

CERN COURIER

INTERNATIONAL JOURNAL OF HIGH ENERGY PHYSICS

VOLUME 34

10

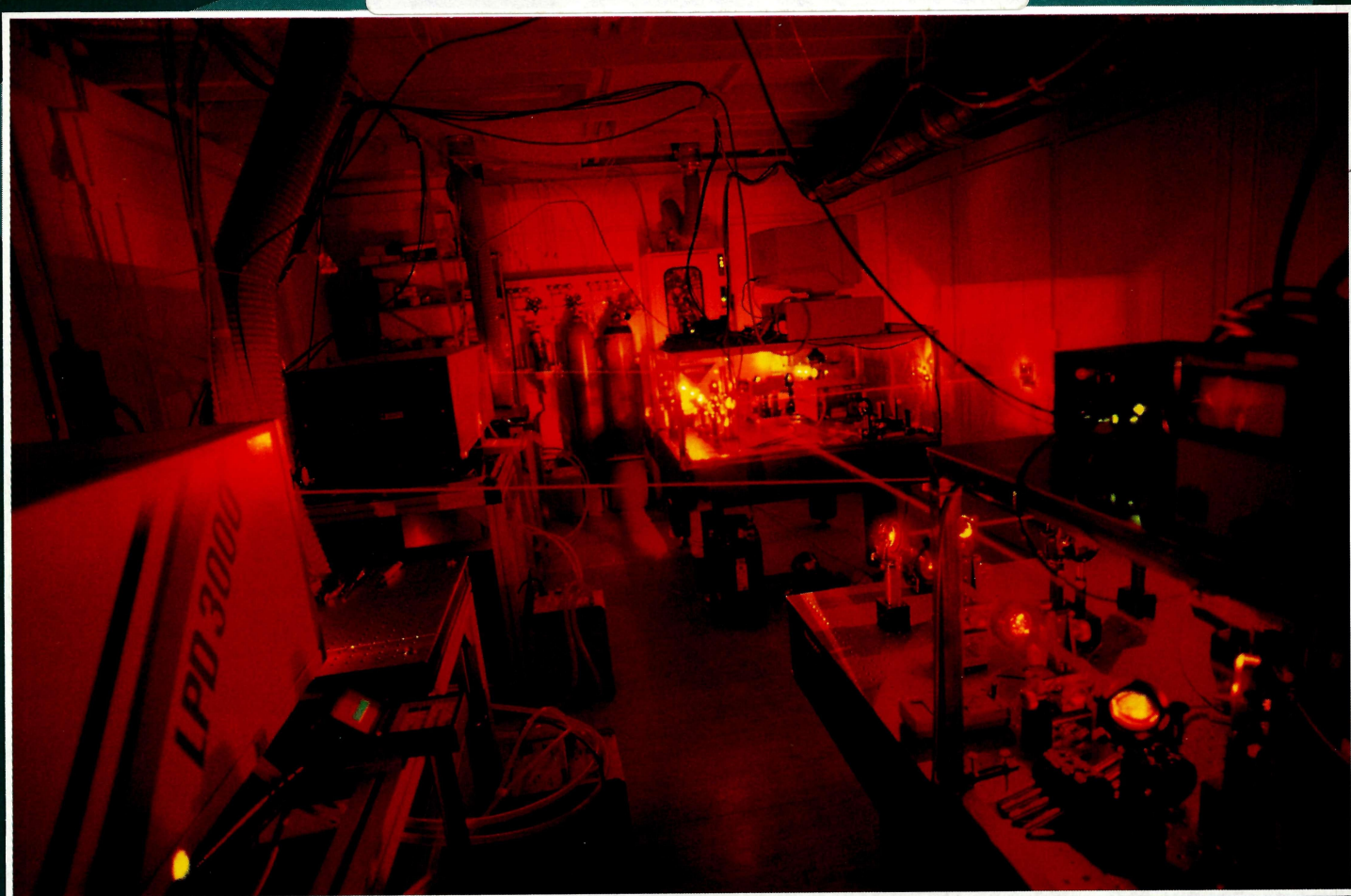
DECEMBER 1994

J112

DGCRCE 002

FROY
Maryse

AS





LA FRANCE AU CERN
4 - 6 AVRIL 1995

Pour toute information ou inscription,
Merci de contacter :

au CFME (Comité Français des Manifestations Economiques à l'Étranger)

- Mme Khaiat : Tél. : (33.1) 40 73 32 42
- Mme Cléro : Tél. : (33.1) 40 73 36 01
Fax : (33.1) 40 73 39 69

au CERN

- Mr Diraison : Tél. : (41.22) 767 45 85
Fax : (41.22) 782 06 58

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

Laurie Shapiro
Advertising Manager, USA
Gordon and Breach Publishers
P.O. Box 200029
Riverfront Plaza Station
Newark, NJ 07102-0301
Tel.: 201-643-7500 (ext. 228)
Fax: 201-643-7676

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

General distribution

Jacques Dallemagne
CERN, 1211 Geneva 23, Switzerland

In certain countries, copies are available on request from:

China

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

Germany

Monika Stuckenberg or Kerstin Techriz
DESY, Notkestr. 85, 22603 Hamburg 52

Italy

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

United Kingdom

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

USA/Canada

Cyndi Rathbun (B90904 @ FNALVM)
Fermilab, P.O. Box 500, Batavia
Illinois 60510

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

Printed by: Drukkerij Lannoo nv
8700 Tielt, Belgium

Published by:

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

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

USA: Controlled Circulation
Postage paid at Batavia, Illinois

Volume 34
No. 10
December 1994

CERN COURIER

Covering current developments in high energy physics and related fields worldwide

Editor: Gordon Fraser (COURIER @ CERNVM)*

Production and Advertisements:

Micheline Falciola (FAL @ CERNVM)*

Advisory Board: E.J.N. Wilson (Chairman), E. Lillestol,
H. Satz, D. Treille; with L. Foa,
E.M. Rimmer

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

Physics monitor	
1	Hubble Telescope measures Hubble Constant <i>How fast is the Universe expanding?</i>
	Physics on its taus <i>3rd generation physics</i>
3	Colourless confinement for quarks <i>Mathematical imprisonment</i>
4	HADRONS-94 <i>Strong interactions at large distances</i>
6	1994 is a LEAP year <i>Low energy antiprotons</i>
Dubna - the great survivor <i>Laboratory survey</i>	
7	
Physics revelations <i>by Christine Sutton</i>	
11	
Around the Laboratories	
14	CERN: Physics at LEP2/Strengthening scientific cooperation/Heavy implications for heavy ions/LEAR throws light on antiprotonic helium atoms/Quark rules not OK
20	CORNELL: Superconducting technology breakthrough <i>Cavities for CESR</i>
22	CZECH REPUBLIC: Transition <i>ECFA survey</i>
23	UNITED STATES <i>Particle and nuclear astrophysicists look to the future</i>
People and things	
27	



Cover photograph: Laser techniques in action at CERN's LEAR low energy antiprotoning (see page 6)

TAKING CARE OF YOUR POWER

HOLEC HI

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

ZERO-FLUX MEASURING SYSTEMS

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

HOLEC HI

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

SCINTILLATING FIBRES

- 0,2 ÷ 2 mm diameter
- head-to-head junction with optical fibres is possible
- ribbon arrays can be supplied

pol. hi. tech. s.r.l.

S. p. Turanese; Km 44,400; 67061 Carsoli (AQ) - Italy
Tel. (0863) 99 77 98/99 56 03 - Telefax (0863) 99 58 68

VIENNA WIRECHAMBER CONFERENCE '95

Advisory Committee

G.Charpak (CERN - Geneva, CH)
S.Denisov (IHEP - Protvino, RU)
G.Flügge (RWTH - Aachen, D)
H.J.Hilke (CERN - Geneva, CH)
S.Iwata (KEK - Ibaraki-ken, J)
A.Menzione (INFN - Pisa, I)
A. Policarpo (LIP - Coimbra, P)
V.Radeka (BNL - NY, USA)
I.Savin (JINR - Dubna, RU)
J.Va`vra (SLAC - Stanford, USA)

Invited Speakers

D.Fournier (LAL - Orsay, F)
H.Heijne (CERN - Geneva, CH)
H.Kolanoski (Univ. Dortmund, D)
G.Lutz (MPI - München, D)
A.Oed (ILL - Grenoble, F)
V.Polychronakos (BNL - NY, USA)
D.Saxon (Univ. of Glasgow, UK)
L.Shekhtman (INP - Novosibirsk, RU)

Institute for High Energy Physics of the Austrian Academy of Sciences
February 13-17, 1995

Wire Chambers: Recent Trends and Alternative Techniques

Topics: High Energy and Nuclear Physics, Synchrotron Radiation Experiments,
Astrophysics, Biology, Medicine; associated Electronics included

Proceedings: Nuclear Instruments and Methods in Physics
Research (incl. in conf. fee)
Applications: January 2, 1995
Contributions: November 1994; Fee: 2800.- ATS
Mailing Address: Institut für Hochenergiephysik,
A-1050 Vienna, Nikolsdorfer Gasse 18
Fax: +431-544 75 89 (no abstracts)
E-mail: wcc@hephy.oeaw.ac.at
Organising Committee: W.Bartl, M.Krammer,
U.Kwapil (Secr.), G.Neuhofer, M.Regler, A.Taurok

Patronage: The Minister of Science and Research
The President of the Austrian Academy of Sciences
The Rector of the University of Vienna
The Rector of the University of Technology, Vienna
European Physical Society

AUSTRIAN Airlines - official carrier of the Conference

第七次

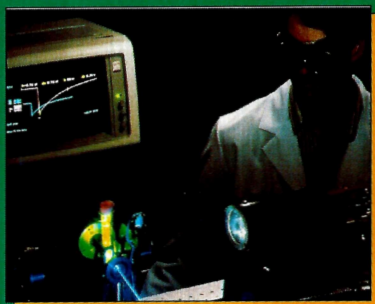
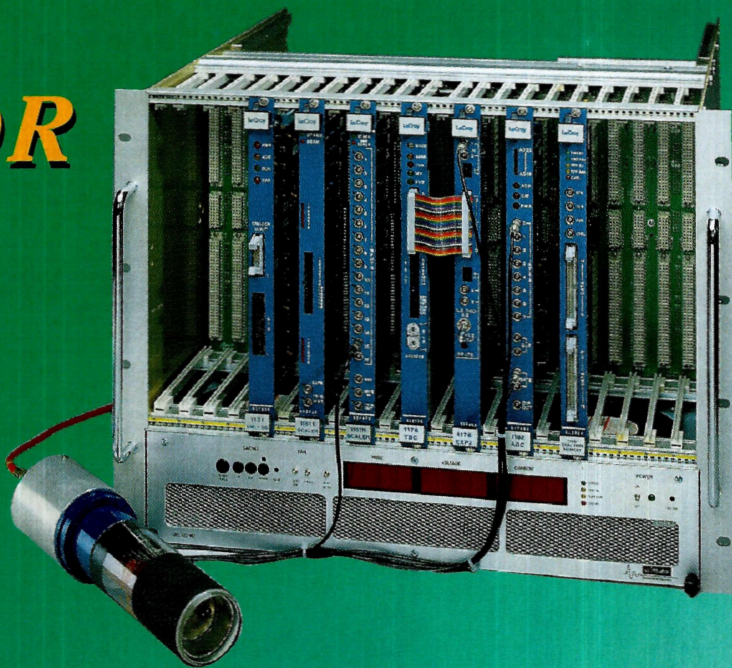
國際絲室
學術會議

維也納

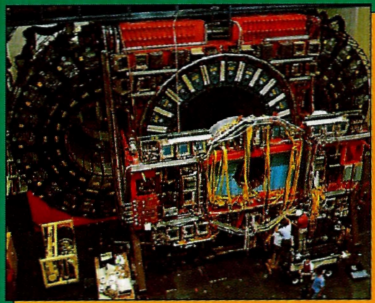
Международная
конференция по
проволочным камерам
ВЕНА-1995

測 國
定 際 第
ウ 器 素 七
ー 會 粒 回
ン 議 子

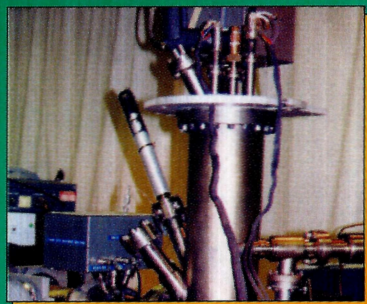
VERSATILE MODULES FOR EVERYONE



Laser Chemistry



High Energy Physics
courtesy of Fermi National Laboratory.



Time-of-Flight Spectroscopy,
courtesy of Northwestern University.

VME users have waited years for sophisticated, multi-input data acquisition modules. LeCroy's new 6U VME product line fulfills this need! Whether you are instrumenting a small or large experiment, LeCroy's products *are* the solution.

For the first time, acquisition modules using the latest technology are available for applications including Time-of-Flight, Laser Chemistry, High Energy, Heavy Ion Nuclear Physics and other fields. We offer a Charge Integrating Analog-to-Digital Converter, a Multihit, Multi-event, Time-to-Digital Converter and two high speed scalars. Interface and memory modules are also available. They enable VME modules to control and read data from large scale experiments using the LeCroy 1821 FASTBUS Master, LeCroy FERA™ ADC system, PCOS III CAMAC Chamber system, or the high density 1440 High Voltage System.

ORDERING INFORMATION

Model	Function
1131	FASTBUS/HV-to-VME Interface
1151E/N	16-Channel, 80 MHz Scaler with ECL (E) or NIM (N) Inputs
1176	16-Channel, 1 nsec Multihit TDC
1176 EXP2	Companion Module to the 1176, Used as a One Input 256 Hit TDC
1182	8-Channel, Charge Integrating ADC with 16 μ sec Conversion Speed
1190	ECLine bus to VME Buffer/Memory

Call, write or fax us to receive more information
on the latest VME acquisition modules.

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

LeCroy

Innovators in Instrumentation

Physics monitor

In orbit 610 kilometres above the surface of the Earth, the Hubble Space Telescope is revolutionizing astronomy.

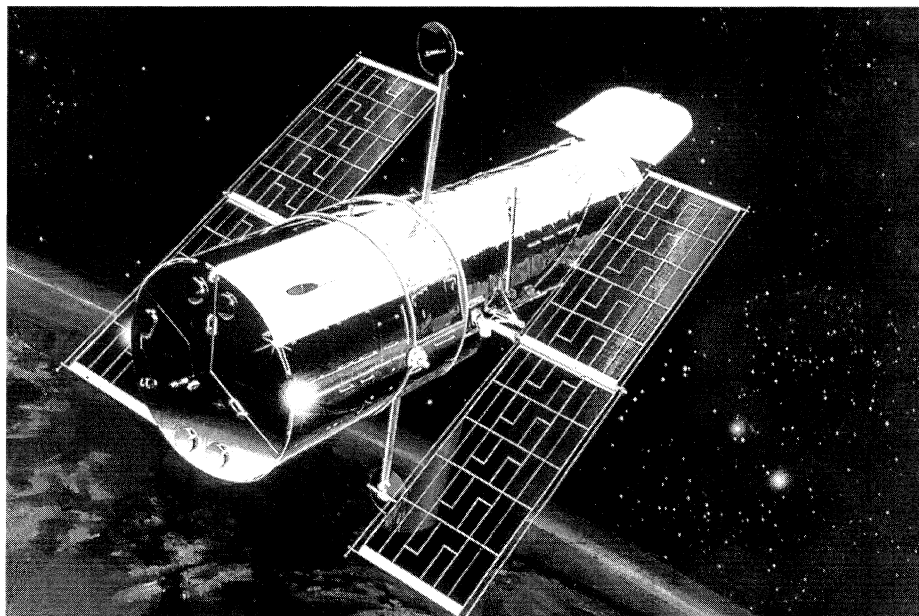
Hubble Telescope measures Hubble Constant

Astronomers using NASA's Hubble Space Telescope (HST) have taken an important step toward determining the age and size of the universe. They have been able to calculate with considerable precision the distance to a remote galaxy, M100, in the Virgo cluster. The ability to make accurate distance measurements over vast reaches of space will help provide a precise calculation of the expansion rate of the universe, the Hubble Constant, crucial in determining the age and size of the universe.

