were the first in the branch certified according to ISO 9001 ff.
Witzenmann - flexible in steel.*



HYDRA

WITZENMANN

Metallschlauch-Fabrik Pforzheim
Telefax ++49-72 31/581-825

For the plenary sessions, the conference moved to the Palace of Culture and Science, a highly visible reminder of Poland's recent history.



to have a very thick beam pipe to absorb radiation from decaying muons, and the detectors would lose a 20° cone to shielding around the beam for the same reason. The great advantage of muon colliders is their small size and cost. On the down side, since the ideas are all new, there's a chance that they might not work.

To close the conference, Gabriele Veneziano praised the "Joint effort" being made by both experimentalists and theorists "to understand not only accelerator data, but also gravity, astrophysics, and cosmology."

The next Rochester conference will be held in 1998 at the University of British Columbia, Vancouver, Canada. Next year's major conference, the 1997 Lepton-Photon Symposium will be in Hamburg, Germany, and the 1999 Lepton-Photon Symposium will be at Stanford, California.

by James Gillies

Euroconference QCD

Another snapshot of contemporary particle physics, slightly more technical, came from the 4th high energy physics Quantum Chromodynamics meeting in Montpellier, France.

Quantum chromodynamics (QCD), the field theory of quarks and gluons, has a traditional summer venue in Montpellier, organized by Stephan Narison. QCD 96 was the first of the new Montpellier Euroconference Series in QCD sponsored by the European commission in Brussels.

Traditionally involving equal numbers of experimental and theoretical talks and participants, the meeting also gives an opportunity for young physicists to contribute at an international level, together with more familiar names. It is thus a compromise between a large scale international high energy physics conference and a small specialized meeting.

The programme covered various QCD approaches, including perturbative series expansions - increasingly limited when the coupling becomes strong - and alternative non-perturbative approaches.

The first results from experiments at CERN's LEP electron-positron collider operating at higher energies (130-150 GeV) on, for example, the quark-gluon coupling (α_s) are limited due the still low statistics available.

Probing the collisions of quarks and gluons deep inside nucleons, data from quark and gluon jet production and event shape from LEP and from Stanford's SLD linear electron-positron collider, from Fermilab's Tevatron (proton-antiproton collider and fixed target studies) and from DESY's HERA electron-proton

collider show a general good agreement with QCD predictions, and give estimates of some non-perturbative power corrections and improved measurements of α_s .

The SMC Spin Muon Collaboration at CERN has new results on the polarized (spin-dependent) quark structure of the proton and deuteron, where the total spin does not reflect the component quark spins. Theoretical talks emphasized that this "spin crisis" is valid not only for the proton, but is a universal QCD property and should occur for any target.

The continued exploration by HERA and by CERN's NMC muon collaboration of the low momentum transfer (Q^2) and momentum fraction (x) regions gives new impetus to perturbative QCD in these low-energy regimes.

For heavy quarks and leptons, experimental results on production and decays of B (containing the fifth 'beauty' quark) and D (containing the fourth 'charm' quark) particles came from the CLEO detector at Cornell's CESR electron-positron collider and from SLD and HERA. The sixth ('top') quark production and decays presented by the CDF collaboration at Fermilab's Tevatron collider show a good agreement with QCD predictions and yield an improved measurement of the top quark mass.

A review of different determinations of the QCD coupling showed how it varies as the inverse of the logarithm of the energy, as predicted by QCD, from around the tau lepton mass of 1.8 GeV up to the LEP energy of 150 GeV, and the increasing range of processes from which it can be extracted.

The Crystal Barrel and Obelix groups at CERN's LEAR low energy antiproton ring have consolidated the evidence for 'gluonia' - fundamental



Organized by Stephan Narison, quantum chromodynamics (QCD), the field theory of quarks and gluons, has a traditional summer venue in Montpellier, France.

A quarter century of hadron colliders



QCD particles containing only gluons but no quarks.

Though there has been no spectacular QCD discovery during the past few years, the Montpellier meeting reflected continuous progress and improved results. It underlined the strong conviction that QCD is the best and unique candidate gauge theory of quarks and gluons, while ongoing results also show that the non-perturbative approaches (such as lattice calculations and QCD spectral sum rules) satisfy most experimental tests.

In many respects the theory is simple, with quarks behaving more and more like free particles at high momenta. However the permanent confinement of quarks is not yet quantitatively explained, making QCD an enigmatic part of the otherwise so successful Standard Model.

The next QCD Montpellier meeting will be from 3-8 July 1997.

From Stephan Narison (Conference Chairman)

With CERN striding confidently along the road towards construction of its LHC - Large Hadron Collider - planned to come into operation in 2005, the Laboratory can also look back 25 years to 1971, when the world's first hadron collider, the Intersecting Storage Rings - ISR - was commissioned.

As CERN's first colliding beam machine, the ISR pointed the way to CERN's future. Mirroring the early history of the Laboratory, the ISR was itself a masterpiece of accelerator building and expertise, for which the full physics benefit came only later.

Following the invention of beam stacking by the US Mid-Western Universities Research Association (MURA), led by Gerald O'Neill, in the mid-1950s, CERN built a model 100 MeV electron machine, and later the CESAR electron storage ring.

While other research centres began looking towards electron storage rings, and subsequently electron-positron colliders, CERN chose a different route. In the early 1960s, CERN proposed building twin rings to store 25 GeV proton beams, fed by the PS proton synchrotron.

A new era begins in particle physics. January 1971 - handling the first-ever collisions of proton beams at CERN's new Intersecting Storage Rings (ISR). Foreground, left to right - Wolfgang Schnell, M. Zanasco, Franco Bonaudi, Fritz Ferger (partially hidden), Klaus Unger, Bas de Raad, Lorenzo Resegotti, Hildred Blewett, Simon van der Meer.

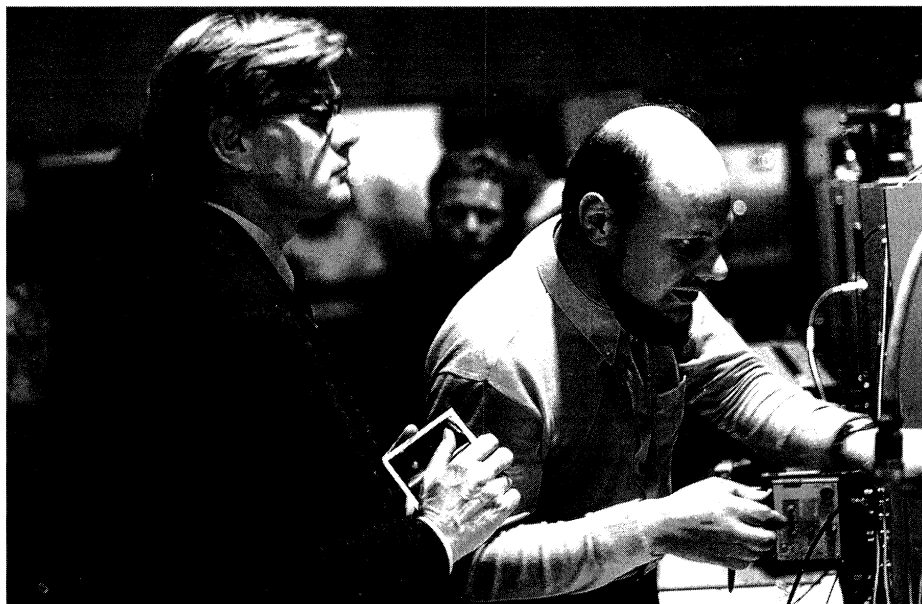
(Photo CERN 159.1.71)

After a detailed design report was published in 1964, the ISR project was formally approved by CERN Council the following year. Momentum behind the innovative project came from the vision of CERN's Director General Victor Weisskopf. Mervyn Hine, responsible for long term planning under Weisskopf, was another key figure.

In a 'Viewpoint' article last year (December 1995, page 20) Hine pointed out CERN's debt to Weisskopf 'in almost all the work it does today'. In reply, Weisskopf wrote 'Whatever I did in this connection was done together with Mervyn Hine, more often than not, on his initiative.'

The ISR also enjoyed the vigorous support of the then new European

Easy does it. ISR project leader Kjell Johnsen (left) and Klaus Unger watch the behaviour of the protons in one ISR ring. (Photo CERN 521.10.70)



Committee for Future Accelerators (ECFA) under Edoardo Amaldi. To provide a home for the new machine, the French government generously offered additional land alongside CERN's existing site in Meyrin, Switzerland, so that CERN symbolically became an international organization on the map as well as in name.

In 1953, CERN, with virtually no experience in accelerator building, had boldly decided to construct the world's largest synchrotron. The 28 GeV PS Proton Synchrotron duly came into action in November 1959, several months ahead of a similar machine at Brookhaven.

The ISR was another bold venture. Stacking and colliding high intensity proton beams was uncharted territory. Foreseen challenges - tight tolerances everywhere, unheard of levels of ultrahigh vacuum, beam instabilities - were met. Unforeseen problems - mainly more beam instabilities - were overcome and the solutions became standard accelerator practice. New techniques were added to the accelerator physics repertoire. Schottky scan

diagnostics, on-line space charge compensation, and superconducting magnets, as well as stochastic cooling, were pioneered at the ISR. The ISR was the first example of industrially built superconducting magnets (to squeeze the colliding beams and boost the collision rate) being used in a synchrotron ring. Circulating beams regularly attained and maintained a whopping 40 amps, showing that particles remained under tight control.

Above all the skill and expertise the CERN accelerator team accumulated from the ISR was to stand it in good stead for subsequent major colliding beams projects - the proton-antiproton collider, for the LEP electron-positron collider, and for the LHC.

In some respects, the ISR was conceived as a single giant experiment in proton-proton scattering, to ascertain how the reaction rate would behave in the new energy range opened up by colliding 25 GeV proton beams. At first glance, protons seemed to behave like soft grey bags of nuclear material through which high energy beams could slice. For

these soft protons, the rising reaction rate with energy and the famous 'dip' in the angular distribution of elastic scattering are now part of physics history. The ISR's 'Roman pot' detectors, protruding into the beam pipe to get as close as possible to the beams, have become another physics standard.