HST's detection of so-called Cepheid variable stars - regularly pulsating stars used for determining distances - in the spiral galaxy M100 establishes the distance to the cluster as 56 ± 6 million light-years. M100 is now the most distant galaxy in which Cepheid variables have been measured accurately. The precise measurement of this distance allows astronomers to calculate that the universe is expanding at the rate of 80 ± 17 km/sec per megaparsec*. This rate of expansion is the Hubble Constant, named after the famous US astronomer Edwin Hubble who discovered early this century that the Universe is expanding.

(*A megaparsec is 3.26 million light-years. A galaxy one million light-years away will appear to be moving away at approximately 90,000 kilometres per hour.)

Using Hubble's Wide-Field and Planetary Camera (WFPC2), the team repeatedly imaged a field where much star formation recently had taken place, and was, therefore, expected to be rich in Cepheids. Twelve one-hour exposures, strategi-



cally placed in a two-month observing window, revealed 20 Cepheids. About 40,000 stars were measured in the search for these rare, but bright, variables, whose periods and brightness were established, the researchers calculated a distance of 56 million light-years to the galaxy.

Faint Cepheids are normally difficult to see using ground-based telescopes, especially in a crowded region of a distant galaxy. Although M100 is now the most distant galaxy in which Cepheid variables have been discovered, the Hubble team emphasized that the HST project must look into even more distant galaxies before a definitive number can be agreed on for the age and size of the universe. This is because the galaxies around the Virgo Cluster are perturbed by the large mass concentration of galaxies near the cluster, which in turn influences their rate of expansion.

These first HST results are a critical step in converging on the true value of the Hubble Constant. To calculate it accurately, astronomers must have two key numbers: the recession

velocities of galaxies and their distances as estimated by one or more cosmic "mileposts," such as Cepheids. The age also depends on the average density of matter in the universe. A simple interpretation of the new value of the Hubble Constant, as calculated from HST observations, implies an age of about 12 billion years for a low-density universe, and 8 billion years for a high-density universe.

However many cosmologists point to the Virgo cluster being inappropriate for making sample measurements. The high local mass concentrations could produce biased values for universal quantities like the Hubble Constant.

Physics on its taus

That tau physics has become a major feature at electron-positron colliders was an omnipresent theme of the 3rd Tau Workshop held in Montreux (Switzerland) from 19-24

September. As CERN Research Director Lorenzo Foà emphasized in his introductory remarks, the tau sector is rich in new results and opens up interesting possibilities.

Already the Glasgow conference this summer (October, page 1) had shown that tau physics was booming, with substantial progress being made in charged current interactions, the strange sector in tau decays, the measurement of couplings, and even in the tau neutrino domain.

Looking back over previous tau workshops, several concerns, such as the so-called one prong decay problem, have disappeared, overwhelmed by huge new data samples and major experimental efforts. Tau physics has become precision physics, competitive in several different fields, and will continue to bring crucial new insights.

In the opening session, chaired by tau lepton pioneer Martin Perl, a theoretical perspective by William Marciano of Brookhaven was followed by a review of tau properties

by Ken Hayes of Hillsdale. Marciano stressed the importance of the tau in heralding the third generation of the Standard Model, shedding new light on, for instance, the origin of mass and CP violation. He also underlined the high precision achieved in testing lepton universality (electron/muon/tau democracy) as well as the advantages of taus as a quark-gluon laboratory.

A highlight of today's tau physics is consolidated measurements of weighted mass spectra (spectral moments) and the strong coupling constant, underlining the importance of tau lifetime and leptonic branching ratio measurements.

These measurements of the quark-gluon coupling (α_s) are showing the need of more theoretical understanding, since theoretical uncertainties are reaching the level of experimental errors.

The Montreux meeting provided a welcome opportunity for a round table on experimental input for tau decay simulations. Chaired by

Zbigniew Was of Cracow, it recommended updating hadron form factors.

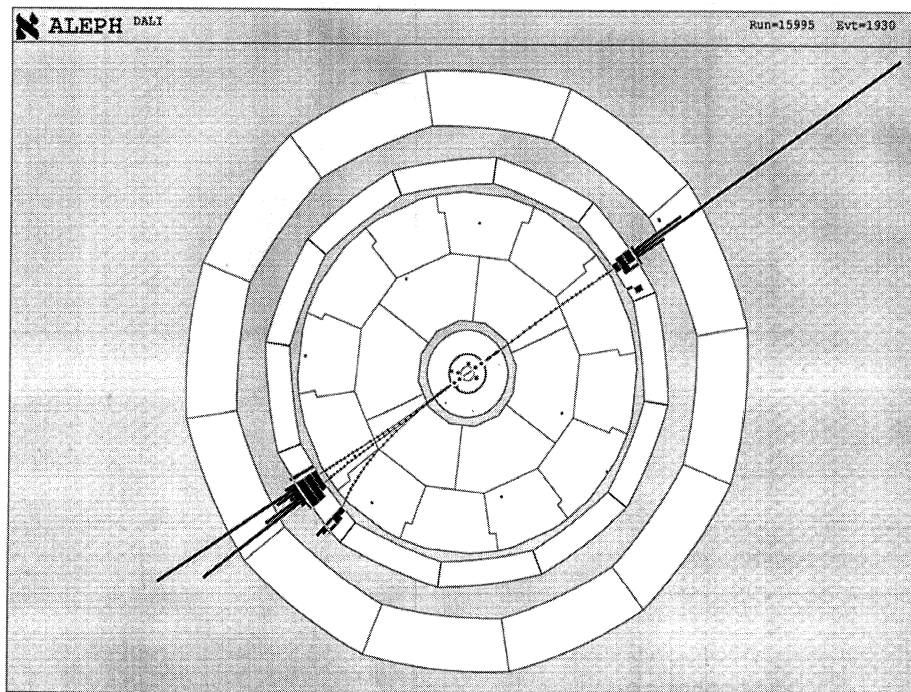
Tau neutrinos

A full Montreux afternoon was devoted to the tau neutrino. The Neutrino 94 conference earlier this year (September, page 2) had shown that determining whether the tau neutrino is massive or not is a vital question.

Results from tau decay into five charged pions by ALEPH give a new upper limit for the tau neutrino mass, lowering it from 31 MeV to 24 MeV. More accurate limits seem to be within reach.

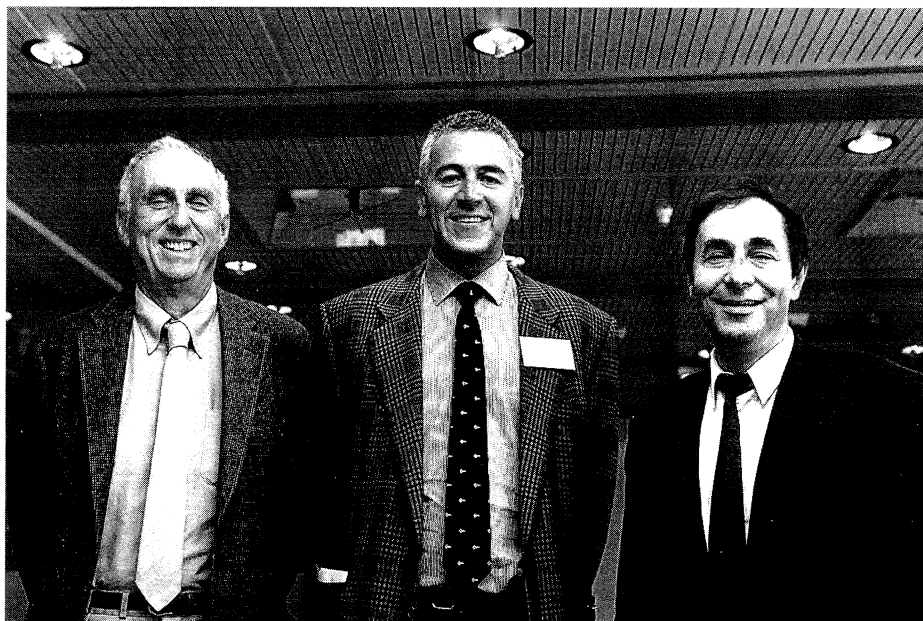
Neutrino properties were enthusiastically reviewed by Haim Harari, of the Weizmann Institute, who stressed that a neutrino mass upper limit of 20 eV can be deduced from cosmological arguments. Neutrino oscillation studies are the best experiments to clarify this question. As Harari remarked: "If neutrinos have mass they decay, slowly maybe, but they decay". Oscillation limits between tau and muon neutrinos came from the CHARM II collaboration at CERN and from Fermilab experiments.

A status report of the new CHORUS and NOMAD neutrino collaborations at CERN indicated the attainable sensitivities for oscillations, which should be complemented by long baseline neutrino experiments projected at Fermilab.



Decay of a pair of tau leptons, as seen by the Aleph detector at CERN's LEP electron-positron collider. One tau decays into an electron (and accompanying neutrinos), giving the narrow pencil, top right. The other tau (below, left) produces a spray of three pions and an invisible neutrino.

Together at the Tau 94 Workshop in Montreux (left to right) tau lepton pioneer Martin Perl, Montreux organizing committee chairman Gigi Rolandi, and workshop series pioneer Michel Davier.



Charged currents

One full day was devoted to charged current tau decays, with data from the ARGUS (DESY), CLEO and LEP collaborations. Michel Davier of Orsay in his review said that tau data is in a 'healthy' state. The structure of tau charged currents is in excellent agreement with the conventional vector/axial-vector picture.

Despite measurements still being statistics limited, LEP experiments give very precise leptonic branching ratios, emphasizing LEP's excellent tau physics capabilities. One notable technique is the impact parameter approach used by OPAL. With different methods used to measure the tau lifetime mutually consistent, the electron-muon and tau-muon universalities can be tested at the 0.3% level.

Hadronic decays, reviewed by Brian Heltsley of Cornell, have also made progress, with an 'explosion' of results in the tau strange sector, and with charged and neutral kaons well identified.

In the future the strange tau sector is expected to provide more quantitative and valuable information about SU(3) symmetry breaking.

Non-strange hadronic decays have been measured by ALEPH with a global analysis yielding 'startlingly' small errors, reaching better than one percent precision in dominant channels.

Neutral currents

LEP results with tau pair events probing neutral current interactions were shown by Andrei Kounine of Massachusetts. Frequent beam energy calibrations with the resonant depolarization method improve the precision of the Z mass and width. There was increased precision also on the electron and tau Z couplings from the LEP and SLC (Stanford) collaborations, however still limited by statistics.

The final day looked at the tau as a probe for new physics, where Charles Nelson of Binghamton surveyed possible tau territory

beyond the Standard Model. From the experimental viewpoint, Martin Perl pointed to future perspectives at LEP, CESR and BEPC (Beijing) where tau research continues. He stressed the advantages of the planned B-factories and the physics possibilities of a tau-charm factory, indicating the detector specifications needed for this research.

Michael Turner of Chicago highlighted the interesting cosmological and astrophysical consequences of a tau neutrino mass between 1 MeV and 30 MeV, with the additional cosmological mischief that could be wrought by unstable tau neutrinos.

The summary talk by Richard Stroynowski of Dallas emphasized the precision that has been achieved in this very active field, and underlined the usefulness of the tau lepton as a laboratory to study quark field theory (quantum chromodynamics - QCD) and resonances, etc. With most of the results still limited by statistics, more stringent tests will come from future tau data.

The Tau 94 workshop, chaired by Gigi Rolandi, was the third in a series pioneered by Michel Davier, and was sponsored by CERN and the Swiss National Science Foundation.

From Ricard Alemany

Colourless confinement for quarks

The enigma of quarks is that they are there, hidden deep inside nucleons and other strongly interacting particles, but refuse to come out. The tighter the quark bonds are stretched, the more difficult they are to break. This dogma has been accepted for some thirty years but has never been

mathematically proved.

The latest excitement with theorists is a proof that, under certain assumptions and in model environments far from reality, quarks can only exist in colourless combinations. This is the first theoretical proof that quarks cannot exist alone and explains why hadrons – clusters of quarks, each carrying fractional electric charge – only have familiar integral electric charges.

As well as their electric charge, quarks have another charge-like property called ‘colour’, denoted as red, green and blue. Although quarks are not really coloured, the description is useful because, according to the hypothesis of colour confinement, quarks always combine to make colourless hadrons in the same way that different coloured light mixes to make white. Colour confinement also forbids hadrons with fractional electric charges, but the hypothesis that they are forbidden has never been proven theoretically until now.

In two recent compelling papers, Nathan Seiberg of Rutgers and Ed Witten of Princeton show that quarks are confined in colourless hadrons. Confinement is shown in the wonderland of N=2 supersymmetry (where there are two supersymmetric partners for each ordinary particle); by ‘soft-breaking’ the proof is extended to the one-to-one N=1 sector. However much remains to be done to reach the real world.

The new development confirms superconductor analogies which describe how, if two magnetic monopoles were placed inside a superconductor, the lines of magnetic flux would just go directly from one to the other, forming a confining potential. Seiberg and Witten use ingenious constructions and many different past results to show that colour is similarly confined. This theoretical

result is a gratifying combination of years of theoretical endeavour.

The papers are numbers 9408099 and 9407087 on the high energy physics theory preprints bulletin board on World Wide Web.

HADRONS-94 Soft interactions at large distances

Ten years ago the Institute for Theoretical Physics (known since 1992 as the Bogolubov Institute after its founder) of the Academy of Science of the Ukraine initiated what has become a very successful series of annual meetings on strong interactions at large distances.

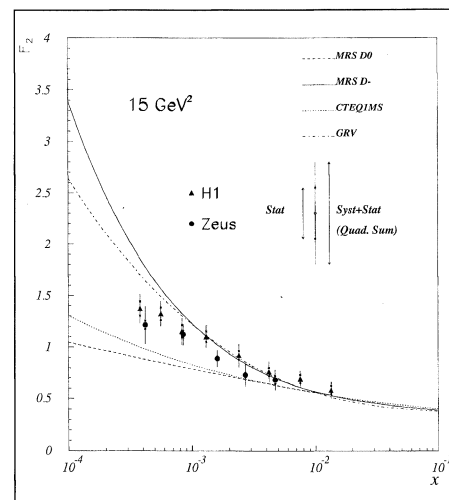
Although sometimes overshadowed by the successes of the Standard Model and the theoretical enticements of supertheories; the Hadrons series has overcome political barriers and financial chaos to bring together physicists from diverse backgrounds to discuss central physics issues.

The latest workshop in the series was held from September 7-11 in Uzhgorod (Ungvár), a small university town in the westernmost reaches of the Ukraine, bordering on Hungary, Poland, Romania and Slovakia.

The main topics were: elastic and diffractive scattering; probing the nucleon at small x (where x is the momentum fraction carried by the struck quark); spin physics; hadron spectroscopy; and collective properties of strongly interacting matter.

Until recently, the pomeron - a hypothetical vacuum quantum number exchange governing the asymptotic behaviour of total cross

Small-x (momentum fraction carried by struck quark) data on nucleon structure from the HERA electron-proton collider at DESY, Hamburg, from H1 and ZEUS experiments. The curves show different theoretical predictions, bracketed by curves assuming very different gluon distributions at low x. The momentum density of gluons inside the proton clearly increases in this range.



sections - was associated with hadronic reactions only. Now, the small-x data on nucleon structure from the HERA electron-proton collider at DESY, Hamburg, provide new information on the nature of the mysterious pomeron, establishing a link between ‘soft’ (small momentum transfer) hadron-hadron and the violent interactions of ‘hard’ deep inelastic lepton-hadron scattering.

Latest data on the small-x behaviour of the proton structure and diffractive behaviour were presented at the workshop by both HERA experiments - H1 (Christophe Royon) and ZEUS (Hong Joo Kim). The data in the x range 10^{-3} - 10^{-4} are compatible with a power 0.2-0.5 increase in the richness of the underlying structure. The Gribov-Lipatov-Altarelli-Parisi QCD fit for these data shows that the momentum density of gluons inside the proton could increase tenfold in this range.

Hard scattering in both photoproduction and deep inelastic scattering has been observed with concentrations in distinct kinematical regions, an effect called ‘rapidity gap’ in the trade. For the diffractive photoproduction events, the hadronic final states show a predominantly two-jet structure, each jet having



CERN
European Laboratory for Particle Physics

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

Visits on demand
 tél. 767 8484

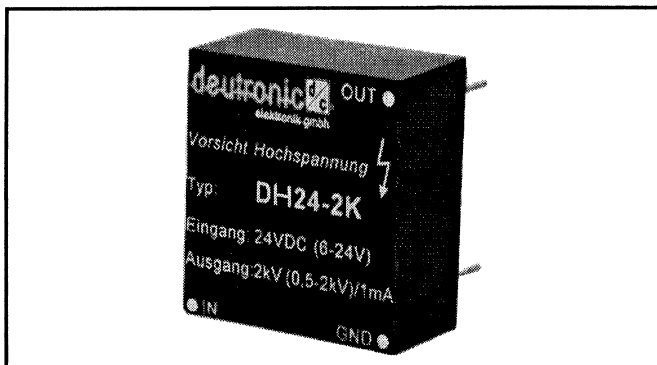
Microcosm exhibition,
 Monday-Saturday from 9.00 to 17.00 hr,
 entry free.

Route de Meyrin (bus 15).



Deutronicstr. 5, D-84166 Adlkofen
 Tel.: +49-8707/920-0
 Tel.: +49-8707/920-34 Sales Dept.
 Fax.: +49-8707/1004

High-Voltage DC/DC-Converters Innovation at a fair price



- **Attractive pricing** by delivery from producer
- **Wide input range** 2-12V resp. 2-24V
- **No minimal load** required
- **Small dimensions** (40x40x20mm)
- **Output voltages** up to 3kV
- **1,5W continuous, 3W peak power**
- **Output proportional** to input voltage
- **PCB-mounting**
- **Small scatter of magnetic field**
- **Positive or negative output voltage**

OUR PRODUCT RANGE:

- DC/DC-Converters
- Power supplies in 19" design
- Open frame modules
- External switchers, adapters particular

- High voltage devices
- Power supplies for industrial installation
- Battery chargers
- Power supplies for Telecom-applications

Special devices are our strength.

Hadron workshop participants in front of Count Schönborn's castle, now the Sanatorium Carpathy, near Beregvár.



transverse energy above 4 GeV.

Most of the theoretical talks were related in one way or another to the pomeron, its QCD evolution (M. Giffon, F. Paccanoni, M. Bertini, E. Martynov) and the confinement problem. In deep inelastic lepton-hadron scattering, the odderon (to account for the difference between proton-proton and proton-antiproton scattering) is excluded by quantum number conservation if only electromagnetic interactions are taken into account, but the odderon can be exchanged by weak interactions, according to the electroweak unification (L. Jenkovszky). More HERA data (including those collected from the positron beam) may shed new light on the odderon.

Recent Tevatron data on single diffraction dissociation could resolve the long-standing problem of how fast cross-sections rise. These data favour models with a moderate increase ("soft" pomeron) such as the dipole one. The real part of the forward scattering amplitude may be affected by oscillations found in the slope of the diffraction cone (J. Kontros, A Lengyel).

The absence of clear evidence for glueballs - resonances made of at least two gluons - is an embarrassment for the theory. If the pomeron is made of two gluons (with a possible quark admixture) then glueballs should be related to it. From a fit to proton-proton and proton-antiproton

data, the lowest-lying (spin two) glueball was predicted (P. Desgrolard et al) to have a mass of 2.75 GeV and a decay width 0.55 GeV.

Fine-structure meson and baryon spectroscopy, based on an interquark potential, suggested earlier by F. Paccanoni and co-authors, was presented by an international collaboration including Uzhgorod, Kosice and Presov. The potential was derived from a dipole gluon propagator and partial confinement is among its virtues. It may have interesting applications in the study of possible phase transitions in a non-relativistic quark model with density-dependent interactions (W. Alberico).

A first-order phase transition from the quark-gluon plasma to hadronic matter may proceed by nucleation, preceded by deep supercooling (L. Csernai, M. Gorenstein), with important cosmological consequences.

The proceedings of the workshop Hadrons-94 may be ordered from: ABUGRIJ@GLUK.APC.ORG The next meeting - Hadrons-96 - will be held in the Crimea in June 1996.

From David Atkinson and Laszlo Jenkovszky

1994 is a LEAP year

Despite its suggestive acronym, the Conference on Low-Energy Antiproton Physics - LEAP - is biennial. The third in the series, dominated by recent results from the LEAR Low Energy Antiproton Ring at CERN, was held from 12 - 17 September in the resort of Bled at the foot of the Karawanken mountains in northern Slovenia. Organized by the Jozef Stefan Institute, Ljubljana, the meeting attracted some 100 participants. As with previous meetings held in Stockholm (1990) and Courmayeur (1992), this conference reviewed progress in low energy antiproton physics, covering nuclear and atomic physics, astrophysics, meson spectroscopy, charm and strangeness production and fundamental symmetries.

In atomic spectroscopy, intriguing long-lived bound states of the helium-4 antiproton atom have been discovered and studied with laser induced annihilation in helium (see page 16). The Crystal Barrel and Obelix collaborations are studying the meson spectrum with unprecedented statistical accuracy and have discovered three new mesons. One of them has properties consistent with those expected for the ground state glueball and was reported in physics meetings this summer (October, page 7). The CPLEAR group has established time reversal violation in the neutral kaon system. The antiproton mass was measured and found equal to the proton mass within unrivalled accuracy (November, page 6). With the technical progresses achieved in trapping low-energy antiprotons, the study of the gravitational attraction of antimatter and the production of antihydrogen

Dubna - the great survivor

atoms are now around the corner.

The Conference closed with the award of N. Hamann Prize to A. Masoni of Cagliari, for his presentation on a high statistics study of ρ decay with the Obelix spectrometer. This Prize, funded by the Jozef Stefan Institute, Ljubljana, is in memory of Niklaus Hamann, PS coordinator and LEAR physicist who died last year, aged 40.

This year, as CERN celebrates its 40th anniversary (November, page 26), not far behind in the celebration stakes is the Joint Institute for Nuclear Research, Dubna, near Moscow, established in 1956. While CERN's goal was to provide a physics platform on which to rebuild Western European science after World War II, JINR had a similar mission for the USSR and the socialist countries, including Eastern Europe.

The fact that both organizations are reaching their 40th anniversary testifies to their success. While their aims were very similar, their political contexts and scientific strategies have led along very different routes.

Faced with the challenge of building a major machine, CERN took the bull by the horns and went for the new technique of strong focusing. The bet succeeded, and the dividends were rich and numerous. Dubna chose a more conventional solution, designed under the guidance of the legendary Vladimir I. Veksler, co-discoverer of the principle of phase stability. For several years the resulting 10 GeV synchrotron, commissioned in 1957, was the highest energy ma-

chine in the world. This machine is still operational, and features in the Guinness Book of records as the planet's largest electromagnet.

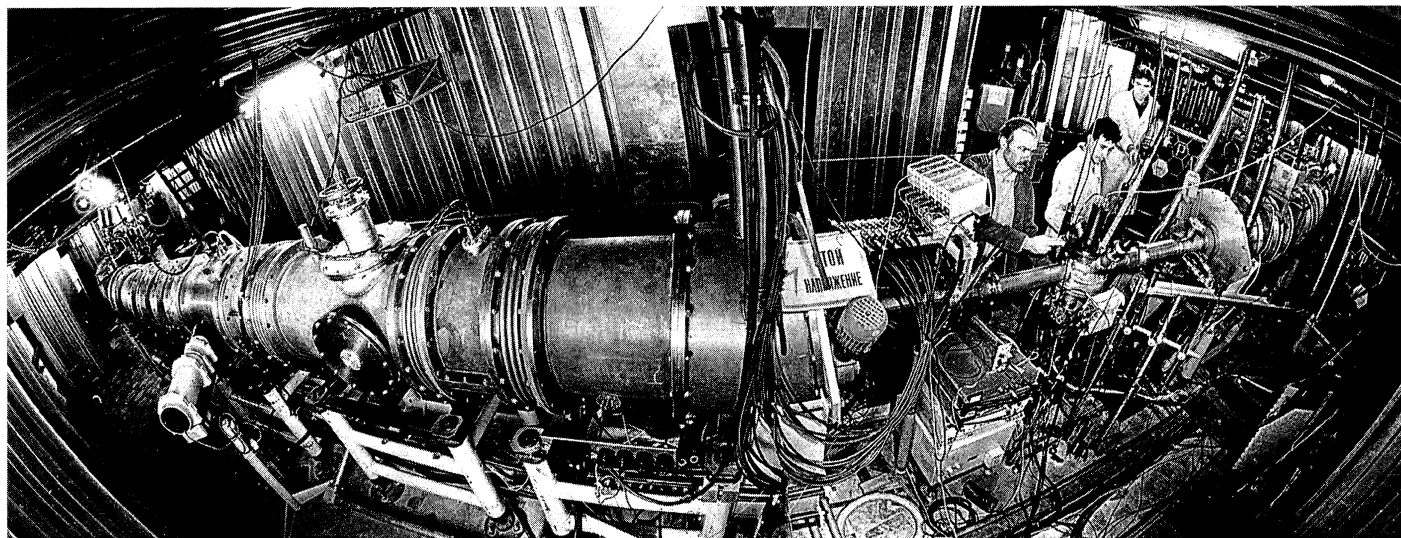
While eclipsed by the new generation of strong focusing machines, the Synchrotron enjoyed a new lease of life as a heavy ion machine (up to silicon-28), as well as providing polarized deuteron beams. The machine currently runs for some 1,500 hours per year, providing research material for more than 500 scientists from 100 institutions.

The next energy step had very different scenarios at CERN and at JINR. In the early 1970s, CERN decided to build the '300 GeV Project' (now the 450 GeV SPS Super Proton Synchrotron) on site, with the 28 GeV PS proton synchrotron as its injector, rather than building a totally new infrastructure somewhere else in Europe (there was no shortage of candidate sites).

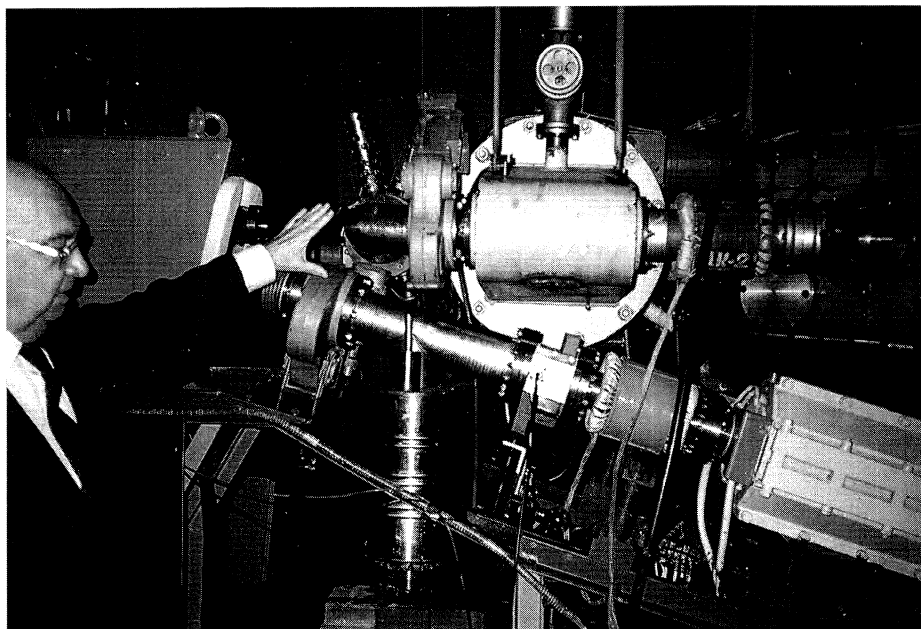
In the prestige field of high energy physics, the USSR chose a different route. Their next major machine was the 70 GeV proton synchrotron, which was pushed through rapidly, coming into operation in 1967 at the new Institute for High Energy Physics

The jewel in the research crown at the Joint Institute for Nuclear Research, Dubna, is the superconducting Nuclotron.

(Photo Yu. Tumanov)



The parting of the ways. Dubna's Laboratory of High Energies Director Alexander Baldin explains the injection scheme which feeds the Synchrophasotron (top beamline) and the Nuclotron (below). (Photo G. Fraser)



at Protvino, roughly as far south of Moscow (100 kilometres) as Dubna is north.

Until the arrival of CERN's Intersecting Storage Rings and Fermilab in the early 1970s, the Protvino machine provided the world's highest energies. The USSR had wrested back the high energy crown, but the price had been high for Dubna. Much Dubna expertise and manpower migrated, never to return.

Despite these two cruel twists of fate, and the current financial difficulties after the breakup of the Soviet Union, Dubna has stuck courageously to its guns and remains a valuable focus of research. Although it has no glamorous new machines, it covers a wider field of science than does CERN.

The decision to go for research using heavy ion beams in 1971 and open up relativistic nuclear physics has paid off. Heavy ion beams are also provided by Dubna's veteran U200 and U400 cyclotrons and the new U400M accelerator (December 1993, page 28). Together, these machines provide a wide range of

ions to suit many tastes.

Through this work, Dubna has made major contributions to ion source technology, while on the experimental side Dubna's Flerov Laboratory of Nuclear Reactions has made its mark in the study of superheavy elements (see the article by Laboratory Director Yuri Oganessian which appeared in the November issue, page 16). The quality of Dubna's beams has attracted a steady stream of informed specialists. A US team from the Lawrence Livermore Laboratory has been working at JINR since 1990.

But the jewel in Dubna's heavy ion crown is undoubtedly the superconducting Nuclotron (July/August 1993, page 9), brainchild of Laboratory of High Energies Director Alexander Baldin. This 250-metre ring, assembled in the synchrophasotron's basement, provided its first beams last year.

Experiments currently use internal targets, achieving luminosities of 10^{33} $\text{cm}^{-2} \text{s}^{-1}$, but the plan is to develop external beams too, with energies up to 6 GeV per nucleon. Progressively,

users are expected to switch from the synchrophasotron to the Nuclotron. A useful Nuclotron bonus is surplus liquid helium, piped off to waiting trucks and supplied to the European market, adding a useful cash bonus to JINR funds.

The initial goal of the Nuclotron was 20 GeV per nucleon. While this is still a dream, Baldin is optimistic about the physics that can be explored nevertheless. Nuclotron beams can be used for studying practically all the characteristics of highly excited nuclear matter.

Another Dubna on-site feature, further extending the range of applications, is a well-equipped six-cabin facility for radiotherapy using synchrocyclotron beams. The good localization of these beams is valuable for treating eye and cranial tumours, while a neutron beam is used to treat larger radioresistant tumours.

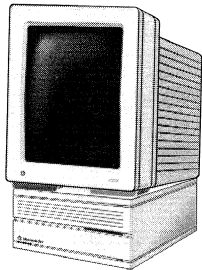
The IBR-2 reactor, commissioned in 1982 and with a spectacular pulsing system using strobed plates, has a wide range of spectrometers covering both nuclear and condensed matter research. As well as JINR Member States and ancillary special programmes, Dubna's neutron programme includes bilateral agreements with Saclay and the international Institut Laue-Langevin in France and with the Rutherford Appleton Laboratory in the UK.

Other neutron beams are provided by the older IBR-30 pulsed machine using an electron linac as injector. The plan is to replace this with an Intense Resonance Neutron Source - IREN - using a 150 MeV electron linac and a sub-critical uranium booster. This project involves close collaboration with Novosibirsk's Budker Institute. Three klystrons are being supplied by the Stanford Linear Accelerator Center in the US.

CES INTRODUCES:

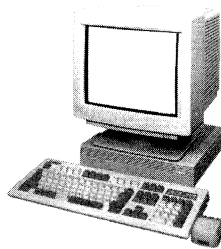
The meeting of two world class standards: LabVIEW® and VICbus

Macintosh



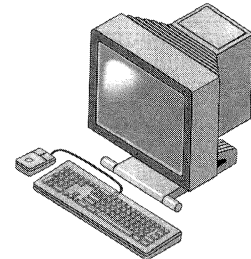
MAC 7212

SUN



SVIC 7213

PC/AT compatible



VBAT 8218

VICbus

The Software is the Instrument® and
VICbus the Fastest Link

LabVIEW®

VIC 8250, VIC 8251, VIC 8252

VIC Interface Initialization, Page Descriptor Generation, VDREG, VME Read, VME Write, Block Transfers, VME Test, File to VME, VME to File, VME Dump, File Dump, ...