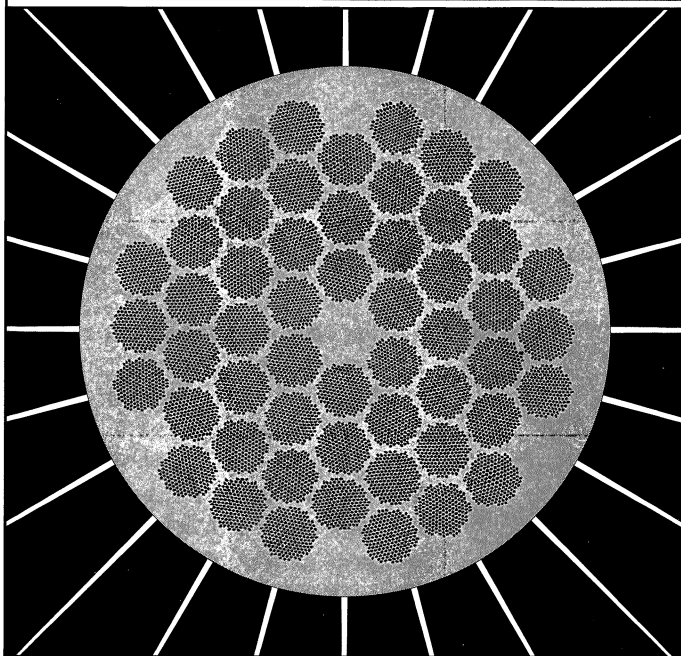
In other areas of physics, a wall had been blocking the view. Only with the arrival of the ISR were researchers able to peer over and get a first glimpse of what lay on the far side. While the ISR was being built, high energy electron beams at the Stanford Linear Accelerator Center, SLAC, for the first time probed deep inside protons. Most of the time the electrons easily pierced the soft proton, but occasionally the beams hit tiny hard grains, or 'partons' (later identified as quarks) from which electrons ricocheted violently.

For the ISR, few had paid attention to the contribution of the component quarks hidden deep inside the proton. Initially, the experiments concentrated on intercepting proton debris which continued to follow the direction of the colliding beams. But soon after the ISR began operations, particles were seen flying out sideways from the collisions. Against a background due to soft mushy protons slithering over each other, the ISR, for the first time in physics history, was seeing what happened when constituent quarks collided.

While the SLAC experiments had discovered electrically charged partons through their electromagnetic interactions, at the ISR these 'hard' collisions were found to occur much more frequently, at rates typical of strong interactions. Partons were also strongly interacting.

The pioneer experiments with electron beams at SLAC or with neutrino beams at CERN which

High-Tech Superconductors produced by a world leading industrial Group



LARGE SCALE PRODUCTION OF:

- Nb/Ti and Nb₃Sn wires
- Rutherford cables
- Coextruded Al stabilized cables
- CIC with Al alloy and stainless steel jackets
- High temperature superconductors

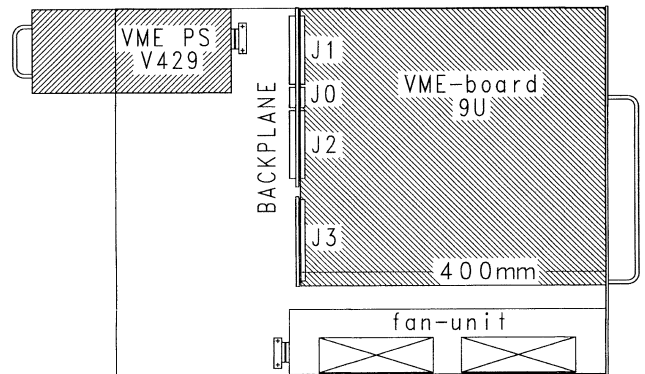


EUROPA METALLI spa SUPERCONDUCTORS DIVISION

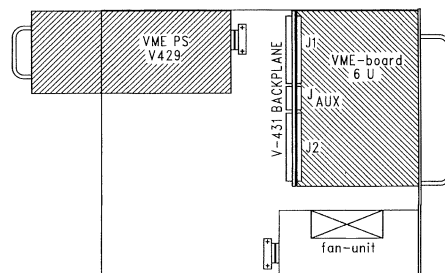
55052 FORNACI DI BARGA (Lucca) - Italy
Phone + 39 (583) 701422 - 701447
Fax + 39 (583) 75007

Powered Crates

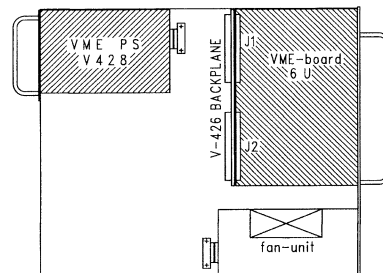
Further to all our **CERN approved CERN-Spec. Crates**
NIM-, CAMAC-, FAST BUS-, VMEbus 422/430
Wes-Crates supplies other Crates based upon these Systems.



VMEbus-crate VME64 9U x 400 mm
according to the recommendation of VIPA



VMEbus-crate CERN-spec. V430



VMEbus-crate CERN-spec. V422

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

Crates and Power Supplies from Wes-Crates are flexible because of modular systems.

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

E-mail: sales@wes-crates.de

Statement of Ownership, Management, and Circulation

(Required by 39 U.S.C. 3685)



1. Publication Title Cern Courier Magazine	2. Publication No. 0 3 0 4 - 2 8 8 X	3. Filing Date November 10, 1995
4. Issue Frequency Monthly (two combined issues per year)	5. No. of Issues Published Annually 10	6. Annual Subscription Price FREE
7. Complete Mailing Address of Known Office of Publication (Street, City, County, State, and ZIP+4) (Not Printer) Corner of Wilson & Kirk Road P. O. Box 500 Batavia, Illinois 60510-0500 Kane County		
8. Complete Mailing Address of Headquarters or General Business Office of Publisher (Not Printer) European Laboratory for Particle Physics CERN - 1211 Geneva 23 SWITZERLAND		
9. Full Names and Complete Mailing Addresses of Publisher, Editor, and Managing Editor (Do Not Leave Blank)		
Publisher (Name and Complete Mailing Address) CERN - Publisher - European Laboratory for Particle Physics Gordon Fraser - Editor 1211 Geneva 23 Switzerland		
Editor (Name and Complete Mailing Address) Gordon Fraser - Editor 1211 Geneva 23 Switzerland		
Managing Editor (Name and Complete Mailing Address) ----		

10. Owner (If owned by a corporation, its name and address must be stated and also immediately thereafter the names and addresses of stockholders owning or holding 1 percent or more of the total amount of stock. If not owned by a corporation, the names and addresses of the individual owners must be given. If owned by a partnership or other unincorporated firm, its name and address as well as that of each individual must be given. If the publication is published by a nonprofit organization, its name and address must be stated.) (Do Not Leave Blank.)

Full Name	Complete Mailing Address
Fermi National Accelerator Laboratory	Corner of Wilson & Kirk Road P. O. Box 500 Batavia, Illinois 60510-0500

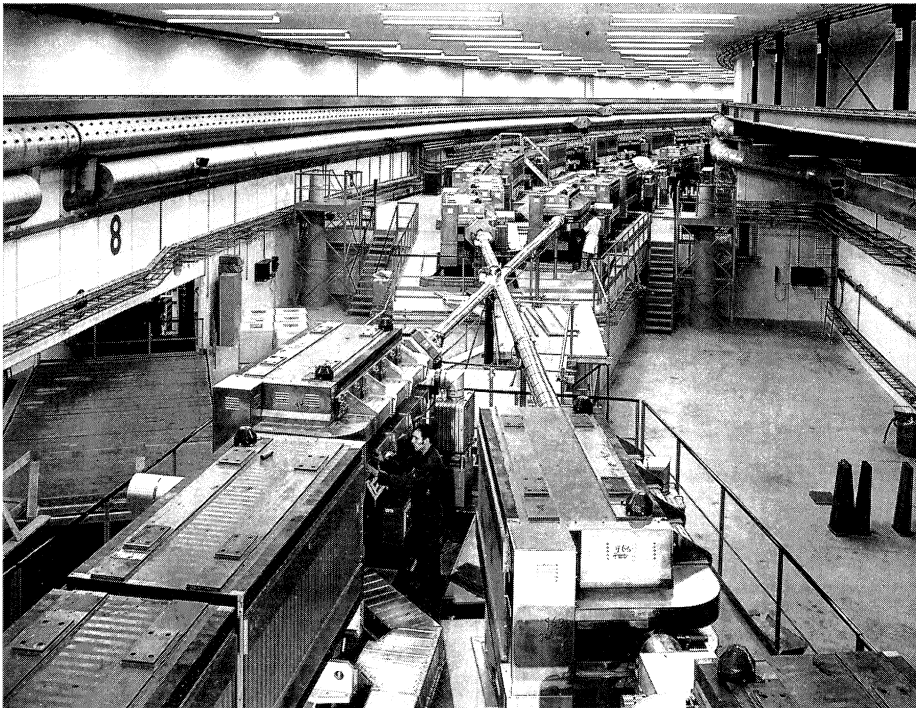
11. Known Bondholders, Mortgagees, and Other Security Holders Owning or Holding 1 Percent or More of Total Amount of Bonds, Mortgages, or Other Securities. If none, check here. None

Full Name	Complete Mailing Address

12. For completion by nonprofit organizations authorized to mail at special rates. The purpose, function, and nonprofit status of this organization and the exempt status for federal income tax purposes: (Check one)

- Has Not Changed During Preceding 12 Months
 Has Changed During Preceding 12 Months
(If changed, publisher must submit explanation of change with this statement)

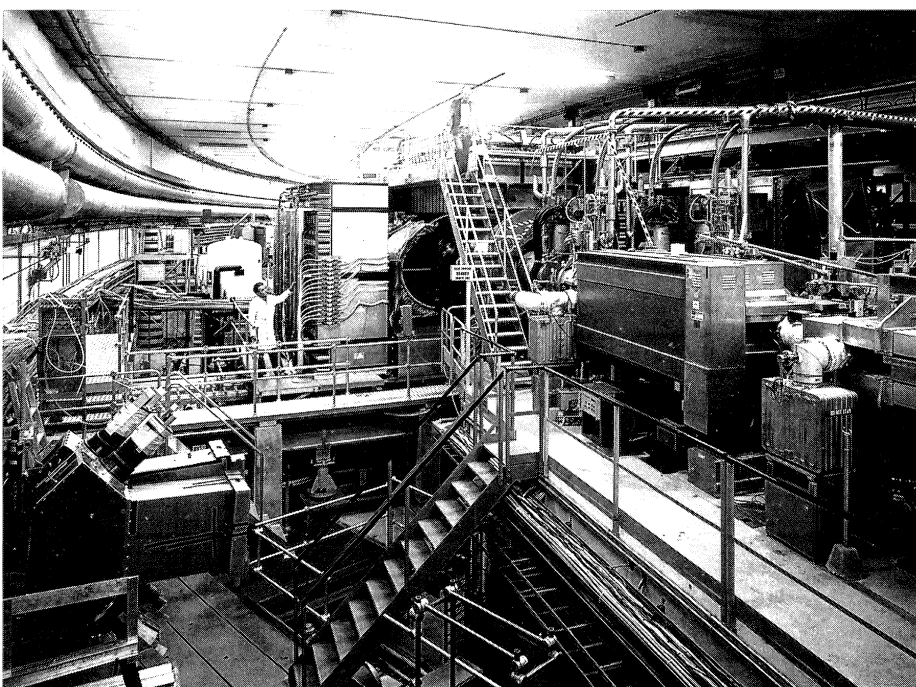
*The writing on the wall. Intersection 8 at the ISR as it was in 1970, almost devoid of instrumentation for experiments. Compare this stark scene with the picture below.
(Photo CERN 91.8.70)*



elucidated the parton/quark picture were however blind to the gluon component of the proton, which only interacts strongly. It soon became clear that the ISR, as well as seeing quark-quark collisions, was also seeing interactions between quarks and gluons or between two gluons. A classic example of such quark-gluon interactions, with the struck gluon turning into a photon, was the ISR's 1978 discovery of 'direct' photon production at wide angles.