VME

VCC 2117, CBD 8210

VCC Initialization, CDREG, CSSA, CSSA Repeat, Generate Z, Generate C, Clear Inhibit, Auto Scan, Q Repeat, LAM Sync, Wait LAM, ...

CAMAC

FVSBI 9210 + VFI 9214

Standard FASTBUS routines in LabVIEW Style (FBOPEN, FRC, FRDB, ...)

FASTBUS

- Simple, efficient tests for CAMAC, FASTBUS and VME boards
- Can be connected at any time to the DAQ system
- High-speed, multimaster operation.

Low Cost Starter Kits:

- MAC - VME
- MAC - CAMAC
- MAC - FASTBUS



LabVIEW® is a trademark of National Instruments Corporation

At CES, tomorrow's systems are available now

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

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

CES
CREATIVE ELECTRONIC SYSTEMS

In 1989 Dubna celebrated the 80th birthday of former Dubna Director and renowned scientist Nikolai N. Bogolubov (left, who died in 1992). On Bogolubov's left is Dubna Vice-Director Alexei Sissakian, responsible for Dubna high energy physics and an enthusiastic supporter of CERN-Dubna collaboration.



JINR is especially proud of its theory group, with traditions dating back to its establishment under Nikolai N. Bogolubov and Dimitri I. Blokhintsev and which maintains the high traditions of Russian mathematics and analysis.

With its ready source of knowledge and expertise, coupled with the attractions of a leafy site and the proximity (but not the disadvantages) of Moscow, Dubna's vigorous programme of special schools attracts good participation.

More ambitious are Dubna's plans for a fully-fledged international university on the site, with teaching in English. Already some 100 students pass through Dubna each year for lectures and practical work.

For the future, Dubna is pushing for an electron-positron ring to mass-produce charmed particles and tau leptons - a 'tau-charm factory'. This project involves a close collaboration with the electron machine specialists at Novosibirsk's Budker Institute.

Experiments at other Laboratories

Away from Dubna, JINR teams are prominent on the world stage, partici-

pating in experiments either planned or underway at Protvino, CERN, Saclay, PSI (Villigen), Jülich and Prague. Flagship of Dubna participation in the current CERN research programme is the Delphi experiment at CERN's LEP electron-positron collider, where Dubna produced more than 20,000 streamer tubes to equip the detector's hadron calorimeter.

In total, about 100 Dubna physicists are involved in experiments at other Laboratories. About half are at CERN, where JINR teams are heavily involved in detector development for the Atlas and CMS experiments planned for the LHC proton-proton collider, as well as the major NA48 CP-violation study. The programme of experiments currently underway includes the SMC spin study, where JINR polarized target expertise has been useful. The large-scale Dubna involvement in current CERN experiments sets the pace for ongoing collaboration.

Support

JINR was established to cater for the USSR and satellite countries.

Unlike CERN, truly international despite being sited near Geneva, JINR today is predominantly Russian, both in terms of funding (60 per cent) and sociology.

With the breakup of the Union, many of the former Soviet republics still regard Dubna as a research focus. Support comes in kind as well as in cash. While Hungary has left the family and departed for CERN, a special Hungarian agreement continues to cover that country's involvement in JINR neutron physics and heavy ion research.

Poland, now also a CERN Member State, retains its ties to Dubna, as do the Czech and Slovak Republics.

The most conspicuous empty seat is that of East Germany, whose membership lapsed when the country ceased to exist as such. However special support from Germany, earmarked for cooperation in specific topics and the use of Dubna facilities is the subject of a special annual agreement.

Although the shine may have worn off some of its research facilities, JINR remains an important interface between Western and Eastern science and is packed with know-how. Many Dubna specialists would be happy to work on 'sub-contract' research projects.

Even when the Cold War was at its most frigid, Dubna cherished the bright flame of international collaboration. In 1957, the possibility of collaboration between the infants CERN and JINR began to be explored, and a framework for future collaboration emerged which went on to involve several major Soviet centres. In the early 1970s, inspired by Fermilab Director Robert Wilson, fruitful contacts were made with the US.

While new sources of funding have opened up to support former Soviet

Physics revelations

by Christine Sutton

Science, JINR Director General Vladimir Kadyshevsky prefers to take a more pragmatic approach, paraphrasing a Japanese proverb - 'do not give me fish, invite me to go fishing'. 'Science is by nature international', he continues, adding that he was pleased to find a US Department of Energy report quoting the Russian writer Anton Chekhov 'Science cannot be national, in the same way that a multiplication table cannot be national. If a science becomes national it ceases to be a science.'

By Gordon Fraser

Christine Sutton, Oxford physicist, well-known science writer and regular contributor to the CERN Courier, reports on the International Conference on the History of Original Ideas and Basic Discoveries in Particle Physics, held at the Ettore Majorana Centre, Erice, Sicily, this summer.

Erice must be not only one of the most picturesque settings for a conference on history, but also one of the most appropriate, founded so the legends say more than 3000 years ago. Particle physics, by contrast, is strikingly modern, but the Ettore Majorana Centre at Erice was a fitting location for physicists to gather and discuss their subject in the International Conference on the History of Original Ideas and Basic Discoveries in Particle Physics, from 29 July to 3 August.



The setting of the Ettore Majorana Centre, Erice, Sicily. Erice, founded so the legends say more than 3000 years ago, was a fitting location for physicists to gather and discuss their subject in the International Conference on the History of Original Ideas and Basic Discoveries in Particle Physics this summer.

Particle physics can probably be said to have begun during the 1930s, a decade that saw Pauli's invention of the neutrino and Fermi's theory of beta-decay, as well as the discovery of the neutron, antimatter (the positron) and the first heavy lepton (the muon). In the relatively short time since then the subject has grown enormously, with many more discoveries, many new theoretical concepts, and many new experimental techniques. For the conference at Erice to cover all of this in five days required the gathering of a large number of experts from a broad range of fields, so that the list of 49 scheduled speakers resembled a "Who's Who" of particle physics.

Speakers such as Vicky Weisskopf really could go back to the first days of particle physics, telling the audience of how in 1933 he had learned physics from Rudolf Peierls in Cambridge (as it was impossible to learn from Dirac!) before becoming Wolfgang Pauli's assistant in 1934. Other speakers of a younger generation came to Erice straight from the frontiers of present-day research. Risto Orava, for example, brought the audience up to date on work on linear colliders, while Blas Cabrera discussed various detectors designed to pick up signals from the dark matter particles that could account for up 99 per cent of the Universe.

Talks on theoretical ideas ranged from the early days of quantum electrodynamics (Weisskopf) through asymptotic freedom and confinement in quantum chromodynamics (David Gross) to supergravity (Dmitrij Volkov and Dimitri Nanopoulos) and superstrings (John Schwarz), and thus spanned the complete period from the early 1930s to the present day. Reminiscences of discoveries stretched back nearly as far across

the years, from the muon (Oreste Piccioni) and neutrino (Fred Reines) to the W and Z particles (Pierre Darriulat), and mention even of the top quark (Alvin Tollestrup). On a personal note, particular highlights were to learn from Toichiro Kinoshita about the challenge in computing terms of calculating quantum electrodynamics to eighth order; to hear about the development of accelerators and detectors (vital to progress in the subject, but often submerged beneath the weight of theoretical ideas) ranging from Gus Voss on electron-positron colliders to Albert Walenta on multiwire chambers; and to meet for the first time with Chien-Shiung Wu (who had a special status for a certain undergraduate as one of the few well known women in physics).

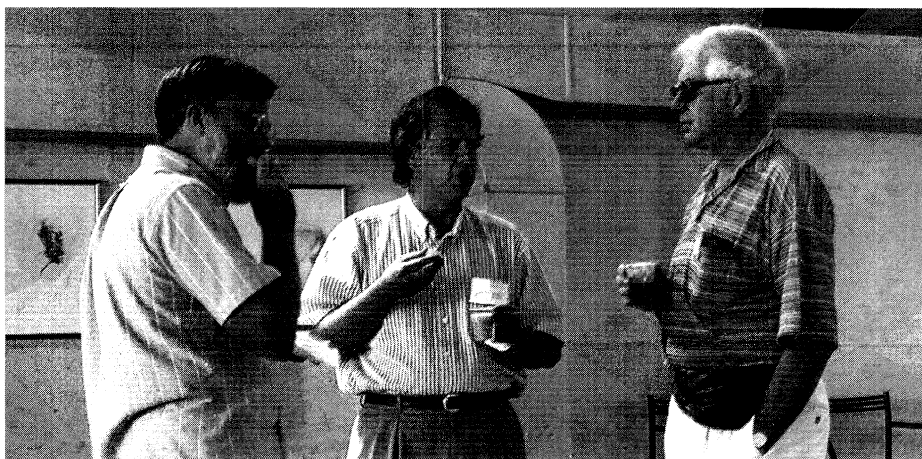
One of the aims of the conference was to provide some of today's young particle physicists with the opportunity to hear from and mix with the people who have been instrumental in shaping the subject. Among those present were Christopher Tully (Princeton) and Avi Yagil (Fermilab), winners of Richard P. Feynman Scholarships for exceptional young physicists, and Thomas Gould (Johns Hopkins), Sekhar Mishra (Fermilab) and Fuqiang Wang

(Brookhaven) who received honourable mention as outstanding candidates. The five received their awards before a ceremony to dedicate the original lecture theatre at the Ettore Majorana Centre to Richard Feynman - although the ceremony did not quite go to plan. Appropriately for this conference, history intervened at the last minute while workers were preparing the walls to be decorated with Feynman diagrams. They discovered ancient frescoes hidden beneath a dozen or so layers of whitewash accumulated over many generations. The frescoes included a depiction of the Last Supper, painted around 1500 probably at the request of Antonino Zichichi, an ancestor of his current namesake, founder of the Ettore Majorana Centre. Was this, as the present Antonino commented, in a sense Feynman's last discovery?

Feynman contributed further to the conference on the final day, when David Goodstein, a low temperature physicist from Caltech, talked of the history of superconductivity and Feynman's efforts to understand the phenomenon. As part of his fascinating contribution, Goodstein played extracts from recordings of Feynman discussing superconductivity in 1964 at a seminar at Caltech, the year that

his introductory lecture on the same subject became enshrined in the last chapter of the celebrated books. Feynman is of course not the only link between particle physics and superconductivity. Superconducting detectors play an important role in the search for dark matter, as Cabrera described; and there is a deep connection between superconductivity and the higgs mechanism, which endows particles with mass in the electroweak theory discussed in a paper submitted by Steven Weinberg (who could not be present). To bring the audience completely up to date on superconductivity, Paul Chu from Houston presented the recent history of high-temperature superconductors, in which he has played a leading role.

It is not possible to give here more than a hint of the flavour of a conference like this, and those who wish for more details must await the publication of the proceedings. For the young people, however, that will not be quite the same as having had the opportunity to make contact with the roots of the subject, perhaps even breakfasting with those such as Weisskopf who themselves breakfasted with Pauli and other founders of particle physics.

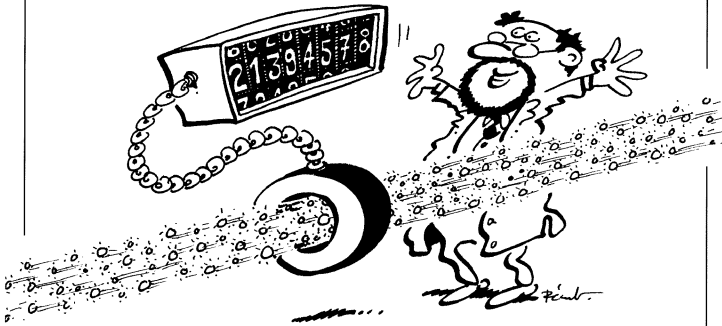


Participants at the Erice history meeting. Left to right - Howard Georgi, Blas Cabrera, Sheldon Glashow. (Photos C. Sutton)

Count the particles in your beam with the

Beam Charge Monitor

- On transfer lines or linacs, it measures single pulses with $\approx 3 \times 10^6$ particles resolution
- On circulating machines it measures the orbit current with $\approx 10\text{nA}$ rms resolution



ESRF, DAFNE, DELTA, ELSA, CESR, SRRC, LEP use it. Even the Swiss Office of Metrology in Bern uses it for its irradiation national primary standard.

Knowing the Swiss tradition of high precision, it says a lot....

Precision Beam Instrumentation



Europe: Bergoz Tel.: +33-50.41.00.89
U.S.A.: GMW Tel.: (415) 368-4884
Japan: Repic Tel.: (03) 3918-5110

At last, a VMEbus filter board that you can't program on the VME bus...

Kemo®
LIMITED

which is good news, according to our VME customers! The 6U/1600 Eight Channel Filter Card (expandable, of course – up to 128 channels) takes its power from your VME-based data acquisition and control system.

The filters, however, are programmed through an RS232 port on the front panel. The 6U/1600 uses 'FICL', our new high-level control language, which facilitates product-independent programming across many Kemo filter systems. The on-board microprocessor has non-volatile storage for all parameters so it won't forget what you wanted it to do.

Your analogue signals are handled by Kemo's 1600 Series programmable filter module, which offers low noise and offset, and excellent linearity. No clock-related errors either (and the microprocessor is optoisolated from the signal path).

There has never been an easier way of adding state-of-the-art analogue filtering to your VME system (or any other 6U bus

system), whatever the application.

Consult Kemo for all your fixed frequency and variable filter requirements in the frequency range of 0.001Hz to 1MHz. A wide range of literature is available on request.

© Registered Trade Mark.

Kemo Ltd., 12 Goodwood Parade, Elmers End, Beckenham, Kent BR3 3QZ.
Tel: 0181 658 3838. Fax: 0181 658 4084.

Cryogenic Components



Manufacturing Line

- Cryogenic Valves (Shut-off and Control Valves, Vacuum Jacketed and also for Cold Box Mounting)
- Special Valves for any Cryogenic Applications (Check-Valves, Pilot Cryogenic Valves, Relief Valves etc.)
- Bellows Sealed Valves (up to PN420)
- Cryogenic Transferlines and Couplings (Johnston and Multi-Coaxial Couplings)
- Space Cryogenic Components
- Custom made Cryogenic Components e. g. Cryostats and Ejectors

Cryogenic Control Valve >

pneumatically operated with electro-pneumatic positioner and limit switches, for cold box mounting



IMO
IMO Industries Inc.

WEKA AG - Schürlistr. 8
CH-8344 Bäretswil
Switzerland
Telefon 01 939 29 59
Telefax 01 939 29 63

For USA and Canada:
PROVAC LTD - POB 18411
Greensboro, North Carolina 27419
Phone (910) 282 6618
Telefax (910) 288 3375

Around the Laboratories

Bunch trains arrive at LEP

On 11 November at CERN's LEP collider, after surprisingly few hours of machine development, a train of four electron bunches

collided with a similar train of positrons. This successful debut bodes well for future operations with the higher energy LEP200 (November, page 6).

CERN Director General Chris Llewellyn Smith (right) observes as Robert Cailliau demonstrates World Wide Web to European Commissioner for Research, Development, Education and Training Antonio Ruberti. Developed at CERN, the World Wide Web hypertext-based information system has revolutionized access to computer networks. World Wide Web was recently awarded the 'Laser d'Or' at the XVth International Video Art festival in Locarno, Switzerland.

CERN Physics at LEP2

With the LEP2 project pushing ahead to boost CERN's LEP electron-positron collider to higher energy, in February a Workshop on Physics at LEP2 will review the studies for the preparation and interpretation of LEP2 data.

The organization of this Workshop and its final report will resemble the 1989 Workshop on Z Physics at LEP1.

With LEP2 physics scheduled for 1996, conveners and experiments contact persons have now been appointed, and working groups are being formed. The first General Meeting of all working groups will take place on 2-3 February at CERN in the Main Auditorium. After one or two more such meetings, the final General Meeting will be in October 1995. All the General Meetings will take place at CERN. Those interested in participating are invited to attend the first General Meeting in February, where formation of the working groups will be completed.

Four sectors are foreseen, each with one or two co-ordinators and four to eight contact persons nominated by the four LEP experiments to promote and organize participation in the working groups.

The sectors with their working groups are:

Standard physics - 1) WW cross sections and distributions, 2) W mass, 3) Standard Model processes, 4) QCD, 5) Gamma-gamma physics;

New physics - 1) Three-gauge couplings, 2) Higgs, 3) New particles: virtual effects and/or real production,

4) Z-prime;

Event generators - 1) WW and Standard Model processes, 2) Gamma-gamma physics, 3) Discovery physics, 4) Bhabha luminometer, 5) QCD;

Machine/physics interface - 1) Absolute energy calibration and polarization, 2) Interaction point, 3) Integrated luminosity versus energy.

Each working group will have two conveners.

Up-to-date information may be found in the World-Wide Web: <http://www.cern.ch/Physics/Conferences/C1995/LEP2PHYS/Announcement.html>

Strengthening Scientific Co-operation

On a visit to CERN in October, European Commissioner for Research, Development, Education and Training, Antonio Ruberti signed an administrative agreement promoting closer scientific and technological cooperation between the European

Union and CERN.

The first meeting of the Joint EC-CERN Research Committee established by the agreement followed the signing ceremony. Potentially fruitful areas identified for cooperation include information technology, industrial and materials technology, training and mobility of researchers, and developing scientific cooperation with Central and Eastern European countries.

CERN has already actively participated in various EC programmes such as SCIENCE, which encourages researcher mobility, and RACE and ESPRIT promoting telecommunications and information technology respectively. The recently installed CS-2 scalable parallel computer in the CERN Computing Centre formed part of the ESPRIT-funded European High Performance Computing initiative.

In addition, CERN's wunderkind World Wide Web network information system will be further developed and maintained with support from the European Union and in collaboration



with the Massachusetts Institute of Technology. Financial support of 1.5 million ECU – 2.5 million Swiss francs – has been earmarked for this project. World Wide Web is a spinoff from CERN's involvement in advanced networking and in the past few years has revolutionized access to computer networks.

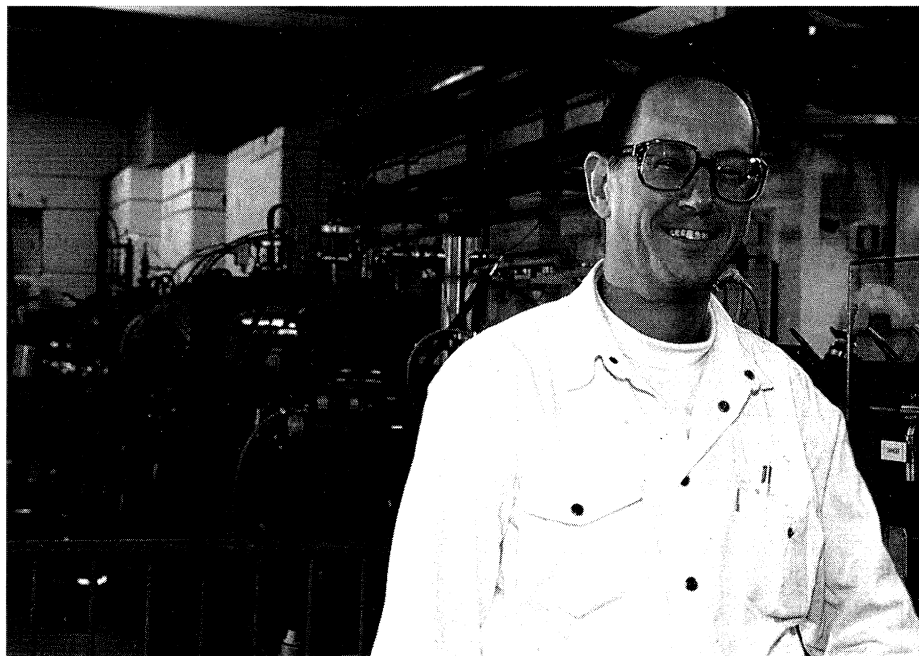
Heavy implications

Heavy ions at CERN are back, and heavier, as a new CERN facility supplies its first lead ion beams. Ingenious upgrades of existing accelerators together with several new systems accelerate lead ions to the high energies and intensities required by experiments searching for the long-awaited quark-gluon plasma. With lead beams, the more compact nuclear concentrations of matter will improve the chances of seeing quark-gluon matter in turmoil.

As with the oxygen and sulphur beams of the late 1980s and early 1990s, the system uses an Electron Cyclotron Resonance source operating in afterglow mode. Microwave power pulses transfer energy to the source's electrons, creating a plasma. At the end of the pulse, there is a sudden, brief increase in beam intensity as the plasma collapses and the lead ions escape.

The lead ions travel along a new Low Energy Beam Transport and through a high resolution spectrometer. This separates the different isotopes, selecting only lead 27+. These ions are then accelerated from 2.5 keV to 250 keV per nucleon by a new Radio Frequency Quadrupole (RFQ).

After traversing the specially built Medium Energy Beam Transport, the



Helmut Haseroth, project leader for CERN's heavy ion facility - "The nicest present for our enthusiasm and effort will be from physics: the discovery of quark-gluon plasma. We hope they discover something interesting."

beam enters the new linac. This has an interdigital H structure: an arrangement of drift tubes that give a higher accelerating field for lower input power, and occupy a much smaller space than conventional linacs. Its three tanks push the lead ions to 4.2 MeV per nucleon.

The beam then passes along the High Energy Beam Transport to a carbon foil that strips the ions to lead 53+. It is much easier to accelerate lead in this highly ionized form as, for a given field, acceleration is proportional to a particle's electrical charge. Other, unwanted charge states are removed by a filter system.

The next stage is the Booster, suitably upgraded. Without these improvements, the ions would be lost through interactions with residual gas in the system. Cleaning out the Booster and adding more vacuum pumps has brought the pressure down to the 10^{-9} Torr region. Pulsing the Booster's radiofrequency (RF) acceleration system to bunch the ions, they are accelerated from 10 to 20 per cent of the speed of light. The

RF is then switched off and the ions allowed to debunch. The bunching and acceleration are then repeated to take the ions from 20 to 42 per cent of the speed of light.

The ions are next fed into the Proton Synchrotron (PS), whose radiofrequency is synchronized with the Booster. The PS is also used to accelerate protons, electrons and positrons, and injection of the lead ions somehow has to be fitted into this crowded programme. A complicated timing device ensures that all these particles can be accelerated in turn. There are four ion cycles of 1.2 seconds within a supercycle of 19.2 seconds; protons, electrons and positrons are individually inserted in the remaining time. The lead ions travel about 200,000 times around the PS in each ion cycle, rising to 4.25 GeV per nucleon before being ejected to the Super Proton Synchrotron (SPS) through a foil that strips them to lead 82+.

The four batches of lead ions injected consecutively from the PS are accelerated simultaneously by

the SPS. One potential problem was that the lead ions do not have a high enough velocity, and thus the frequency swing in the SPS travelling wave cavities is not large enough. The novel solution exploits the fact that the four batches do not fill the whole ring but only about 10 microseconds of the total revolution time of 23 microseconds. The short filling time of the SPS cavities – about 1 microsecond – allows the cavity phase to be readjusted during the beam-free period. The cavities hence operate at constant frequency and their phase is fine tuned after each revolution of the beam. The SPS supplies lead $82+$ ions to the experiments at between 50 and 160 GeV per nucleon. Speaking at a party to celebrate the successful acceleration of heavy ions, project leader Helmut Haseroth said, "The nicest present for our enthusiasm and effort will be from physics: the discovery of quark-gluon plasma. We hope they discover something interesting."

The project is the result of a 1988 proposal to accelerate lead ions using an interconnecting series of accelerators. It was achieved by the collaboration established in 1990 between GANIL in France, Legnaro, Torino and Padua in Italy, GSI and Frankfurt in Germany, and CERN. Financial contributions were made by Sweden and Switzerland; India helped with software and some hardware production, and the Czech Republic contributed some labour.

Heavy ion experiments

A range of major experiment are lined up for the new heavy ion beams. Each uses a different method to search for signs of the elusive quark-gluon plasma.

To the best of our knowledge,

quarks in today's world only exist in clusters which form hadrons, strongly interacting particles. However, at extremely high energy densities, the idea that a particular quark belongs to a particular hadron becomes meaningless. At these energy densities, strong interactions surpass the electromagnetic interactions that dominate matter at everyday densities. Since gluons mediate strong interactions, the mix of particles becomes a quark-gluon plasma.

To detect quark-gluon plasma, experimentalists need to collide matter at high energy and density, and find a record of what happened. Heavy ions such as lead provide the necessary volume of nucleons and have now been accelerated to higher energies at CERN.

There are three types of experiment searching for quark-gluon plasma. The first will detect electromagnetic signals: P280, a proposed Brookhaven/CERN/Dubna/Heidelberg/Milan/Weizmann, collaboration hopes to look for electron-positron pairs; NA50, an Annecy/Bucharest/Cagliari/INFN/CERN/Clermont Ferrand/CNRS/Lisbon/Moscow/Orsay/LPNHE Palaiseau/Strasbourg/Turin/Lyon group, will look for muon pairs; and WA98, of Bhubaneswar/Calcutta/CERN/Chandigarh Punjab/GSI/Dubna/Geneva/Groningen/Jaipur Rajasthan/Jammu/Lund/Moscow/Münster/Oak Ridge/Tennessee/Utrecht/Warsaw will search for photons issuing from the early part of the collision. These experiments will measure the state of the system at the time when quark-gluon plasma is expected to exist, and study whether the properties of the hadrons produced in the dense medium are altered.

A second approach is taken by experiments NA44, a collaboration between Brookhaven/CERN/Colum-

bia/Copenhagen/Creighton/Hiroshima/KEK/Los Alamos /Lund/Ohio State/Pittsburgh/Tbilisi State/Texas A&M/Tsukuba; NA49, from Athens/Birmingham/Budapest/CERN/Crakow/GSI/UC Davis/Frankfurt Main/Freiburg/LBL/UCLA/Marburg/München/Warsaw/Washington/Zagreb; and WA97 of Athens/Bari/INFN/Bergen/Birmingham/CERN/Paris/Genoa/Kosice/Legnaro/Padua/Rome/Salerno/Serpukhov/Strasbourg ULP/Trieste. These will examine the hadronic signals and determine the overall conditions when hadrons are formed, possibly from quark-gluon plasma.

In addition, NA52 of BERN/CERN/Annecy/Helsinki/Stockholm/CNRS/Strasbourg, will look for material that may be left over from a quark-gluon plasma.

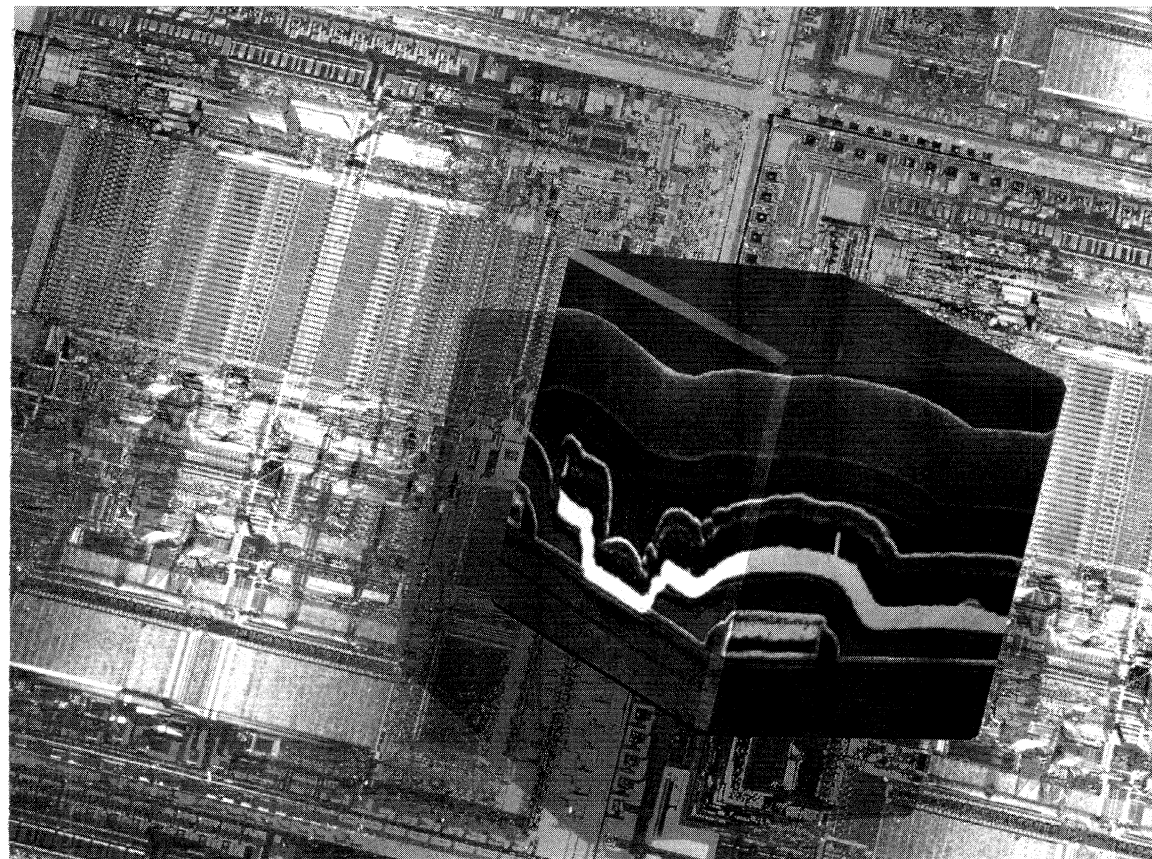
Supplementing these major experiments is a range of studies using emulsion targets.

LEAR throws light on antiprotonic helium atoms

Antiprotonic helium is an exotic atom formed when a low energy (a few electronvolts) antiproton collides with a helium atom, displacing one of its two orbital electrons.

Newly installed inside the charge cloud of the remaining electron, the antiproton ejects this too within a few of its own orbits of some 10^{-15} seconds. As with the dog that did not bark in the night in the Sherlock Holmes story, the missing electron plays a crucial role in what happens next, ensuring that subsequent

THOMSON-CSF SPECIFIC SEMICONDUCTORS



FRANCE

bp 46 - 91401 Orsay cedex
tel : (33.1) 69 33 00 00
fax : (33.1) 69 33 03 45

GERMANY

d-8000 München 70
tel : (49 89) 78 79 0
fax : (49 89) 78 79 145

INDIA

New delhi 110048
tel : (91 11) 644 78 83
fax : (91 11) 645 33 57

ITALY

00165 Roma
tel : (39 6) 639 02 48
(39 6) 638 14 58
fax : (39 6) 639 02 07

JAPAN

Shinjuku-Ku, Tokyo 160
tel : (81 3) 5351 1184
fax : (81 3) 5351 1986

UNITED KINGDOM

Basingstoke, Hants rg24 0ug
tel : (44 256) 84 33 23
fax : (44 256) 84 29 71

USA

Totowa, nj 07511
tel : (1 201) 812 9000
fax : (1 201) 812 9050

Harnessing the power of high-tech.