With the emergence of this hard scattering as the staple physics diet of high energy hadron colliders, the ISR ushered in a new era in instrumentation and detector building. To analyse these quark interactions, the ISR was subsequently equipped with big detectors wrapped round the collision point to intercept the results of these violent quark collisions and exploit this new physics. These major detectors, with large teams of physicists and complicated triggering to isolate interesting events, were the forerunners of the collaborations at today's large colliding beam machines.

At the formal closure of the ISR in 1984, Victor Weisskopf admitted that the ISR had 'probably missed one or two Nobel prizes', but that did not matter that much. Had these discoveries been made at the ISR, the course of physics would not have



*By 1983, the scenery at ISR Intersection 8 had changed. The beam crossing point was almost surrounded by the uranium calorimeter of the R807/808 experiment which saw initial evidence for 'jets' in high energy collisions and discovered single photons emerging from quark-gluon interactions deep inside the colliding protons, with the struck gluon turning into a photon. Intersection 8 was also the site of superconducting 'low-beta' magnets used to squeeze the beams and boost the collision rate, the first time such magnets had been used in an accelerator.
(Photo CERN 295.10.83)*

Physics monitor

been altered. 'The really important thing about the ISR,' he continued, 'is its success as an instrument, because that did change the landscape of high energy physics'.

As a proton collider, the ISR did more to change physics than the more modest contemporary electron-positron colliders.

With construction of LEP imminent, the ISR was finally sacrificed on the financial altar, but did not depart before giving a sparkling display of the world's first high energy proton-antiproton collisions.

The foreclosure of the ISR led many physicists to wax unusually lyrical. Maurice Jacob began the trend, quoting from Shakespeare's Julius Caesar:

I come to bury Caesar not to praise him;
The evil that men do lives after them,
The good is oft interred with their bones;
So let it be with Caesar.

The ISR's evil was the missed discoveries, the good was the fresh approach to collider physics.

Later, CERN Director General at the time Herwig Schopper said 'he had come to bury the ISR and to praise it,' while Weisskopf came 'to praise the ISR and leave others to bury it'.

SPACE Gravitating towards physics

Fundamental Physics in Space made its debut on the international conference scene this year with a three-day programme during the biennial COSPAR space science jamboree, held this summer at Birmingham, UK.

The parent COSPAR - Committee on Space Research - was established by the International Council of Scientific Unions (ICSU) in 1958 following the successful international cooperation in rocket and satellite research during the 1957-8 International Geophysical Year.

After invited introductory talks, the COSPAR Fundamental Physics in Space programme covered searches for gravitational waves and tests of the equivalence principle (the underlying idea of general relativity that inertial mass - the amount of matter in a body - and weight - the effect of gravity - are the same), together with an overview of NASA's upcoming Gravity Probe B experiment and a survey of possible future studies.

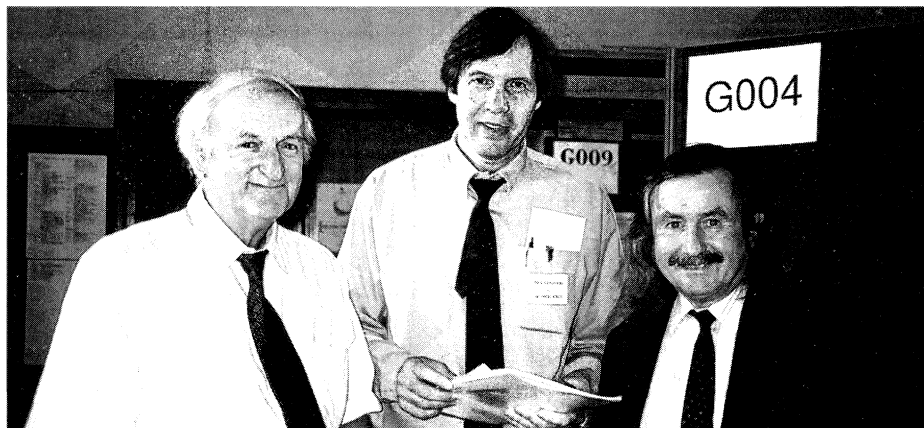
For Europe, the European Space Agency (ESA) has a Fundamental Physics Advisory Group (FPAG), currently chaired by Maurice Jacob of CERN, to complement its Astronomy and Solar System Working Groups.

This ongoing effort will surely extend the growing symbiosis between astrophysics, cosmology and particle physics, where the historic 1992 cosmic microwave background results from the COBE satellite provided a first insight into the structure of the early Universe. ESA's COBRAS/SAMBA project, scheduled to go aloft in 2004, should give a much needed higher resolution picture of the cosmic microwave background.

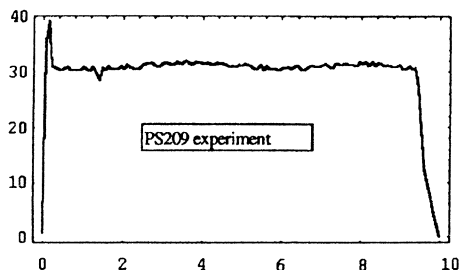
BEAM EXTRACTION LEAR and COSY

Having ingeniously and painstakingly accelerated their particles, the next task for accelerator physicists is to put them to use. For a linear accelerator, where the beam shoots out of the end of the machine, this is no problem. However more ingenuity is required to remove

R. Reinhard (centre), secretary of the European Space Agency's Fundamental Physics Advisory Group (FPAG) and organizer of the Fundamental Physics in Space symposium at the major COSPAR space meeting in Birmingham this summer, seen here with J.-P. Blaser (left), former FPAG chairman and director of the Swiss PSI Laboratory, and (right) F. Everitt of Stanford, Principal Investigator of NASA's forthcoming Gravity Probe B mission, which had its own session at the symposium. At its meeting in Birmingham on 21 July, COSPAR Council decided to create a new COSPAR Scientific Commission (Commission H) on Fundamental Physics in Space with Prof. Everitt as Chairman and Prof. Blaser as Vice Chairman.



Ultra-long spills have been achieved at CERN's LEAR low energy antiproton ring (the horizontal scale is in hours).



particles from a circular machine where, unless something is done, they prefer to remain in their captive orbits.

For transferring particles from one machine to another, and for some experiments, extraction is generally via 'fast extraction' during one turn (say a hundred nanoseconds). This is done by powering a magnet, energized between two successive bunches to 'kick' the particles out.

However to feed most experiments, a smoother particle supply is usually needed. In such 'slow extraction', the tune of the circulating beam is shifted through a resonance by varying the current in a focusing quadrupole magnet. Not all the particles are shifted at the same time, so that the beam, instead of being suddenly bumped, is more smeared towards an extractor magnet, and the extraction becomes a 'spill'.

But for some experimental facilities, such smears of a few seconds are too brief, and a more continuous particle feed is required. In his famous invention of 'stochastic cooling', Simon van der Meer had the brainwave of monitoring individual particle pulses, ascertaining the pulse's deviation from an optimum value, and applying an appropriate correction. In this way an unruly beam can gradually become more well behaved, and the door was open for antiprotons to be accelerated in big synchrotrons.

For ultra slow extraction, the problem was the other way round. Instead of being made more orderly, the beam instead had to be made more diffuse. 'Leaking' the beam towards a resonance extends the smearing and lengthens the spill. Van der Meer's 'stochastic extraction' technique uses a source of electronic noise to slightly unravel the beam prior to ejection. It was first applied at CERN's LEAR low energy antiproton ring in 1983, and has yielded extraction spills of up to 13 hours. Under such conditions, one antiproton leaves the LEAR ring every 20 turns.

A new example of this technique in action is now the COSY synchrotron at Jülich which has achieved 12-second spills of 2.75 GeV protons. COSY uses kickers taken from the LEAR design but employs digital rather than analogue synthesis for the stochastic noise to diffuse the circulating beam.

Wolfgang Pauli - scientific legacy



Collecting this dispersed correspondence, despatched well before the era of electronic mail and even the preprint boom, required a considerable effort. Mrs. Franca Pauli, assisted by Charles Enz, Pauli's last assistant at Zurich, and with the help of Victor Weisskopf, who had been one of Pauli's first assistants, began the work of correlating and administering this scientific heritage. Soon afterwards Weisskopf became CERN's Director General.

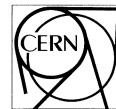
Through two formal deeds of gift by Franca Pauli, in 1960 and 1971, CERN became the official home of the Pauli Archive. After Franca Pauli's death in 1987, CERN inherited the copyright on all Pauli's hitherto unpublished works and all authors' rights on Pauli's scientific work. CERN was also charged with the responsibility of publishing his scientific correspondence.

These affairs are monitored by the Pauli Committee, of which Victor Weisskopf remains a member, and who was recently at CERN for a

HISTORY

Pauli heritage

As well as his immediate scientific legacy, when Wolfgang Pauli died on 15 December 1958 he left a dispersed wealth of scientific correspondence. As one of the great architects of quantum mechanics and 1945 Nobel prizewinner, his advice had been sought on many issues. As well as regularly exchanging letters with the great figures of the time - Einstein, Bohr and Heisenberg - many aspiring young researchers asked for, and received Pauli's guidance and opinion. Many of these young researchers went on to become famous in their own right. For a figure who earned a reputation for arrogance and irascibility, this is particularly revealing.



CERN
European Laboratory for Particle Physics

CERN is the world's largest laboratory for scientific research.
With 19 Member States, it is used by elementary particle physics researchers from all countries.

Visits on request
tél. 767 8484

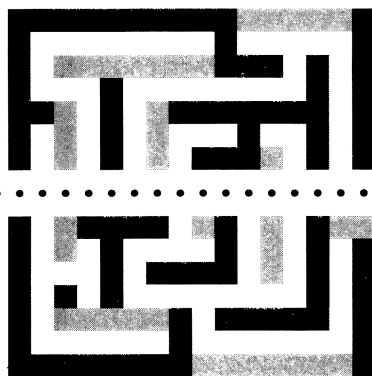
Microcosm exhibition,
Monday-Saturday from 9.00 to 17.00 hr,
entry free

Route de Meyrin (bus 9 CERN)

Polysoft Consulting présente

le logiciel de CFAO TELLRISC

Basé sur un procédé de travail nommé PROCESSUS ISOLOGIQUE, TELLRISC met fin au labyrinthe des menus.



Polysoft Consulting
3, rue des Buis
1202 Genève
Tél. 022 732 43 02
Fax 022 738 24 64

Tellrisc by  Polysoft Consulting

meeting. The other members are now Charles Enz (Geneva), Hans Primas (ETH Zurich, Pauli's long-time home and where there is also a Pauli collection, the 'Pauliana'), Karl von Meÿenn (MPI Munich) and CERN archivist Roswitha Rahmy, while Maurice Jacob, as Chairman, represents the CERN Director General. The CERN Pauli Archive's Web URL is <http://wwwas.cern.ch/ASinfo/AS-SI/archives/paulicom.html>

CERN and the Pauli committee have an agreement with German publishers Springer for the publication of Pauli's scientific correspondence - "Wolfgang Pauli, Wissenschaftlicher Briefwechsel mit Bohr, Einstein, Heisenberg u.a./ Scientific Correspondence with Bohr, Einstein, Heisenberg a.o."