Thomson-CSF Semiconducteurs (TCS) is the merger of Si & GaAs semiconductor activities from Thomson-CSF. With a breadth of expertise unrivaled in the industry, we offer customers a full range of high-tech products designed for optimum equipment performance:

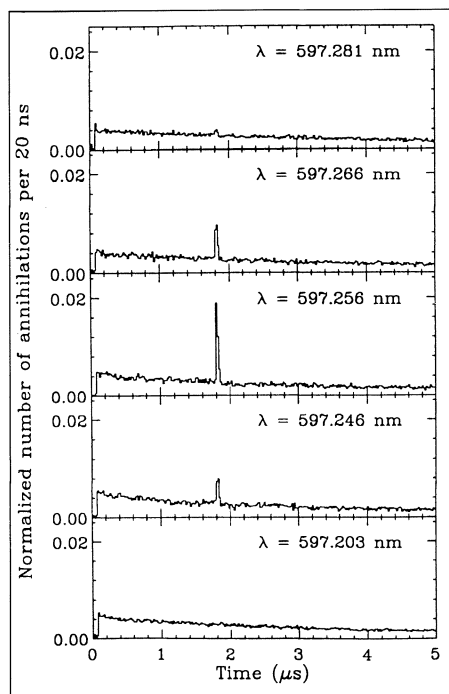
- **Silicon ICs** for defense and aerospace applications: ASICs (digital, analog and mixed A/D), microprocessors, A/D converters and rad-hardened devices on SOI technology.
- **GaAs semiconductors** for defense, aerospace, and data communication applications: standard and application specific MMICs (up to 60 GHz), microwave transistors and diodes.
- **Optoelectronic components** for all high-end applications: CCDs, high power laser diodes and fiber optic components.

By choosing TCS, you'll benefit from the long-term stability, industrial power and world-class quality of an electronics leader.

Harness the power of high-tech. Call TCS today.

 **THOMSON-CSF SEMICONDUCTEURS SPECIFIQUES**
Your global partner in world-class performance

Antiproton annihilation rate vs. time in metastable antiprotonic helium atoms, measured by plastic scintillation counters. A dye laser pulse was fired into the helium target 1.8 microseconds after the entry of each antiproton. At the critical wavelength of 597.256 nm, it stimulated any atom still in the $n=39, l=35$ state at that time to jump to the lower $n=38, l=34$ state, resulting in a sharp increase in the annihilation rate



collisions bring the antiproton near the nucleus in less than 10^{-12} seconds, when it annihilates.

In three or four cases in every hundred in such atoms, the antiproton survives for as long as 25 microseconds (June 1992, page 14). To put this in perspective, if the antiproton's orbital period is an atomic 'year', its expected lifetime is then of the order of 'centuries', while in the long-lived atoms the antiproton can survive for the equivalent of the age of the Universe.

The PS205 collaboration (Tokyo, Okazaki, Munich, Budapest and CERN) has been hard at work on this phenomenon at CERN's LEAR low energy antiproton ring since November 1991, unearthing an isotope effect, which makes the antiproton live 14% longer in helium-4 than in helium-3, studying the influence of additional foreign gases on the lifetime, and showing that this metastability is unique to helium.

Intriguing though these results were, they have been eclipsed by the

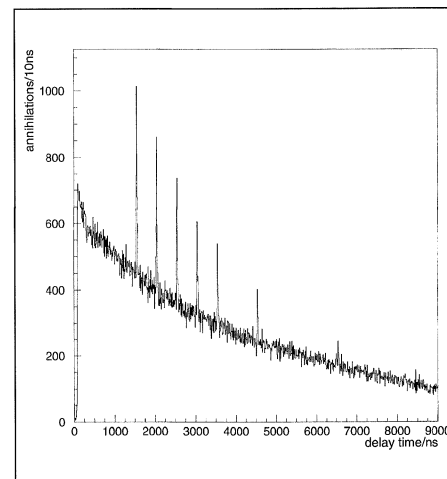
collaboration's latest exploits. The metastability was tentatively explained as a property of those antiprotonic helium atoms which at birth have the antiproton in states with large principal and orbital quantum numbers. The spacing of these levels should be only 2-3 eV. Ejecting the second electron requires 25 eV energy release, and this should therefore be strongly suppressed.

However if the second electron remains, the dog barks - deexcitation by collisions becomes ineffective, and the atom can only approach the nucleus very slowly, by radiating 2-3 eV photons. This contrived-sounding model has been questioned, but it held out enticing prospects for making very precise visible-light spectroscopic measurements on atoms containing antiprotons. Could it be possible in the same experiment both to confirm the model and open up this new field of investigation, bordering on particle as well as atomic physics? Precision measurements on other exotic atoms have always deepened our understanding of fundamental particles, so it was certainly worth trying.

But it was a classic needle in a haystack. At any given moment, only one metastable atom was present in the helium target among some 10^{23} ordinary helium atoms (the experimenters went to considerable trouble to arrange this, so that their detectors would know exactly which antiproton had annihilated). In addition the searchers were blindfolded - theoretical models could only suggest approximately which regions of the haystack to search, and when a transition did occur the deexcitation photon would be emitted in an arbitrary direction, making it very difficult to catch in a spectrometer.

Luckily, a further feature of the

Effect of varying the laser ignition time. The progressive decay of the metastable state shows up through the decreasing areas under the peaks at successive ignition times.



model is that some metastable levels must have adjacent non-metastable partners. A high powered laser pulse was therefore fired into the helium target every time a metastable atom was known to be inside [1]. By scanning the laser wavelength a search could be made for transitions between such pairs; when the resonance condition was reached the antiproton would jump down to the nearby non-metastable level and annihilate in the fast lane.

The beauty of this method is that it converts the problem of catching the photon into one of catching the annihilation products, something which can be done easily by surrounding the helium target with scintillation or Cherenkov counters.

After several days of scanning, the experimenters' persistence was rewarded by a sharp increase in the antiproton annihilation rate 'on resonance' at 597.256 nm. By studying the shape of the peak and the number of events in it, quantum numbers could be assigned to the transition. The principal quantum number goes from 39 to 38 while the orbital quantum number goes from 35 to 34. In further experiments [2], the laser light delay was varied in order to study the time evolution of the metastable state population.

Two-laser experiments were also done, the second being used to measure the repopulation of the level depopulated by the first.

In September, PS205 removed any remaining doubts about the validity of the model by shooting down antiprotons from a second metastable level, and demonstrated a new technique in which 100ns bunches containing some 10^8 antiprotons were stopped in helium, producing several million metastable atoms simultaneously.

Laser stimulated annihilation has now been demonstrated in this new mode of operation, and should result in a vastly increased efficiency when searching for and studying new resonances. The collaboration also plans to study fluorescent transitions and investigate the fine and hyperfine structure of the spectrum. This may bring greatly improved measurements of the antiproton's static properties.

References

- [1] Phys. Rev. Lett. 72, p.180.
- [2] Phys. Rev. Lett. 73, p.1485

Hidden strangeness? Quark rules not OK

Recent results from the annihilation of stopped antiprotons at CERN's Low Energy Antiproton Ring (LEAR) have demonstrated a significant violation of the Okubo-Zweig-lizuka (OZI) rule, which forbids the production of particles containing quarks which were not in the reaction initially.

Production of the phi meson is a particularly sensitive test of the rule because the phi is almost a pure strange quark-antiquark state, while the omega meson, in contrast,

contains up and down quarks and antiquarks, present initially. The proton or neutron is not normally considered as containing strange quarks or antiquarks.

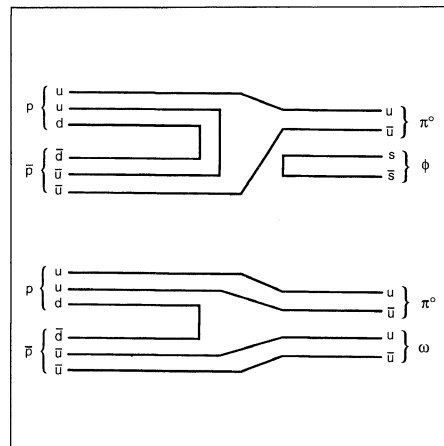
According to OZI, the ratio of phi to omega-meson production in hadron interactions should be rather small, on the level of a few parts per thousand. This has been nicely confirmed in a number of experiments with proton-proton, pion-proton and antiproton-proton annihilation at different projectile energies.

After this confirmation, results from LEAR showing strong deviations from the OZI rule are something of a surprise. The Crystal Barrel collaboration, for example, has measured the production of phi and omega accompanied by one or two neutral pions, an eta or a photon in proton-antiproton annihilations after the antiprotons have been stopped in liquid hydrogen. The experiment sees a large deviation from the 'naïve' OZI rule for single pion production, whilst the other cases deviate only slightly. However, the most striking result was an extremely large anomaly in the case of accompanying photons, where the phi production rate was found to be about 100 times higher than expected!

Also at LEAR, the OBELIX collaboration has complemented these results by comparing phi and omega production in antineutron annihilations in liquid hydrogen, and in antiproton annihilation on gaseous deuterium. Large deviations from OZI were found when the phi and omega were accompanied by a negative or a positive pion.

An interesting result was obtained by the ASTERIX collaboration at LEAR, which compared phi and omega production accompanied by a range of mesons when annihilation

The Okubo-Zweig-lizuka (OZI) rule forbids in principle the production of particles containing quarks which were not there initially. The top process, giving a phi meson, is suppressed. In the process below, all the final quarks were there initially.

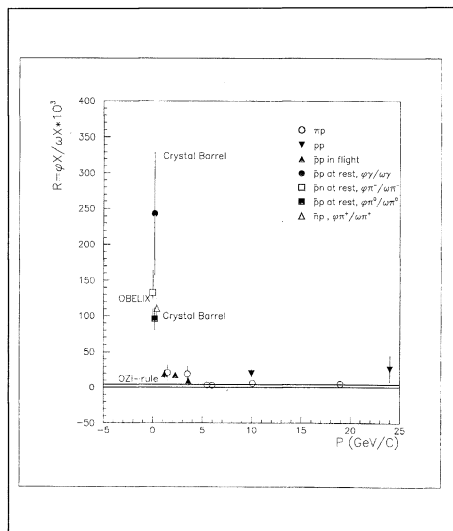


took place from low angular momentum (S- or P-wave) states of the resultant proton-antiproton atom. The phi/omega ratio in S-wave annihilations is generally higher than the OZI prediction by a factor of 2 to 8, but the most striking variation is the case of an accompanying single pion in S-wave annihilations, when the disagreement is a factor 20 or so. However, in P-wave annihilations there is no corresponding enhancement.

A phi meson and a pion can only be produced in proton-antiproton annihilation from the S-wave, when the proton and antiproton spins are parallel (spin triplet state). If annihilation takes place from the P-wave, only the spin-singlet state (antiparallel spins) is possible.

Why are results from antiprotons at rest so different from other hadronic tests? Why does the OZI rule violation depend so strongly on the quantum numbers of the initial state? There are different theoretical models on the market. One interesting possibility is a small strange quark component inside the nucleon. Deep inelastic scattering experiments using beams of neutrinos and polarized (spin oriented) muons and electrons have shown that the nucleon's valence quarks are accompanied by strange quarks which may carry part

Comparison of phi- and omega-meson production under different conditions, showing the startling increase in phi production at the three experiments at CERN's LEAR low energy antiproton ring.



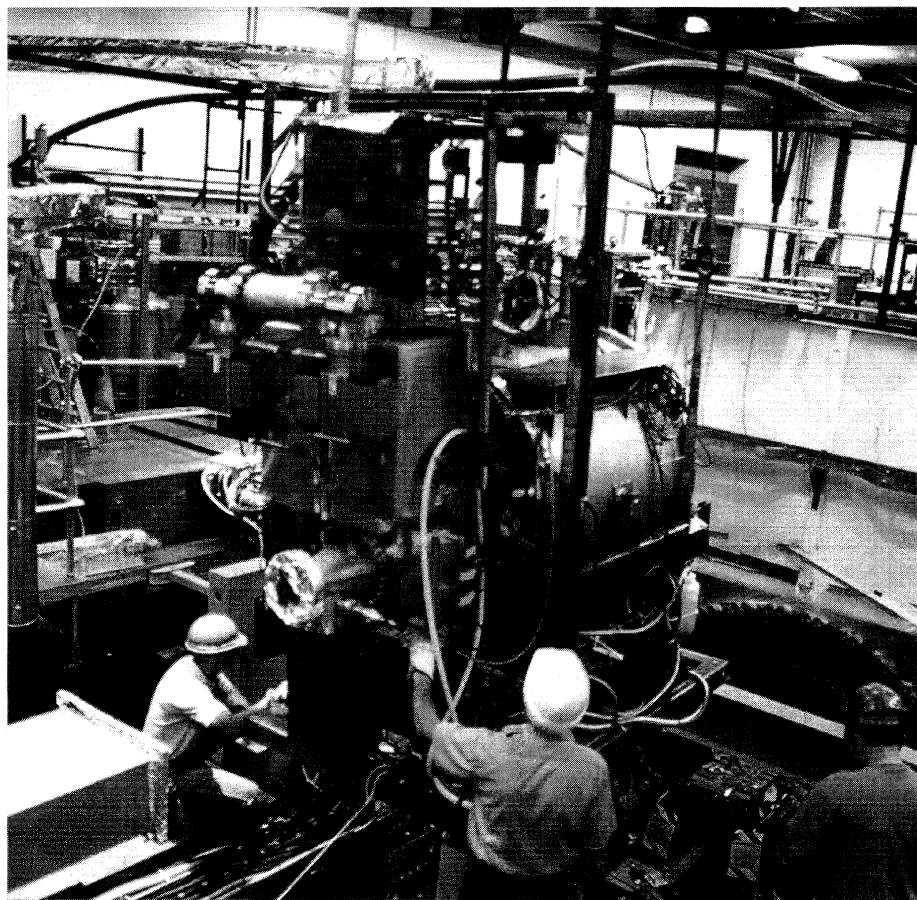
of the nucleon spin (July, page 19). If so, these strange quarks have special spin assignments.

Annihilation at rest explores a kinematic region with much less momentum transfer than the deep inelastic experiments. But if under these conditions the nucleon contains some polarized strange quarks then some of the puzzles of antiproton annihilation can be explained.

If the nucleon contains strange quarks, then the phi could be created directly via OZI-allowed processes. Dependence on the quantum configuration of the initial state is due to the polarization of the strange quarks: they willingly form the spin-one phi meson from the spin-triplet states.

Only in proton-antiproton annihilation at rest are phi mesons created from a pure spin state. Other interactions have a mixture of different spin and angular momentum states, hiding the OZI-violation. Experiments on phi production in polarized proton beam interactions with polarized targets could test whether there is intrinsic strangeness in the proton.

Installing the superconducting radio frequency cavity for its test run in CESR. The CLEO experiment is visible in the background.



CORNELL Superconducting technology breakthrough at CESR

Superconducting accelerating cavities are routinely employed in the present generation of electron storage rings at TRISTAN (KEK, Japan) and HERA (DESY, Hamburg) and will be used in CERN's LEP II. In order to be useful in future high current machines, such as the Phase III upgrade of Cornell's CESR ring (December 1993, page 22), B factories, tau-charm factories, or other ongoing plans, superconducting cavities must meet extremely stringent requirements.

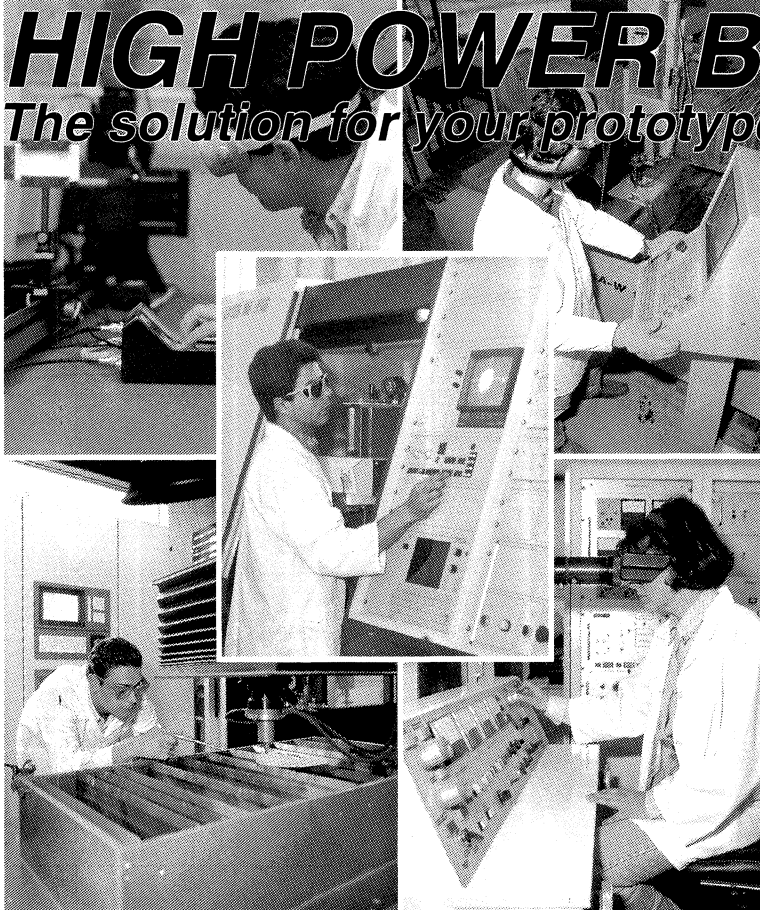
The cavities must be able to operate safely with very high circulating beam currents and must deliver hundreds of kilowatts of radiofrequency (r.f.) power to the beams. At the same time, this power must be transmitted to the cavities through the cryogenic liquid helium environment, and many kilowatts of beam-induced higher-order-mode (HOM) power must be conducted out of that environment and dissipated at room temperature. Finally, the cavities must be designed to minimize impedance (excitation of the cavities by beam wake fields) in order to avoid beam instabilities at high currents.