Volume 1, published in 1979, and edited by A. Hermann, K. von Meÿenn and V. Weisskopf, includes 242 letters covering the period 1919-29. Volume 2, published in 1985 and edited by K. von Meÿenn, includes 364 letters covering the period 1930-39, together with some additional material from the previous decade. Volume 3, published in 1993 and edited by K. von Meÿenn, includes 486 letters from the 1940s.

With Pauli's prolific output and diversification of interests in his later years, Volume 4, covering the 1950s

will be split into four parts. Now published is Part 1 (ISBN 3 540 59442 6), edited also by K. von Meÿenn, with some 400 letters from 1950-52.

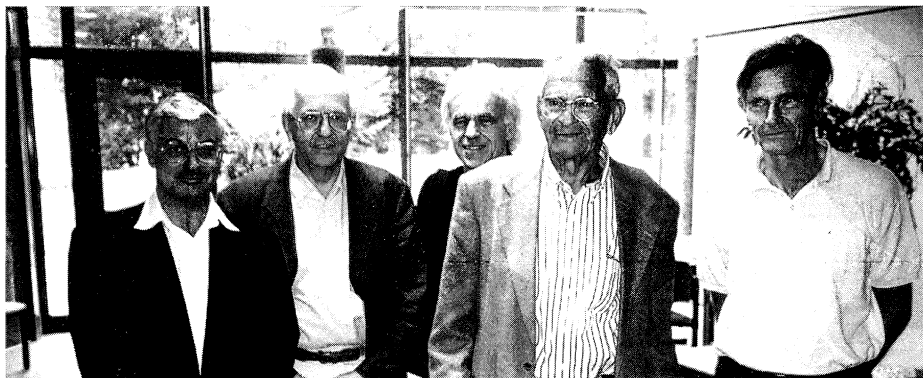
The letters (typeset, but faithfully reproduced, including grammatical and spelling mistakes - Pauli wrote in English and French as well as German) in this latest volume cover the epoch when the new Feynman/Schwinger formulation of relativistic field theory was in the ascendant. Meticulously referenced and cross-referenced, this scholarly work includes some gems of editorial comment. Particularly fascinating is the correspondence between Pauli and young researchers of the time, such as Freeman Dyson, Gunnar Källén and C.N. Yang. For many, Pauli was considered a touchstone of wisdom.

Pauli is already assured of a place in history as a great scientist. But as a prolific communicator and one of the century's great intellects, Pauli played other significant roles, as yet less generally appreciated. The book reveals Pauli's increasing awareness of psychology and in particular his interest in dreams, where he carefully catalogued his own uncontrolled thoughts. This has already been described in a quarter of a century of correspondence between Pauli and

Jung ("Wolfgang Pauli & C.G. Jung - Ein Briefwechsel 1932-58", Springer Verlag, 1992, which will lead to English, French and Spanish editions).

Pauli's deep interest in the philosophy of science led him to write his book "Aufsätze und Vorträge über Physik und Erkenntnistheorie" (Vieweg, 1961), while a major article with C.G. Jung is also revealing. With encouragement from the Pauli Committee at CERN, these two works are available in English as "W. Pauli, Writings on Physics and Philosophy" edited by C.P. Enz and K. von Meÿenn (Springer 1992). French, Spanish and Japanese versions are also in the pipeline, and the Pauli Committee wisely insists that these translations should be based on the German originals rather than taking a short cut through the more readily available English translation.

The Pauli Committee at CERN therefore plays an important role in continuing to disseminate the wealth of knowledge about this key scientist, who continued to influence physics much later than a cursory glance at physics history might suggest, while at the same time overseeing publications which reveal the workings of one of the century's great minds.



Members of the Pauli Committee at CERN. Left to right, Maurice Jacob, Chairman, Hans Primas (ETH Zurich), Karl von Meÿenn (MPI Munich) Victor Weisskopf and Charles Enz (Geneva).

THE MANY FACES OF PRINTING



Lannoo has been printing **since 1909** - almost 90 years of craftsmanship, experience and dynamism.

Lannoo Printers is a **fully integrated** company with its own studio, prepress department (incl. database publishing and multimedia facilities), print shop, bindery and distribution organisation.

We specialize in **quality printing** of books, brochures, annual reports, greeting cards, diaries, calendars and magazines.

150 professionals with a passion for quality and never-ending **concern for customer requirements** are ready to answer your specific questions.

Lannoo Printers

Kasteelstraat 97 • B-8700 Tielt • Belgium
Tel. 32 51/42 42 11 • Fax 32 51/40 70 70

E-mail: lannoo@lannooprint.be



 **lannoo** drukkerij

CERN COURIER

A unique advertising medium for scientific and technical equipment

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

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

The annual expenditure on high energy physics in Europe is about 1800 million Swiss francs. The expenditure in the USA is about \$ 1100 million. There is also considerable expenditure in Russia.

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

All enquiries to:

Europe

Advertising Manager
Micheline Falciola
CERN COURIER
CERN
CH-1211 GENEVA 23
Tel. (022) 767 41 03
Telex 419 000 CER
Telefax (022) 782 19 06

Rest of the world

Guy Griffiths
Advertising Manager, USA
Gordon and Breach Publishers
820 Town Center Drive
LANGHORNE PA 19047
Tel.: (215) 750-2642
Fax: (215) 750-6343

Around the Laboratories

CERN Another step for LEP

In mid-August, six weeks after its first electron-positron collisions at 80.5 GeV per beam on 9 July (September, page 15), CERN's energy-boosted LEP2 halted for installation of more superconducting radiofrequency cavities.

After six years studying electron-positron annihilations into Zs, the electrically neutral carrier of the weak nuclear force, these energies gave the four LEP experiments - Aleph, Delphi, L3, and Opal - their first look at pairs of W particles, the electrically charged partners of the Zs, breaking new physics ground.

Initial luminosities, a measure of the electron-positron collision rate, reached a healthy 3×10^{31} per sq cm per s, and integrated luminosity, a measure of the number of collisions achieved, at the new higher energy was 12 inverse picobarns, including a week of machine development work when the physics score stood still. This was slightly up compared to the corresponding operating periods in previous years, promising well for the future. The highest luminosity recorded in one day was an inverse picobarn, equalling earlier record performance.

Equipped with 28 more superconducting cavities, taking its complement from 144 to 172, and pushing its beam energy ceiling to 87 GeV, LEP2 is scheduled for a further five-week run in October-November.

Major item in an extensive upgrade for the H1 detector at DESY's HERA electron-proton collider has been a new 'SPAggetti CALorimeter' (SpaCal), seen here in the centre of the detector.

DESY Upgrading H1

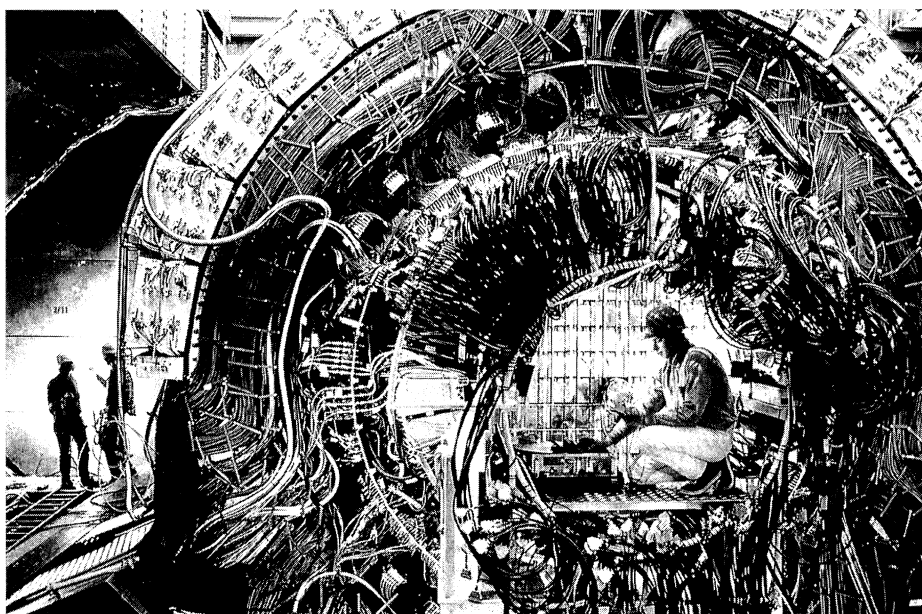
The usual evolution a particle physics experiment is increasing interest in rarer, more violent interactions at high momentum transfer, putting the stress on detection away from the beam direction.

The ever-increasing luminosity delivered by DESY's HERA electron-proton collider is allowing deep inelastic (DIS) probing of the proton to take place at unprecedentedly high momentum transfers (Q^2) up to several tens of thousand GeV^2 . The proton's structure is thus becoming ever better determined and searches for the production of new particles, as well as possible interactions which would reveal quark substructure, are being ever extended.

The HERA experiments are also able to extend the kinematical range over which the proton is probed to very low x, a variable which may be thought of as the struck quark or

gluon's share of the proton momentum. It is in the x region below 0.001 that the intriguing sudden rise in the proton structure function was first seen several years ago. Subsequent precision measurements have attributed this rise to a steep increase in the proton's gluon density. If this trend continues, interesting "hot-spot" clustering properties should eventually be seen.

Low x inevitably implies low momentum transfer at high collision energy, requiring accurate detection of scattered electrons closer to the beam pipe. This is also the area where decay products from a "nearly-real" photon will be intercepted, so studies of the hadronic structure of photons will also benefit. These and other requirements were described last month (September, page 21) in a general review of plans for the ongoing HERA research programme. Current analyses are already dominated by systematic errors, so the major item in an extensive upgrade for the major HERA H1 detector became the construction of



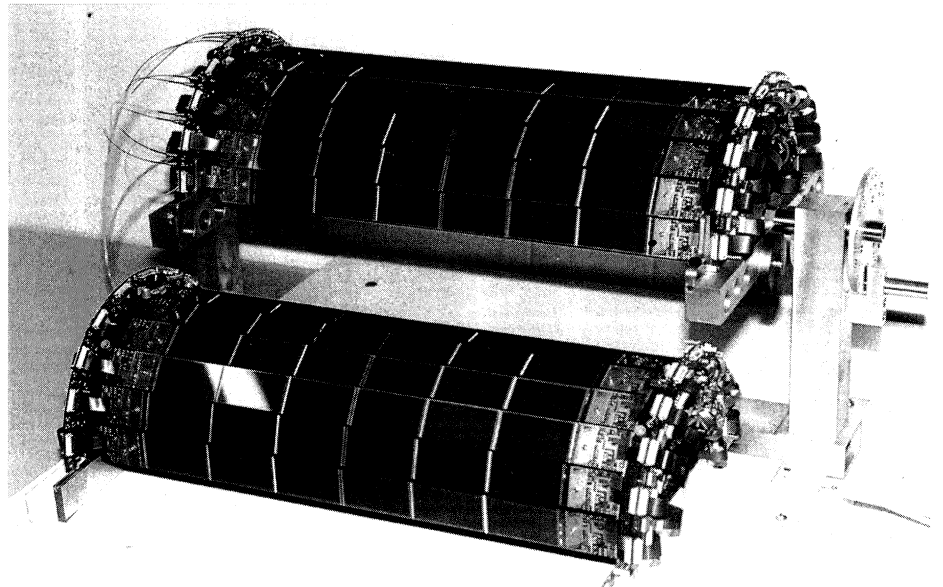
Two half shells of the H1 Central Silicon Tracker, which should reduce the uncertainty of a charged track angle measurement to below 0.5 mrad.

a new 'SPAggetti CALorimeter' (SpaCal). 0.5mm and 1mm diameter scintillating fibres embedded in separate lead matrices for the electromagnetic and hadronic sections are read out by 1400 mesh dynode photomultipliers capable of operating in the ambient 1T magnetic field. With this compact arrangement, 1995 data demonstrated the expected energy resolution for electrons, with millimetre precision.

The SpaCal has a time resolution of less than 1ns, important for differentiating the physics signal from large beam-induced backgrounds arriving some 9ns earlier. The calorimeter covers an angular range from 30° to within 3° of the electron beam direction (corresponding to Q^2 measurements well below 1 GeV² when "vertex shifting" techniques are used). This gives a smooth bridge to the coverage provided by the recently upgraded 44m electron tagger and a new device at 8m downstream.

SpaCal is fronted by a new 8-layer backward drift chamber (BDC) giving pre-shower detection for photon/electron separation, and reducing necessary showering corrections for energy measurements. However its main advantage is the considerable improvement of tracking in the backward (electron) direction.

Tracking has also been extended and improved by the addition of two silicon wafer detectors in the interaction point area. These combined devices can reduce the uncertainty of a charged track angle measurement to below 0.5 mrad. The central silicon tracker (CST) consists of two concentric cylinders, one side of which was already installed and tested in 1995. The backward silicon tracker (BST) will have eight disc planes, four of which should be fully operational this year. Eventually the silicon



detectors will surround a new light-weight carbon fibre beampipe which will further increase tracking capabilities and allow sophisticated vertex detection in heavy flavour production.

Another revelation at HERA has been the contribution from a class of events bearing all the hallmarks of 'colourless' exchange, with the proton essentially remaining intact. These are the so-called large rapidity-gap, or diffractive, events. Although the diffractive final state is clearly seen in the central barrel, the global kinematic properties are best determined by accurate detection close to the beam, this time in the forward direction. Interest in energy deposition in the forward direction has also been fuelled by new ideas for alternative formulations of the quark-gluon field theory equations. Since 1995, H1 has operated 'Roman Pot' stations at 81 and 90m downstream of the interaction point in the proton direction. Scintillating fibre hodoscopes may be lowered to within millimetres of the beam to measure proton

momenta to better than 0.5%. Two additional stations at 63m and 80m are planned for next year and two planes of silicon pixel devices are being prepared to supplement the 90m downstream detectors. This will increase the proton energy acceptance and extend measurements of the diffractive mechanism. This year will also see the first operation of a forward neutron calorimeter (FNC) 107m downstream, a lead/scintillating fibre calorimeter providing equal response for hadronic and electromagnetic showers.

So many additions to the H1 detector inevitably puts a strain on both data acquisition and the trigger. Presently the microprocessor equivalent of several hundred IBM 3090 units take events of 4-5 Mbytes of raw information at a level-1 trigger rate of typically 50 Hz and reduce them to about 50 Kbytes at 10 Hz for writing to tape. The flexible architecture is enabling a 1996 upgrade totalling the addition of some 28 PowerPC 604 cards which

Curt Ekström at the frozen hydrogen pellet target system at Uppsala's CELSIUS ring.

should significantly reduce overall dead-time.

HERA's 96 ns bunch crossing time is only a factor of four away from that planned for CERN's LHC proton collider. The level-1 pipelined trigger has some 2.2 microseconds for its decision, and was previously fed directly into an on-line software trigger. The central trigger system has been supplemented with an intermediate level-2 trigger which presently has two parts, one exploiting preselected topological aspects of the events, and the other consisting of several parallel neural networks, each optimized for a specific class of reactions.

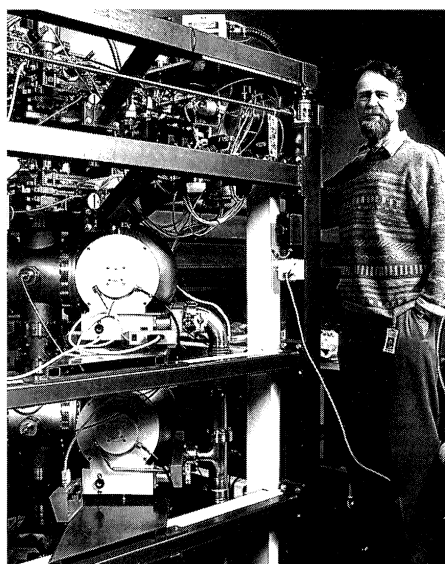
The upgraded detector will be in a good position to exploit the improved and extended physics possibilities provided by HERA.

From Graham Thompson, Queen Mary Westfield College, London

UPPSALA Pelting pellets

A collaboration between Sweden's Uppsala University and the Japanese KEK laboratory came to fruition in August when a thin walled superconducting solenoid magnet was delivered to Uppsala's The Svedberg Laboratory.

The solenoid is a vital part of the Wide Angle Shower Apparatus, WASA, which will make precision measurements of unstable mesons (neutral pions and etas). It was developed with support from the Japanese Ministry of Education, Monbusho, and the Nippon Kokan Company.



The WASA detector is being assembled at the The Svedberg Laboratory's CELSIUS (Cooling with ELectrons and Storing of Ions from the Uppsala Synchrocyclotron) storage ring. About 70 researchers from Germany, Japan, Poland, Russia and Sweden are involved.

The magnets of the CELSIUS ring have an illustrious history, starting life in the classic muon anomalous magnetic moment experiment at CERN in the 1970s before being used in pioneering cooling studies and finally being shipped to Uppsala in 1983.

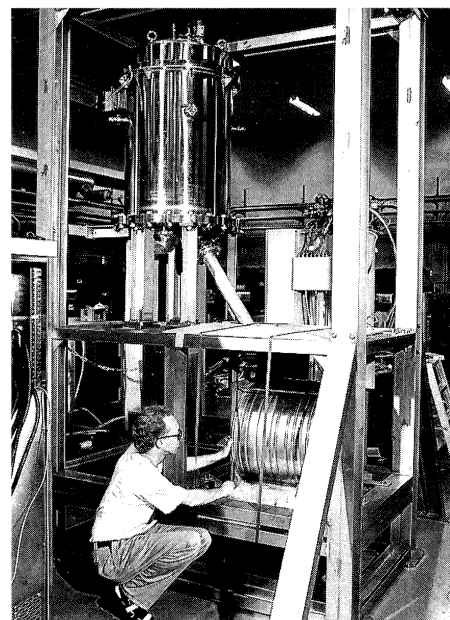
WASA will use a novel target system developed at Uppsala with support from the Wallenberg Foundation. The new target achieves high luminosity by replacing a traditional gas jet with a stream of solid pellets - 0.03 mm-diameter micro-spheres of frozen hydrogen, injected vertically into the proton

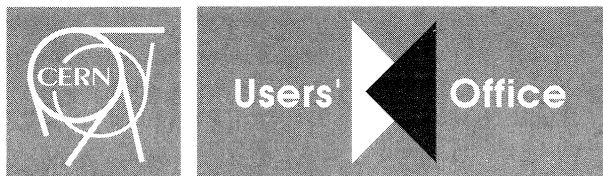
The new superconducting solenoid for the The Svedberg Laboratory's WASA detector shortly after its arrival in Uppsala in August.

beam at a rate of about 7 thousand pellets per second travelling at 60 metres per second.

The pellets are formed by breaking up a liquid hydrogen jet into droplets at the temperature and pressure where solid, liquid, and vapour coexist in equilibrium and injecting these droplets into a vacuum. Mesons are produced when the 1360 MeV CELSIUS proton beam collides with the frozen pellets.

The new solenoid provides the magnetic field for momentum measurements of the emerging charged particles. It is made in a split coil configuration with 40 mm separation between the two windings allowing the stream of frozen hydrogen pellets to pass. Each winding consists of four layers of superconducting wire wound on the inside of an aluminium bobbin. The total coil thickness is 9 mm, or 0.18 radiation lengths, with a length and diameter about 50 cm and cold mass of 20 kg. The central magnetic flux density is 1.3 Tesla at a current of





ARE YOU COMING TO WORK ON AN EXPERIMENT AT CERN

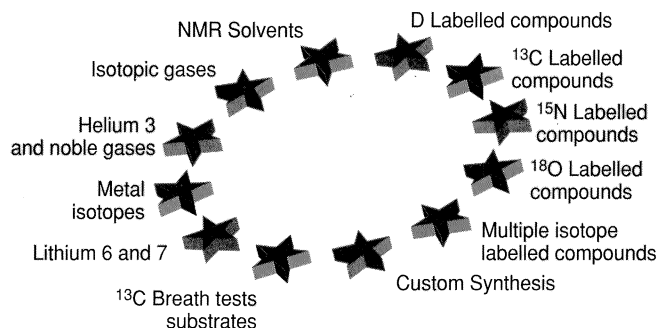
WHETHER YOU BE STAYING FOR JUST A FEW DAYS OR FOR SEVERAL MONTHS,
THEN YOUR FIRST STEP SHOULD BE TO COME AND SEE US.
THE CERN USERS' OFFICE IS THERE TO HELP YOU.

USERS' OFFICE
Bldg 61 / CERN
1211 GENEVA 23
TEL. : +41 22 7676767
FAX : +41 22 7679191

IMPORTANT INFORMATION CAN BE FOUND ON WORLD WIDE WEB
URL : <http://www.cern.ch/CERN/Division/PPE/Users' Office>



**Euriso-top is the leading manufacturer of
NMR deuterated solvents as well as
stable isotope labelled compounds in
Europe and offers a very high quality service**



Parc des Algorithmes
Bâtiment Homère - Route de l'Orme
F-91194 Saint-Aubin Cedex
Tel : 33 (01) 69.41.95.96
Fax : 33 (01) 69.41.93.52

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	2200	2100	2000	1900
1/2	185 x 130 90 x 265	1300	1200	1100	1020
1/4	90 x 130	750	700	650	600

These prices include no entitlement to special placing.

Supplement for:

-one additional colour 1500 SwF
-1/2 page 800 SwF

-Covers:

Covers 2 and 3 (one colour) 2200 SwF
Cover 4 (one colour) 2700 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 60l/cm (150 English)

Advertisements cancelled after 1st of month preceding cover date will be invoiced.