These rigorous requirements have been met in a prototype (December 1992, page 17) of the superconducting radiofrequency (SRF) cavity

HIGH POWER BEAM SERVICES

The solution for your prototypes and small batch Production

With Lasers, Electron Beam and Water Jet



Flexibility

Short time delivery

Feasibility analysis

What do we have?

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

What can we perform?

special parts requiring precision and high quality:

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



instituto de soldadura
e qualidade

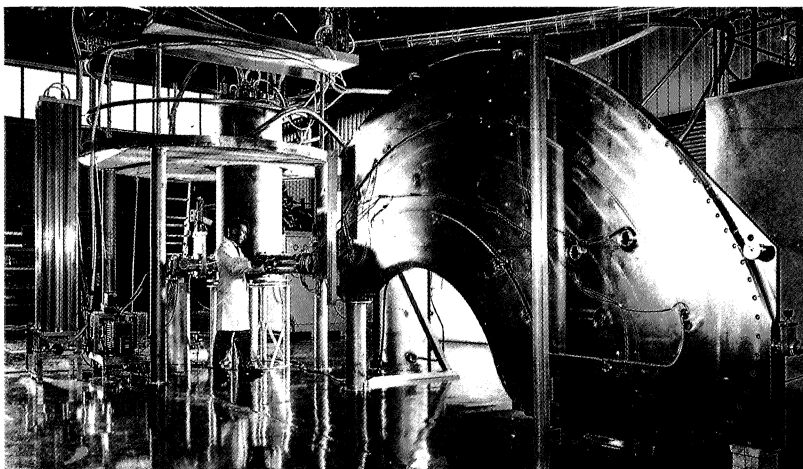


Laboratório de Feixes de Elevada
Densidade de Energia

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

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

Think Big Physics. Think Oxford.



Did you realise the scope of Oxford Instruments' long term commitment to the world of particle detection in high energy physics? Our expertise is in the engineering of complex superconducting magnet systems, for detectors large and small, to your specification. With a track record including solenoids for Cornell, GSI and a large six coil toroidal magnet system for CEBAF, you can trust Oxford Instruments to deliver an expert solution for your research needs.

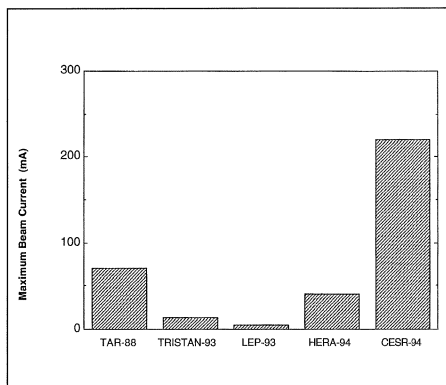
Call or fax Will Clark at Oxford Instruments
for a copy of our "Special Projects" brochure.

OXFORD

**Oxford Instruments Scientific Research Division
Research Instruments**

Old Station Way, Eynsham, Witney, Oxon OX8 1TL
Tel: +44 (0)865 882855, Fax: +44 (0)865 883891

Maximum beam currents achieved in superconducting radio frequency cavities in a number of storage rings and the year in which the current was achieved. TAR is the Tristan Accumulation Ring at the Japanese KEK Laboratory..



system planned for the Phase III upgrade of CESR. The system has several special design features suited for high current operation. In order to minimize impedance, a single cell, 500 MHz niobium cavity with a 24 cm diameter beam pipe is used. A superconducting waveguide conducts r.f. power through the cryogenic environment to the cavity, and room temperature loads dissipate the HOM power. The unique HOM loads are room-temperature sections of 24 cm diameter beam pipe, lined with ferrite, extremely lossy at microwave frequencies but with acceptable vacuum properties. The cavity, the input coupler, and the higher-order-mode load are all original designs of the CESR SRF group.

This system performed very well in a CESR test. At an operating electric field gradient of 4.5 MV/m, the cavity accelerated a beam of 220 mA in 27 bunches, the maximum single-beam current ever run in CESR. No instability attributable to the cavity was encountered. This current is three times the previous 70 mA record held by KEK in Japan with a five-cell cavity at a field gradient of 2 MV/m. The high power of the circulating beam did not increase the heat load, or present any danger to the SRF cavity.

After additional high pulsed power processing without beam, the SRF

cavity was operated at gradients between 5 and 6.1 MV/m with beam currents near 100 mA. A maximum of 155 kW of rf power was transferred to an 118 mA beam through the input power coupler/window and the SRF cavity. This is to be compared to the previous record of 70 kW through a single SRF cavity coupler set at KEK. The maximum higher order mode power extracted from the beam was 4 kW, a factor of 20 above the previous CESR world record.

Most of the tests were conducted at the nominal beam energy of CESR (5.3 GeV), with 1.4 MV of accelerating potential provided by the SRF single-cell cavity and 6 MV provided by the 20-cell copper cavities of the normal CESR r.f. system. With the SRF system operating alone, it was possible to accelerate a 30 mA beam to 4.3 GeV - injection into unconventional optics, not the SRF system, was the limiting factor.

In order to achieve high luminosities, future storage rings will require closely spaced bunches, where interactions of bunches with each other via higher order modes in the cavities can lead to instabilities that could be very difficult to control.

To see if this could be a problem with the CESR SRF system, beam stability studies were carried out with a variety of bunch configurations: single 45 mA bunches, 9 bunches (13 mA/bunch) equally spaced 85 metres apart, 9 trains of 3 bunches (8 mA/bunch) 4.2 m apart, 2 bunches (15 mA/bunch) 0.6 to 3 metres apart, and finally, 1281 bunches (36 microA/bunch) 0.6 m apart. In addition, a 117 mA beam was bumped horizontally and vertically by 5 mm and, while supporting a 100 mA beam, the cavity was axially deformed with the tuner by 0.4 mm in order to sweep the frequencies of the

higher modes across dangerous beam revolution harmonics. In all these tests, no resonant excitation of higher modes or beam instabilities were observed, which confirms that the potentially dangerous modes were damped strongly and rendered harmless.

The CESR SRF group has long pioneered research and development of SRF cavities, providing the design of the SRF cavities used in CEBAF and expanding the limits of accelerating fields (25 MV/m for the TESLA project, CERN Courier, Oct 1993). This R&D effort will continue, but production of the four single-cell cavities required for the CESR Phase III upgrade is now an additional major goal.

CZECH REPUBLIC Transition

Continuing its round of CERN Member States, the European Committee for Future Accelerators (ECFA) met in Prague in September*. After the division of Czechoslovakia, which became a CERN Member State in 1992, into two states later that year, this was the first time that ECFA had looked at particle physics in the new Czech Republic.

As well as having been reshuffled at a national level, the organization of Czech scientific research has gone through a transition, with its previous clear separation between research in Academy Institutes and in teaching universities now dissolving.

Czech involvement in modern particle physics developed through involvement in experiments organized through the Joint Institute for Nuclear Research (JINR), Dubna, near Moscow. Dubna (see page 7)

was established in 1956 as the counterpart for socialist countries.

Czech physicists began working first at Serpukhov. Subsequently, through the CERN-JINR agreements set up in the late 1960s, they began participating in experiments at CERN, particularly the NA4 muon scattering study which went on to produce landmark results on nucleon structure.

Subsequent experiments with Czech participation at CERN include UA2, UA4, Delphi, Isolde and heavy ion studies as well as the Atlas and Alice projects and their associated research and development programmes for LHC. At DESY, Czech physicists are part of the H1 team at the HERA electron-proton collider. International schools and workshops have been held in Czech centres.

In total, there are some 40 Czech experimentalists, mainly based in Academy institutes and in universities in Prague. There are also a similar number of theorists.

The Czech Republic is keen to expand its industrial contribution to CERN, and an industry exhibition at

CERN in June made important initial contacts.

The nation's contribution to CERN, yet to attain its cruising altitude, is paid through the Ministry of Foreign Affairs, but CERN-Czech relations are closely supervised by the Ministry of Industry and Trade, which also provides special support funding for physicists working at CERN. The science itself is covered by the Academy and the universities as well as through grants. A Czech-CERN committee monitors activities at and related to CERN.

(*These regional meetings involve only a 'restricted' ECFA, rather than the full committee.)

Members of the European Committee for Future Accelerators (ECFA) met in Prague in September to appraise the position of physics in the new Czech Republic. Czech hosts at the event included (left to right) President of the Committee for Czech-CERN Cooperation Jiri Niederle, University Rector I. Wilhelm, and Czech ECFA delegate Vladislav Simak, here with Ivan Lehrs of CERN.



UNITED STATES

Particle and nuclear astrophysicists look to the future

While many high-energy physicists are planning giant colliding beams machines as the vessels to sail beyond the familiar waters of the Standard Model, others are testing alternate conveyances to explore the most fundamental issues of particle physics.

Studies of proton decay, neutrino masses and oscillations, dark matter, high-energy astronomy, microwave background fluctuations, large-scale structure, and the physics of the early Universe could move the field far from the Standard Model shore.

Just as zoologists and geologists once explored new lands together, high-energy physicists have been joined by nuclear physicists and astrophysicists who are interested in the experiments because of the relevance to their own disciplines.

To recognize and nurture this growing interdisciplinary field, the American Physical Society's Divisions of Astrophysics, Nuclear Physics, and Particles and Fields (DPF) sponsored a two-week summer study to examine emerging research opportunities. The study, modestly called "Particle and Nuclear Astrophysics and Cosmology in the Next Millennium", was held in Snowmass, Colorado from June 29 to July 14.

The Snowmass series of summer studies have been important in planning the future of the US high-energy physics programme. The 1994 meeting was distinguished from previous ones by its broad interdisciplinary and international participation.

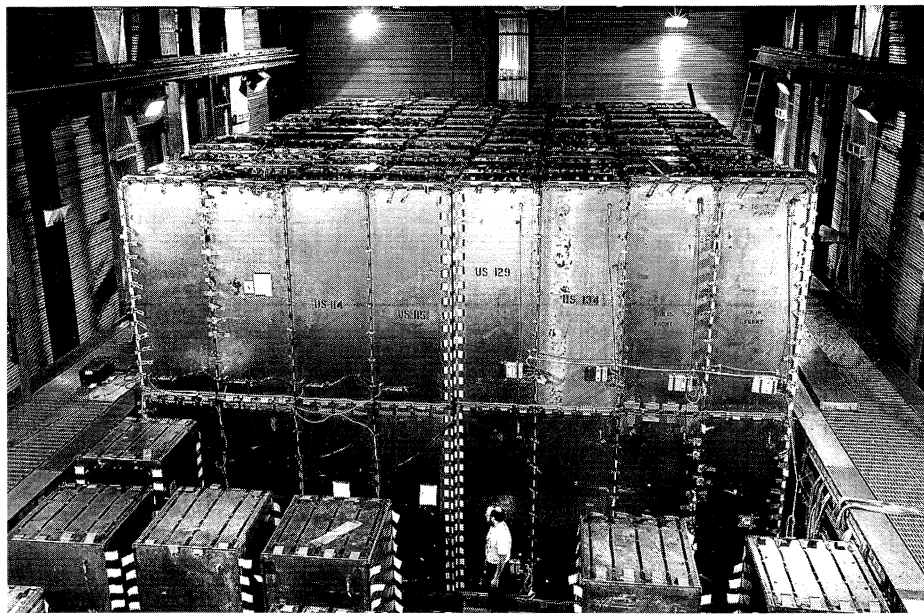
Fermilab plans to construct a neutrino beam aimed at a massive detector in a distant underground laboratory. One possibility would be the new Soudan II detector, 700 metres underground and 730 km away from Fermilab.

Over 400 physicists from 16 countries attended; nearly 20% of them from outside the US.

Twenty working groups were organized around specific topics in neutrinos, cosmic rays, gravitational phenomena, low background experiments, and cosmology. Interest in neutrinos and underground physics was heightened when participants found among their registration material a letter from Fermilab Director John Peoples announcing the interest of Fermilab's Physics Advisory Committee in opportunities for neutrino experiments at the Main Injector (the so-called NuMI programme). In addition to its first use in improving collider luminosity, high-intensity Main Injector beams could be used for sensitive neutrino oscillation experiments around the year 2000.

Following the recommendation, Fermilab plans to construct a neutrino beam aimed at a massive detector in a distant underground laboratory - for example a new 15 kTon detector, 730 km away in the Soudan laboratory. The approved E-803 short-baseline experiment would occupy an underground experimental hall in the same beam on the Fermilab site. Both long- and short-baseline experiments could detect the oscillations of muon neutrinos into tau neutrinos, but in different regions of mixing angle and neutrino mass. E-803 is similar to, but more sensitive than, the CERN Chorus experiment, already in operation. Long-baseline neutrino oscillation experiments are also under discussion at CERN, Brookhaven, and KEK (Japan). The strong Fermilab support for NuMI constitutes an important entry in the neutrino game.

Boris Kayser (NSF) reviewed the list of experimental hints of nonzero neutrino mass to construct several



scenarios for future experiments. The list includes the atmospheric neutrino anomaly, the solar neutrino deficit, the need for hot dark matter, a possible signal for neutrinoless double beta decay, and a possible signal for muon to electron neutrino oscillations from the LSND experiment at Los Alamos.

Data from the gallium solar neutrino experiments continue to support earlier evidence from water Cerenkov and chlorine experiments for neutrino oscillations, and place tighter constraints on mixing parameters. In his summary talk, Wick Haxton (Washington) stressed the importance of such complementary measurements and of calibrations with radioactive sources. Powerful new generation solar neutrino experiments (SNO in Canada and SuperKamiokande in Japan) are already under construction, and several others are being prototyped. Heroic experiments to probe the full spectrum of primary solar neutrinos are being developed by proponents of the HeLaz and HERON detectors. Supernova neutrinos can provide

further information about neutrino masses and mixing, but current stellar collapse models and present detector technology both limit their usefulness.

The high-energy neutrino astrophysics community moved a step closer to a next generation neutrino telescope. Francis Halzen (Wisconsin) argued that the next generation telescope should utilize a cubic kilometre sensitive volume of water or ice, and reviewed the status of the current generation of detectors known as BAND (Baikal, Amanda, Nestor, Dumand). While these huge "prototype" detectors are still in various stages of development, the techniques they have pioneered could be used for a much larger telescope. The cubic kilometre detector could study extragalactic neutrino astronomy and search for neutrinos from WIMP annihilation. Several temporary working groups set up at Snowmass could eventually lead to the formation of an international collaboration.

Proponents of the Giant Air Shower Detector continued design work on

External correspondents

Argonne National Laboratory, (USA)
D. Ayres

Brookhaven, National Laboratory, (USA)
P. Yamin

CEBAF Laboratory, (USA)
S. Corneliussen

Cornell University, (USA)
D. G. Cassel

DESY Laboratory, (Germany)
P. Waloschek

Fermi National Accelerator Laboratory, (USA)
J. Cooper, J. Holt

GSI Darmstadt, (Germany)
G. Siegert

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)
R. Frosch

Rutherford Appleton Laboratory, (UK)
Jacky Hutchinson

Saclay Laboratory, (France)
Elisabeth Locci

IHEP, Serpukhov, (Russia)
Yu. Ryabov

Stanford Linear Accelerator Center, (USA)
M. Riordan

TRIUMF Laboratory, (Canada)
M. K. Craddock



Wear it's at

Your chance to buy a piece of CERN history. Laetitia Veloso da Silva models CERN's 40th anniversary t-shirt. Just the thing for laboratory summer wear or for an offbeat gift. Only 20 Swiss francs, including postage and packing. Send cheques to Christel Ranta, CERN/DSU, 1211 Geneva 23, Switzerland.