These rates are effective for the year 1997

Inquiries for Europe:

Micheline FALCIOLA / CERN COURIER - CERN
CH - 1211 Genève 23 Suisse
Telephone: 022/767 41 03
Telefax: 022/782 19 06

Inquiries for the rest of the world:

please see page III

People and things

875 A. The interaction between protons and pellets was tested for the first time in April. Further tests are under way to optimize the system for WASA experiments, scheduled to start in the autumn of 1998.

Books received

Thermal Field Theory, by Michel Le Bellac, Cambridge University Press, ISBN 0 521 46040 9 (hbk) £45

This treatise in the series of Cambridge Monographs on Mathematical Physics covers thermal effects in relativistic thermal field theory, looking into the implications of quantum chromodynamics for collisions of high energy nuclear beams, and for astrophysics and cosmology.

Doing Physics - How Physicists Take Hold of the World, by Martin H. Krieger, Indiana University Press, ISBN 0 253 33123 4 (hbk) 0 253 20701 0 (pbk)

A useful explanation of the way physicists do physics and try to make sense of the world. With key physics arguments not always as transparent as they could be, such a primer provides a useful bridge.

ICTP medals

The prestigious Dirac Prize of the International Centre for Theoretical Physics (ICTP, Trieste, Italy) is awarded this year to Tullio Regge (Politecnico di Torino) and Martinus Veltman (University of Michigan).

Tullio Regge is honoured "for crucial contributions in theoretical and mathematical physics starting with his seminal investigation of the asymptotic behaviour of potential scattering processes through the analytic continuation of the angular momentum to the complex plane. This technique has found many applications in the study of differential equations while in the physics of the Strong Interactions, the so-called Regge trajectories have helped in the classification of particles and resonances by grouping together entities with different spin. The so-called Regge behaviour was, and still is, an important ingredient in the construction of String theories. In addition, Regge is also known for having introduced the first discretisation of space-time with a simple Einstein dynamics (the so-called Regge Calculus) and for its formulation of supergravity theories in the geometric language of differential forms".

Martinus Veltman is honoured "for his pioneering investigations on the renormalizability of gauge theories and consequently, his analysis of the sensitivity of radiative corrections to both the mass differences in fermion doublets and the Higgs particle mass. These calculations provided the basic prediction in the search for the top quark mass. Towards this goal, Veltman was one of the first to use the computer in Feynman diagram calculations. His software package for manipulations of alge-

braic symbols has been a privileged tool for a full generation of physicists".

Instituted in 1985, the Dirac Medals are awarded annually for contributions to theoretical physics and mathematics, the announcement traditionally being made on P.A.M. Dirac's birthday - 8 August. The Dirac Medals are not awarded to Nobel Prize or Wolf Foundation Prize winners.

Adolf Minten retires

This summer marked the formal retirement from CERN of Adolf Minten. A member of Wolfgang Paul's low energy but highly prolific group at Bonn in the 1950s, he joined CERN in 1962. After a sabbatical at SLAC during the momentous years of electron scattering experiments in 1966-67 he returned to CERN, where he was a pioneer of large electronic detectors, becoming leader, with Georges Charpak, of the Split Field Magnet group at the Intersecting Storage Rings. In 1976 he became the dynamic and popular leader of the newly formed Experimental Physics Facilities (EF) Division, remaining until 1984. After a second stay at SLAC he joined the Aleph collaboration at LEP in 1987.

Ron Newport retires

Recently retired is Ron Newport, Head of the UK Daresbury Laboratory. Graduating from Liverpool in 1955, he began a long career in bubble chamber work at CERN, the UK Rutherford Laboratory and at Berkeley. In the preparations for the experimental programme at CERN's SPS proton synchrotron, he led the design of the rapid cycling bubble chamber at the heart of the big European Hybrid Spectrometer.

invites applications for

**SENIOR RESEARCH POSITION in
Experimental Particle Physics at ATLAS**

The Council's intention in creating these positions is to contribute to the recruitment of researchers and to the renewal of research in Sweden. The programme is aimed primarily at scientists with a doctorate and several years of post-graduate research. The positions are held for three plus three years and are placed at appropriate university departments in Sweden to be chosen in consultation between the candidates, NFR and the universities. The universities decide on tenure. Duties can commence from July 1, 1997. The salary range will correspond to that of an assistant/associate professor (SEK 300 000-360 000 per year, i.e. USD 46 000-55 000 per year). A curriculum vitae including a list of publications, a short research plan plus a description of scientific achievements (max. 5 pages), and a maximum of 10 reprints of scientific papers should be appended. Other documents which the applicant wants to refer to could also be included. Four copies of the application and all appendixes and reprints should be submitted.

Applications should reach the Swedish Natural Science Research Council, Box 7142, S-103 87 Stockholm, Sweden, by December 1, 1996.

Further information can be obtained from Ms Natalie Lunin at the Secretariat of NFR, phone no +46 8 454 42 32, fax no +46 8 454 42 50.

**EXPERIMENTAL
ULTRA HIGH ENERGY
COSMIC RAY PHYSICS**

The Physics Department at the University of Utah is seeking highly qualified candidates for an assistant or associate professor tenure track position in experimental ultra high energy cosmic ray physics. We seek candidates with strong commitments to both teaching and research. Successful candidates will be expected to participate in the work of the High Resolution Fly's Eye Ultra High Energy Cosmic Ray observatory and allied efforts and to teach undergraduate and graduate courses in Physics.

Candidates should submit their curriculum vitae, list of publications and three letters of recommendation by March 15, 1997 to:

COSMIC RAY FACULTY RESEARCH COMMITTEE
Department of Physics
201 James Fletcher Bldg.
University of Utah
Salt Lake City, UT 84112

The University of Utah is an Affirmative Action Equal Opportunity Employer. It encourages applications from women and minorities and provides reasonable accommodations to the known disabilities of applicants and employees.



Department of Physics

Research Officer in Experimental Particle Physics

Applications are invited for the above post from experimental particle physicists, preferably with some years of postdoctoral experience in research. The Research Officer position is a fixed-term academic appointment with the same salary and conditions as a University Lecturer, but with a limited teaching load. Oxford has the largest particle physics group in the UK, with a wide-ranging and very active research programme. This includes the DELPHI experiment at LEP (CERN), the ZEUS experiment at HERA (DESY), the SOUDAN 2 and MINOS experiments (USA), the Sudbury Neutrino Observatory (SNO) project (Canada), the development of cryogenic detectors and the CRESST experiment (Gran Sasso), plus the development of the ATLAS and LHC-B experiments in high-energy physics.

The successful applicant would be expected to participate in the above programme and contribute to the teaching activities of the Department. Preference may be given to candidates wishing to participate in one of the new projects (MINOS, CRESST, ATLAS or LHC-B). An appointment will be made as soon as possible and would be for three years in the first instance, with the possibility of extension for a further two, on the University Lecturer scale (£15,154 - £28,215 p.a.). Further particulars, including details of duties and range of emoluments, may be obtained from the Deputy Administrator, Nuclear & Astrophysics Laboratory, Keble Road, Oxford OX1 3RH (E-mail: P.Dobbs1@physics.oxford.ac.uk).

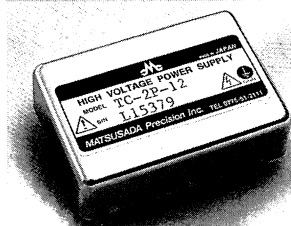
Letters of application, supported by a full curriculum vitae, list of publications, a statement of research interests and teaching experience plus the names of three referees, should be sent to the Deputy Administrator, Mr P.F. Dobbs, at the above address to arrive no later than 15 November 1996. The referees should be asked to send references directly to Dr G. Myatt, acting Head of Particle & Nuclear Physics, at the same address to arrive by the closing date.

It is expected that the short-listed candidates will be interviewed in Oxford in December 1996. Applicants are asked to indicate an E-mail address, and a fax or telephone number where they can be contacted.

The University is an Equal Opportunities Employer.

**HIGH VOLTAGE
POWER SUPPLIES**

Ultra-Compact TC Series

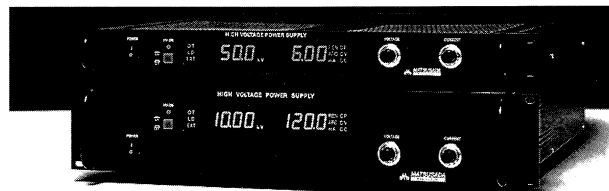


Output 1kV-2kV 1.5W

- Ultra-compact, PCB mountable
- Low ripple
- Low Noise
- Well-regulated, high performance

Rack-Mount Package

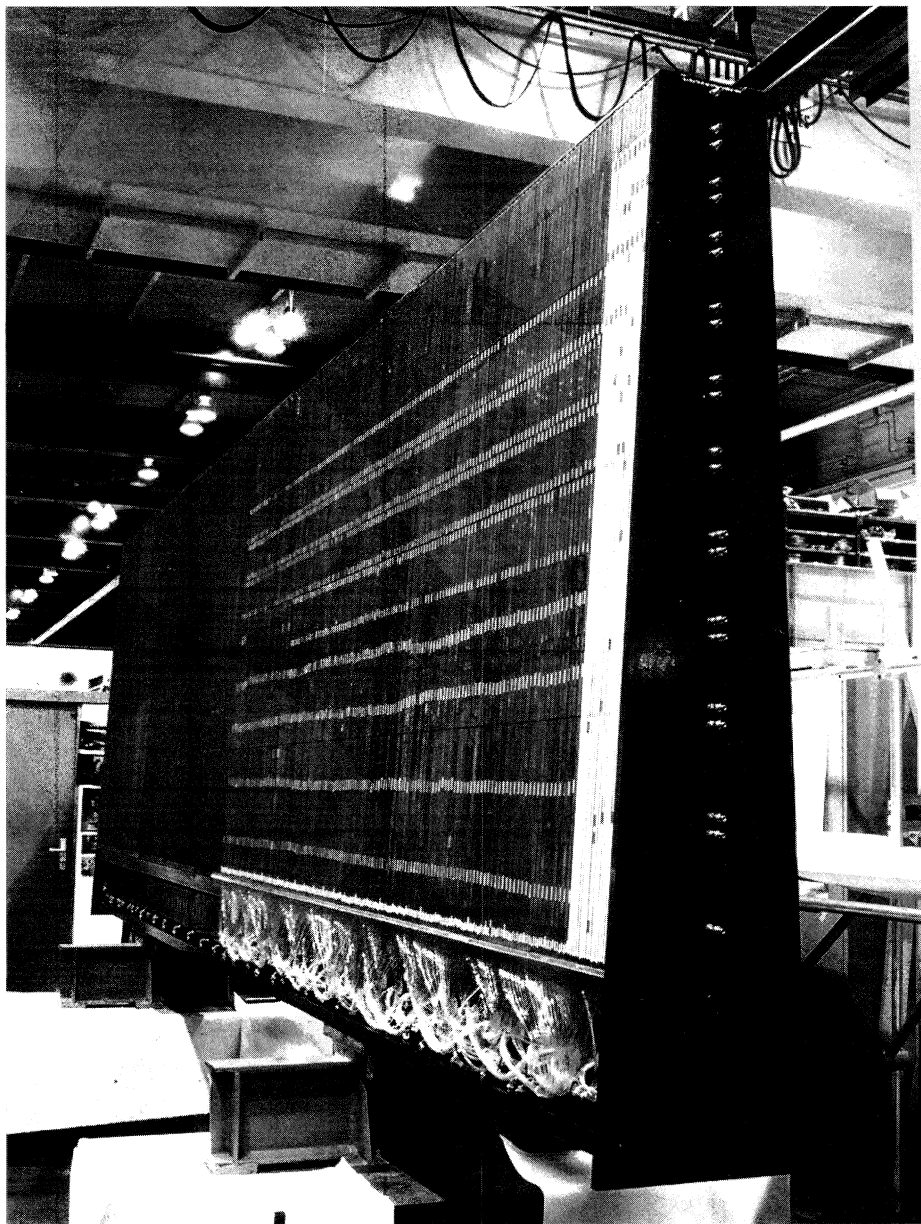
Au Series Output 1kV-120kV 30W-1.2kW



MATSUSADA Precision Inc.

Head Office 745 Aojicho Kusatsu 525 Japan Tel : +81-775-61-2111 Fax : +81-775-61-2112
American Office 2570 El Camino Real, Mountain View, CA 94040 USA Tel : +1-415-917-7050 Fax : +1-415-949-1217
European Office Rosenheimerstr. 145a, 81671 Munchen Germany Tel : +49-89-4991691 Fax : +49-89-403602

First components are coming together for the huge 7,000-tonne ATLAS detector at CERN's future LHC proton-proton collider. Seen here is the first full-size prototype module of the 64 21-tonne azimuthal wedges for the central barrel of the ATLAS scintillating tile hadronic calorimeter. For these modules, components produced in several centres are assembled at the Joint Institute for Nuclear Research (JINR), Dubna, near Moscow. The 64 large modules will be complemented by 128 modules one-half the size for the outer barrels of the calorimeter, which will be assembled at IFAE Barcelona and at Argonne in the US. (Photo CERN 4.7.96/7)



In 1981 he turned to the design of a major new UK astronomy telescope, going on to senior positions in the UK Science and Engineering Research Council, and being appointed as Chairman of the European Synchrotron Radiation Facility Council in 1993. In 1994, he took over from Alan Leadbetter as Daresbury Laboratory Head.

Alexander Hocker 1912-1996

One of the main architects of the reconstruction of post-war German scientific research, Alexander Hocker, died on 7 August. As Deputy Director of the Deutsche Forschungsgemeinschaft in the early 1950s, he, with Werner Heisenberg, represented Germany in the early meetings which

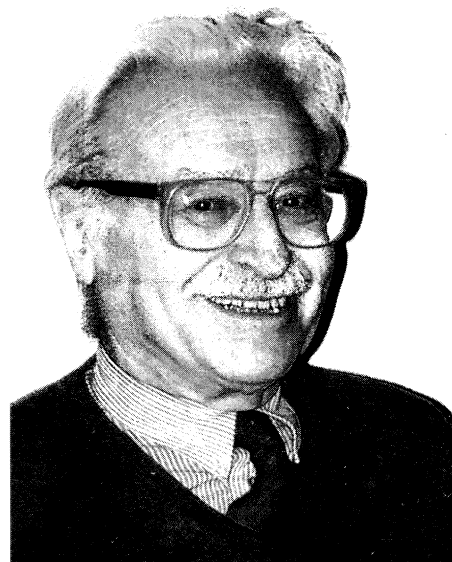
led to the establishment of CERN. As a staunch advocate of European collaboration, he played a vital role in ensuring Germany's participation in CERN. A long-time member of CERN Council, he also served as Chairman of CERN's Finance Committee in 1961. As well as his work for CERN, he was also influential in the establishment of major German research centres, including DESY and Garching. From 1961 he was Administrative Director of the Jülich laboratory, while from 1965-67 he was also President of the European Space Research Organization (ESRO).

Siegfried A. Wouthuysen 1916-1996

Distinguished Dutch theorist Siegfried A. Wouthuysen died on 9 July.

Born in Amsterdam, he moved with his family to Antwerp in Belgium and studied chemical engineering at Ghent. Returning to the Netherlands,

Siegfried A. Wouthuysen 1916-1996



FACULTY POSITION IN THEORETICAL INTERMEDIATE-ENERGY PHYSICS

Indiana University

The Department of Physics of Indiana University is searching for a new faculty member in theoretical physics, with interests in the area of intersection between nuclear and particle physics. The appointment is at the tenure-track, assistant professor level, although exceptional candidates seeking tenured positions will be considered. The expected starting date is the fall of 1997, pending funding. We seek candidates with a strong commitment to teaching and research. The new faculty member will be part of the Indiana University Nuclear Theory Center and will be expected to interact strongly with the department's experimental groups in nuclear and particle physics. Indiana University is a major research institution; the Department of Physics has strong programs in theoretical and experimental nuclear, particle and condensed-matter physics, in high-energy astrophysics, and in accelerator physics. Indiana University is an Affirmative Action/Equal Opportunity Employer. Send applications by December 13, 1996 to Prof. M. H. Macfarlane, Search Committee, Department of Physics, Indiana University, Bloomington, Indiana, 47405

FACULTY POSITIONS IN PHYSICS

University of California, Berkeley

The Physics Department of the University of California, Berkeley intends to make at least two faculty appointments effective July 1, 1997. Candidates from all fields of physics are encouraged to apply. Appointments at both tenure-track assistant professor and tenured levels will be considered.

Please send a curriculum vitae, bibliography, statement of research interests, and a list of references to **Professor Roger W. Falcone, Chairman, Department of Physics, 366 LeConte Hall #7300, University of California, Berkeley, CA 94720-7300**, by Monday, November 25, 1996. E-mail applications will not be accepted. Applications submitted after the deadline will not be considered. The University of California is an Equal Opportunity, Affirmative Action Employer.

MIT

FACULTY POSITION

The Physics Department of the Massachusetts Institute of Technology invites applications for a tenure track position at the Assistant Professor level in the area of experimental high energy physics.

Physicists at MIT currently pursue e+e- physics at CERN (L3 detector) and SLAC (SLD detector), and p+p- physics at Fermilab (CDF detector). They are also preparing for LHC (CMS and Atlas detectors), PEP II (BABAR detector), and a search for antimatter in space (AMS).

These programs would welcome new members, but candidates with other research interests will also be considered. We are seeking, in particular, candidates whose long-term interests include involvement in the high energy frontier at LHC.

*Applicants should submit a curriculum vitae and publication list, and arrange for three letters of recommendation to be sent to: **Professor Wit Busza, Chairman, Search Committee, 24-510, Massachusetts Institute of Technology, 77 Massachusetts Avenue, Cambridge, MA 02139-4307**. Qualified women and minorities are encouraged to apply.*



Massachusetts Institute of Technology
An Equal Opportunity/Affirmative Action Employer
Non-Smoking Environment



DESY is one of the leading German laboratories in high energy physics and synchrotron radiation research.

In the framework of an international collaboration, DESY is developing a Free Electron Laser for wavelengths far below the visible. The project is based on the superconducting TESLA Test Accelerator Facility (TTF), which provides the technological basis for a future high-energy electron-positron linear collider.

A key contribution to the success of this free electron laser will be a number of advanced electron beam diagnostics components. DESY has an opening for a

Postdoctoral Position

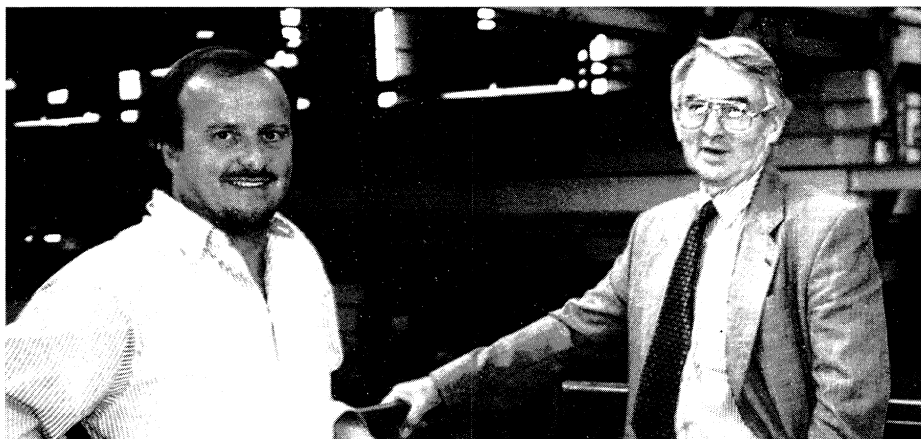
in this field. The successful candidate will be responsible for both coordination of work being already under way and construction of components to be designed by him/herself. The contract will be limited to 3 years. The salary will be according to the German civil services Ila MTV Angestellte.

Post-Docs who have experience in this field and are younger than 32 years, please send their letter of application and three names of referees before November 8th to:

DESY Personalabteilung
Notkestraße 85 D-22603 Hamburg
Tel.: 49-40-8998-3617
Fax: 49-40-8994-4305

Handicapped applicants will be given preference to other applicants with the same qualification. Women are especially encouraged to apply for this position.

Visiting CERN at the end of September was UK Institute of Physics Chief Executive Alun Jones (right), seen here at CERN's LEAR Low Energy Antiproton Ring with Rolf Landua.



his theoretical physics studies with H.A. Kramers were interrupted by the war. Continuing physics as best he could, he managed to communicate to Kramers a curious property of analytically-continued quantum amplitudes showing poles, which he interpreted as bound states. After the war, he followed Kramers' advice and went to Berkeley for a PhD with J. Robert Oppenheimer, subsequently moving to Princeton in Oppenheimer's wake. However his thesis had to be presented in Berkeley, and an overland car trip with Lesley Foldy resulted in the famous Foldy-Wouthuysen transformation.

Despite this success in the US, Wouthuysen preferred to continue his career in the Netherlands, where he established a school of Theoretical Physics in Amsterdam in 1950. He realized very early the importance of CERN, where he served as a national delegate from 1961-79 and was a member of the Scientific Policy Committee from 1963-74. He was a member of the Belgian Academy of Sciences and doctor honoris causa at Ghent. His colleagues and numerous students ensure that his memory remains alive.

Sir Nevill Mott 1905-96

Sir Nevill Mott, who shared the 1977 Nobel Prize with Philip Anderson and John Van Vleck for work on semiconductors, died in August. With parents who had worked at Cambridge's Cavendish Laboratory under J.J. Thomson, Mott was highly physics motivated, and after initial theoretical work at Cambridge in the 1920s went on to work with Bohr at Copenhagen and Bragg in Manchester. Returning to Cambridge in 1930, he made his classic contributions to the interactions of charged particles - Mott scattering. As professor of theoretical physics at Bristol from 1933, he concentrated on the use of quantum mechanics to explain semiconductor properties. In 1954, he became Cavendish Professor at Cambridge, succeeding W.L. Bragg, and formally retired in 1971, although he continued to be active, having most recently proposed a theory of high temperature superconductivity. As prolific writer, he was the author of several standard works.

External correspondents

Argonne National Laboratory, (USA)
D. Ayres

Brookhaven, National Laboratory, (USA)
P. Yamin

CEBAF Laboratory, (USA)
S. Corneliusen

Cornell University, (USA)
D. G. Cassel

DESY Laboratory, (Germany)
P. Waloschek

Fermi National Accelerator Laboratory, (USA)
Judy Jackson

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)
S. Eidelman

Orsay Laboratory, (France)
Anne-Marie Lutz

PSI Laboratory, (Switzerland)
P.-R. Kettle

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

Hinter einem erfolgreichen Wirtschaftsprodukt...



SCIENTISTS

The STAR group in the Physics Department at Brookhaven National Laboratory has the following positions available for Ph.D. scientists with several years experience in high energy or relativistic heavy ion physics.

1) A scientist to develop and maintain the GEANT infrastructure for STAR as well as relational databases and the corresponding interfaces required for other elements of the STAR software framework (simulation, event reconstruction, and on-line/off-line production software).

2) A scientist to develop and implement the software infrastructure for the STAR off-line data processing system and manage the STAR production software development. The successful candidate should have a working knowledge of UNIX operating systems as implemented on various platforms such as SGI (IRIX), IBM (AIX) and SUN (Solaris). Proficiency with scripting languages and with the C programming language is preferred. Responsibilities will include infrastructure support for the STAR analysis framework and the corresponding interface to CERN library software.

3) A scientist to assume the position of Project Leader for On-line Software, who will be responsible for the design, development, and implementation of the on-line computing system for STAR. This person will lead a large collaborative software effort which will be closely coordinated with the Project Leaders for other STAR hardware and software efforts. A thorough knowledge of on-line system software techniques for modern physics detectors is essential.

STAR is a large collider detector experiment to search for a new state of matter thought to have existed shortly after the creation of the universe. Candidates should send a curriculum vitae with names of three references to: Dr. Timothy Hallman, Physics Department, Bldg. 510A, Brookhaven National Laboratory, Associated Universities, Inc., Upton, New York, 11973-5000. Equal Opportunity Employer M/F/D/V.



BROOKHAVEN NATIONAL LABORATORY
ASSOCIATED UNIVERSITIES, INC.

Physics Institute, The Academia Sinica, Taiwan

Postdoctoral Research Associate Positions in Experimental Particle Physics

The Experimental Particle Physics Group at the Physics Institute of the Academia Sinica in Taiwan invites applications to the available Postdoctoral Research Associate positions for further strengthening its program.

The group is involved in the CDF and Hyperon-CP experiments at Fermilab, the AMS project on the International Space Station Alpha, and is starting programs in Neutrino Physics towards long baseline experiments with reactor neutrinos, as well as Detector Development in Medical Physics. Preference for the immediate positions is on the Neutrino and AMS programs, while new openings for other areas are expected soon. Successful applicants will be able to work with an expanding group in a growing field in Taiwan, with much challenges and potentials for future growth.

Interested candidates please submit their curriculum vitae, statement of research interest, as well as the names and addresses of three professional referees, to

Prof. S.C. Lee,
Physics Institute
The Academia Sinica
Nankang, Taipei
Taiwan, R.O.C.

E-mail enquiry can be made to search@hep2.phys.sinica.edu.tw. Applications will be reviewed until the available positions are filled.

PAC'97

The 17th Particle Accelerator Conference (PAC'97) will be held May 12-16, 1997, in the Hotel Vancouver, Vancouver, B.C., Canada. The conference is held under the auspices of the APS and IEEE, and is being organized by TRIUMF and the University of Maryland. Abstracts are due 10 January 1997 at APS Headquarters.

For further information, contact Elly Driessen, TRIUMF, 4004 Wesbrook Mall, Vancouver, B.C., V6T 2A3, tel: (604) 222-7352, fax (604) 222-1074, e-mail: pac97@triumf.ca or visit the Web site: <http://www.triumf.ca/pac97.html>



The European School of High Energy Physics, held this year from 1-14 September at Carry-le-Rouet, near Marseilles, France, brought together 130 students from 30 nations.

CERN Courier contributions

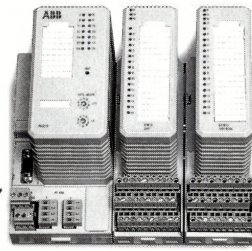
The Editor welcomes contributions. These should be sent via electronic mail to cern.courier@cern.ch

Plain text (ASCII) is preferred. Illustrations should follow by mail (CERN Courier, 1211 Geneva 23, Switzerland).

Contributors, particularly conference organizers, contemplating lengthy efforts (more than about 500 words) should contact the Editor (by e-mail, or fax +41 22 782 1906) beforehand.

...steckt unsere wirtschaftliche Prozesssteuerung.

Der wirtschaftliche Erfolg hängt oft vom effizienten Einsatz der verfügbaren Produktionsmittel ab. Ob Grossindustrie oder Kleinbetrieb, Sie müssen Ihre Konkurrenzfähigkeit sichern und steigern. Deshalb gibt es jetzt eine einfache Lösung, die das ermöglicht. Die noch mehr leistet. Und die noch weniger kostet: Den neuen Advant® Controller 70, die kleine Prozessstation

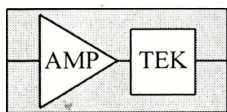


im Automatisierungs-System von Advant® OCS. Damit haben Sie auf nur 8,4 x 16,2 x 12,2 cm Ihren grossen Nutzen: Sie programmieren schneller. Und Sie arbeiten umweltgerechter, produktiver und qualitativ besser. Von Advant® OCS sind übrigens viele Unternehmen begeistert, vermutlich bald auch Sie.

Advant® OCS. Das Automatisierungs-System.
Für alles offen. Für immer besser.



Mehr zu Advant® OCS bei **ABB Industrie AG** · 5401 Baden-Dättwil · Telefon: 056 / 486 71 96 · Telefax: 056 / 486 73 73



X-RAY DETECTOR

XR-100T

FEATURES

- Si-PIN Photodiode
- Peltier Cooler
- Cooled FET
- Amptek A250 Preamp
- Temperature Monitor
- Beryllium Window
- Hermetic Package (TO-8)
- PX2T Amplifier and Power Supply
- Optional CZT Detector

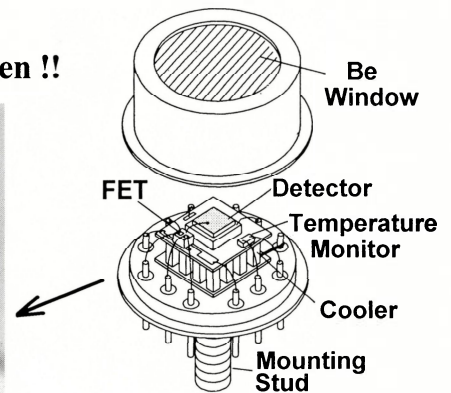
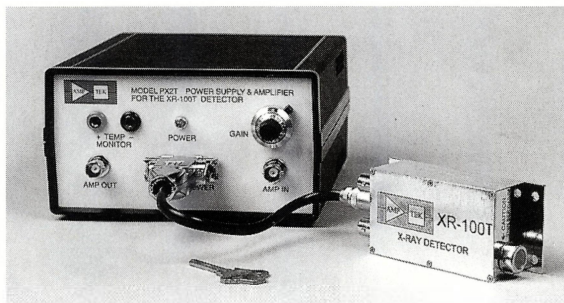
APPLICATIONS

- X-Ray Fluorescence
- Medical X-Ray Detectors
- X-Ray Lithography
- Portable X-Ray Instruments
- X-Ray Teaching & Research
- Mössbauer Spectrometers
- X-Ray Space and Astronomy
- Environmental Monitoring
- Nuclear Plant Monitoring
- Toxic Dump Site Monitoring
- PIXE

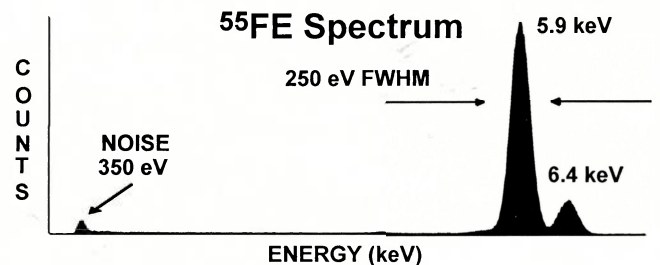
Model **XR-100T** is a new high performance X-Ray Detector, Preamplifier, and Cooler system using a Si-PIN Photodiode as an X-Ray detector mounted on a thermoelectric cooler. On the cooler are also mounted the input FET and the feedback components to the Amptek A250 charge sensitive preamp. The internal components are kept at approximately -30°C, and can be monitored by a temperature sensitive integrated circuit. The hermetic TO-8 package of the detector has a light tight, vacuum tight 1 mil (25 µm) Beryllium window to permit soft X-Ray detection.

Power to the XR-100T is provided by the PX2T Power Supply. The PX2T is AC powered and also includes a spectroscopy grade Shaping Amplifier. The XR-100T/PX2T system ensures quick, reliable operation in less than one minute from power turn-on.

NEW! 200 eV RESOLUTION
Technology Breakthrough
All Solid State Design / No More Liquid Nitrogen !!



The system resolution with a test pulser and the detector connected is 200 eV FWHM. The resolution for the 5.9 keV peak of ⁵⁵Fe is 250 eV FWHM.



AMPTEK INC. 6 De Angelo Drive, Bedford, MA 01730-2204 U.S.A.

Tel: +1 (617) 275-2242 Fax: +1 (617) 275-3470 e-mail: sales@amptek.com WWW: http://www.amptek.com



11200 EYES ARE WAITING

HAMAMATSU 20 Inch photomultiplier tubes are watching "Neutrino" and/or "a moment of Proton decay" in the huge water tank located 1000 meter below the ground surface.

The observation result from this Super Kamiokande experiment will attract an attention from the world for its consequence and progress for particle physics and astrophysics.

Since this April, 1996, 11,200 eyes are waiting for the moment.

HAMAMATSU PHOTONICS K.K., Electron Tube Center

HAMAMATSU

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

United Kingdom: Hamamatsu Photonics UK Limited. TEL:(44)181-367-3560 FAX:(44)181-367-6384

North Europe: Hamamatsu Photonics Norden AB. TEL:(46)8-703-29-50 FAX:(46)8-750-58-95

Italy: Hamamatsu Photonics Italia S.R.L. TEL:(39)2-935 81 733 FAX:(39) 2-935 81 741

Spain: Hamamatsu Photonics Espana S.L. TEL:(34)3-582 44 30 FAX:(34)3-582 44 31

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 69 53 71 00 FAX:(33)1 69 53 71 10

Switzerland: CERN Liaison Office TEL:(41)31/879 13 33 FAX: (41)31/879 18 74