CERN Courier contributions

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

Connections to Stockholm

The 1994 Frank Prize at the Joint Institute for Nuclear Research, Dubna, went to Yu. Abov, L. Pikelner and V. Alfimenkov for their discovery of parity violation in neutron-neutron scattering. The Prize was instituted in 1993 as a memorial to 1958 Nobel prizewinner Ilya Frank, after whom the JINR Laboratory of Nuclear Physics is named. The first recipient was Clifford Shull, who shared the 1994 Nobel prize with Bertram Brockhouse.

Among the guests at the 1994 Nobel Prize Awards in Stockholm was Jenny Van Hove. The theoretical work of her late husband, former CERN Research Director General Leon Van Hove, was acknowledged in the Royal Swedish Academy of Sciences' citation of the Physics prize to Bertram Brockhouse and Clifford Shull for their role in developing neutron scattering techniques.

this next generation cosmic ray facility. Jim Cronin (Chicago) is leading the push for a 5000 square-kilometre array which might record 50 events per year above 10^{20} eV, based on a handful of events seen by existing detectors. The origin of such ultra-high energy particles is a mystery because there is no accepted mechanism capable of accelerating to this energy, while such particles also have only very limited range through the microwave background radiation.

Advances in high energy gamma ray astronomy were summarized by Dick Lamb (Iowa State), who noted that this field is divided into low-energy space-based and high-energy ground-based communities. Closer coordination of their efforts was a major topic of discussion. Challenges for the future include filling the observational gap between 10 GeV and 10 TeV and extending the reach of the EGRET and BATSE detectors (on board the Compton Gamma Ray Observatory) with a new generation of even more sophisticated experiments.

The low-background experiments working group attracted the second largest number of Snowmass participants (after neutrinos). Topics included searches for proton decay, dark matter, double beta decay, and other rare/nonexistent phenomena. Chris Stubbs (Santa Barbara) summarized the status of dark matter searches. While all current evidence for dark matter originates from astronomical observations, the dark matter problem has much broader physical significance. In fact, dark matter was a unifying theme underlying many topics. There was considerable optimism that substantial experimental progress would be made in the foreseeable future.

The gravity sessions were domi-

Black hole encyclopaedia

Theorists first thought about what happens when throwing encyclopaedias are thrown into black holes after Stephen Hawking's remarkable discovery that black holes emit thermal radiation. This hints at profound links between thermodynamics, gravitation, and quantum mechanics, but it also gives rise to a puzzle, which hints of chinks in the links.

If a black hole is formed from the collapse of a pure quantum state and evaporates completely into a thermal state, then one of the fundamental tenets of quantum mechanics would be violated. This question is often posed as "if one throws an encyclopaedia into a black hole, what happens to the information contained in it?" While there is still considerable disagreement among theorists about the fate of the information, most feel that the resolution of the question will provide key information about fundamental physics.

nated by two issues, one theoretical and the other experimental. On the theoretical side the question of the loss of information associated with black holes received the most attention. The possibility that the resolution of this question might involve a fundamental change in our interpretation of quantum mechanics keeps it a burning issue. While their theoretical friends were speculating what would happen if encyclopedias were

thrown into black holes, experimentalists were concentrating on plans for the approved gravitational-wave experiment known as LIGO. With construction under way in Oregon, and groundbreaking planned in Louisiana, they have their hands full. Theorists interested in gravity waves followed reports of gamma-ray bursts from the space working groups in the hope that the mysterious bursts are the result of neutron star or black hole coalescence which would provide a discernible signal.

The cosmology working groups seemed confident that early-Universe theories will soon be put to the test by observations of the cosmic background radiation (CBR), large-scale structure, and dark matter searches. Until recently just detecting CBR fluctuations was a triumph, now experimentalists and theorists are setting targets for the accuracy and angular coverage of future experiments required to test early-universe scenarios.

One strategy expressed by Paul Steinhardt (Pennsylvania) was that the top three goals of CBR studies should be: 1 - test inflation; 2 - test inflation; and 3 - test inflation, with everything else of secondary importance. Many cosmologists agreed with this emphasis on inflation, with much effort directing into connecting inflation theories with present-day observations.

Predicting the dark matter ingredients of the primordial soup continues to be as much an art as a science, with Joel Primack (Santa Cruz) calling for a light neutrino seasoning, Michael Turner (Chicago) speaking up for bland, cold broth of axions, and others calling for a dash of cosmological constant or light supersymmetric particles. Even those with strong tastes agreed that

People and things

upcoming large-scale structure surveys such as the Sloan Digital Sky Survey would be required before we can say if the Universe is a spicy mix of many particles, or if too many theorists have spoiled the primordial soup.

Even after long, hard days in the working groups there was still a little energy available for rest and recreation. The volleyball prowess of the cosmologists was reconfirmed as they easily took care of the gravitationalists to capture the "Universe Cup".

While even from the top of Aspen Mountain the next millennium was slightly over the horizon, the Colorado mountains did provide a most appropriate setting for this visionary summer study. The Organizing Committee was chaired by Roberto Peccei (UCLA). Fermilab provided the usual excellent logistical support, including a Secretariat (under Cynthia Sazama) and a well-equipped computer centre.

By David Ayres (Argonne) and Edward W. Kolb (Fermilab and the University of Chicago)

On people

Maurice Jacob, distinguished theorist, one-time leader of CERN's Theory Division and President of the European and French Physical Societies, and now responsible for CERN's relations with Member States, becomes a member of the French Légion d'Honneur.

Neville Smith, previously with AT&T Bell Laboratories, has been appointed first scientific programme head of the Advanced Light Source at the Lawrence Berkeley Laboratory.

Tom Roser becomes Head of the Accelerator Division in the Alternating Gradient Synchrotron Department at Brookhaven, succeeding Bill Teng, now on sabbatical.

Feynman on film

Watch out next year for the Hollywood film 'Infinity' directed by actor

Matthew Broderick and based on the life of Richard Feynman.

CEBAF beams

After delivering its first beams earlier this year (September, page 42), the Continuous Electron Beam Accelerator Facility (CEBAF) superconducting accelerator in Newport News, Virginia, has attained 1.46 GeV, recirculating the beam in two passes. The goal is 4 GeV or higher in five passes. Preparations for higher passes alternate with detector commissioning.

Sergei M. Polikanov 1926-94

Sergei M. Polikanov died on September 2 at the age of 67. He was a member of the scientific staff of the GSI Darmstadt heavy ion Laboratory.

Born in Moscow in 1926, Polikanov studied physics with prominent teachers like L. D. Landau and I. E. Tamm and worked with G. N. Flerov



On 7 October CERN's Associate Director for Future Accelerators Lyn Evans (left) explains LHC preparations at CERN to Portuguese Minister Luis Valente de Oliveira (right) and Secretary of State for Science and Technology Manuel F. Thomaz.

Sergei M. Polikanov 1926-94



on the synthesis of transuranic elements. In these experiments, carried out at the Joint Institute for Nuclear Research (JINR), Dubna, element 103 (Nobelium) was first synthesized. In 1962 he discovered a spontaneous fission activity of 14 ms in uranium-238 reactions with heavy ions. This initially confusing phenomenon was soon recognized to be the spontaneous fission of an excited nuclear state of americium-242 and subsequently observed to be a phenomenon that occurred in many other transuranics. Few accomplishments in nuclear physics in recent years have had such a wide impact. The discovery soon received appropriate recognition: the Lenin Prize in 1967; election to corresponding membership in the Soviet Academy of Sciences in 1974; and in 1977 the Tom Bonner Prize of the American Physical Society.

In the early 70s Polikanov was the first to propose using muons to probe nuclear fission and nuclear dynamics. This early work in Dubna soon brought him into contact with CERN which offered the best possibilities for experiments with muons. His desire to depart with his family for a prolonged research abroad and his subsequent affiliation with Sakharov's Helsinki Group led to a

complete break with the Soviet establishment. In 1978 Polikanov and his family were expelled from the Soviet Union, and he formally returned all his Soviet prizes and honours. After working at the Niels Bohr Institute in Copenhagen from 1978 - 1980 and at CERN from 1980 - 1982, in 1982 he received a permanent position as a staff scientist at GSI, Darmstadt. He was appointed Honorary Professor at Heidelberg and in 1988 was awarded an honorary doctorate by the University of Uppsala in Sweden.

We have all learned much from Sergei Polikanov. With his death we have lost a man of great integrity, an outstanding physicist, and a highly regarded colleague.

From P. Armbruster and H.J. Specht

Tanguy Altherr 1963-94

This summer the promising French theorist Tanguy Altherr lost his life in a climbing accident in his home Brittany. After completing his thesis at Annecy, he went on to do research at Helsinki and in the French CNRS before coming to CERN as a Fellow. An acknowledged specialist in the theory of finite temperature fields, he was a prolific collaborator and the author of 31 papers, his age when he died.

Ilya M. Kapchinsky

On 5 July, Ilya M. Kapchinsky, well known for his work in oscillation theory, radio engineering, particle beam physics and accelerator technology, who died in 1993 (September 1993, page 33) would have been 75. A meeting at Moscow's Institute for Theoretical and Experi-

mental Physics (ITEP) commemorated the event.

After graduating from Moscow, he worked in radio and radar. From 1958, he headed ITEP's Linac Laboratory (later Division), directing teams which built linacs both at ITEP and at IHEP, Protvino. Characteristic of his work was a deep understanding of technical problems. Both these linacs went on to surpass their design values and be reliable for many years. Later came new high current ion machines.

After fresh results on the behaviour of intense beams of charged particles, in 1968, with V.V. Vladimirov and V.A. Teplyakov, he discovered the space-uniform quadrupole focusing effect, leading to a new method of ion beam acceleration (now best known as the radiofrequency quadrupole technique), now used all over the world. He also proposed a two-frequency proton linac idea.

His achievements, ingenuity and mastery of the field brought him several awards, in the US and Germany as well as in his home country. The continual and widespread application of his ideas serve as a fitting memorial to his work.

Meetings

The 3rd International Workshop on B-Physics at Hadron Machines - Beauty '95 - will be held at Oxford University, U.K. from 10-14 July, 1995. Further information from BEAUTY95@PHYSICS.OXFORD.AC.UK

The URL of the World Wide Web Home Page will be: <http://www-pnp.physics.ox.ac.uk/beauty95.html>

The 2nd International Workshop (Beauty '94) was held at Mont-St.-Michel, Normandy from 25-29 April. Peter Dornan of London's Imperial

Advertisements in COURRIER CERN

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	2150	2040	1950	1840
1/2	185 x 130 90 x 265	1280	1200	1100	1020
1/4	90 x 130	750	680	630	590

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)	2000 SwF
Cover 4 (one colour)	2500 SwF
Publication date	1st of month of cover date
Closing date for positive films and copy	1st of month preceding cover date
	The cost of making films and of translation for advertisements are charged in addition.
Screen offset	60 l/cm (150 English)
	Advertisements cancelled after 1st of month preceding cover date will be invoiced.

These rates are effective for the year 1995.

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.

Max-Planck-Institut für Physik

(Werner-Heisenberg-Institut)

München, Germany

We invite applications from recent PhD graduates for a postdoctoral position in

Experimental High Energy Physics

The initial appointment is made for two years with the possibility of renewal for up to a total period of five years. The position is available now.

Our group has been engaged in the design and construction of the H1-detector and is actively participating in the data taking at the HERA e-p collider as well as in the upgrade program of the H1-detector.

We expect that the person appointed will actively participate in the exploitation of the physics potential of the H1-detector. Since we are presently constructing a level-2 neural network trigger for the H1-detector, the possibility of working in addition in this more hardware-oriented field is also offered. The location of work will be mainly at Munich, with regular trips to DESY, Hamburg.

For full consideration, applications must be received by January 31, 1995. Candidates should submit a curriculum vitae and arrange for three letters of recommendation to be sent to:

Prof. G. Buschhorn

Max-Planck-Institut für Physik

(Werner-Heisenberg-Institut)

Föhringer Ring 6

D - 80805 München

Germany

(e-mail: gwb@dmumpiwh.mppmu.mpg.de)

NFR Naturvetenskapliga forskningsrådet Swedish Natural Science Research Council

invites applications for

RESEARCH POSITIONS in

**Experimental astroparticle physics
Theoretical nuclear physics, esp. hadron physics**

The Council's intention in creating these posts is to contribute to the recruitment of researchers and to breathe new life into research itself. The programme is, therefore, aimed primarily at the young researcher. These positions will be at an appropriate research group within Sweden. Tenure will be for 3 years as from October 1, 1995 and may be prolonged for another three years.

The salary range will correspond to that of an associate professor (SEK 255 000-350 000 per year). Applications should reach the Swedish Natural Science Research Council, Box 7142, S-103 87 Stockholm, Sweden, by March 15, 1995.

A curriculum vitae including a list of publications, a short research plan and, at most, 10 reprints of scientific papers should be appended in four copies to the application which should also be in quadruplicate.

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.



UNIVERSITE DE GENEVE

**La Faculté des Sciences ouvre
une inscription pour un poste
de Professeur ordinaire en**

PHYSIQUE THEORIQUE DES INTERACTIONS ELEMENTAIRES

Charge: Il s'agit d'un poste à charge complète, comprenant 6 heures de cours par semaine. Recherches dans le domaine de la physique théorique des interactions élémentaires.

Nous cherchons des candidats maîtrisant un éventail étendu de sujets théoriques modernes en relation avec les interactions élémentaires et ayant fait des contributions significatives dans ces domaines.

Titre exigé: doctorat ou titre jugé équivalent.

Entrée en fonction: 1er octobre 1995, ou à convenir.

Les dossiers de candidature comportant le curriculum vitae et la liste des publications devront être adressés, avant le 31 janvier 1995, au Doyen de la Faculté des Sciences, 30 quai Ernest-Ansermet, CH - 1211 Genève 4 (Suisse), où peuvent être obtenus des renseignements complémentaires sur le Cahier des charges et les conditions.

NB Désirant associer tant les femmes que les hommes à l'enseignement et à la recherche, l'Université souhaite recevoir davantage de candidatures féminines.

College was the summary speaker. The Proceedings appeared in *Nuclear Instruments & Methods A* 315 (15 November, 1994). The 15th International Conference on Physics in Collision will be held from June 8-10, 1995 at the Marian Miesowicz Centre of High Energy Physics in Cracow, Poland. The conference is intended to provide an overview of the current status of high energy physics. Further information can be obtained from PHYSCOLL95, Institute of Nuclear Physics, ul. Kawory 26A, 30-055 Krakow, Poland, E-mail: PHYSCOLL@VSK01.IFJ.EDU.PL, Tel: (4812) 33 33 66, Fax: (4812) 33 38 84.

LTD6 - the Sixth International Workshop on Low Temperature Detectors - will take place from 28 August to 1 September at Beatenberg, near Interlaken, Switzerland. Further information from LTD6@LHEP.UNIBE.CH

The 1995 Low dimensional quantum

field theory meeting will be held at Centro Stefano Franscini, Monte Verita', Ascona, from 10-15 September 1995, sponsored by the European Science Foundation, ETH Zurich and Swiss National Science Foundation. Directors: K. Osterwalder (ETH, Zurich) and V. Rittenberg (Univ. of Bonn). Information: Secretariat CSF, ETH Zentrum, HGG24.1, CH-8092 Zurich, Phone : +41-1 632 25 00, Fax : +41-1 262 56 22.

NuPECC, the Nuclear Physics European Collaboration Committee, is the nuclear physics analogue of ECFA, the European Committee for Future Accelerators, which covers particle physics. Here NuPECC Chairman Peter Kienzle (left) considers a moot point with former Chairman Claude Detraz, now head of IN2P3 in France.

European Physical Society in support of the LHC

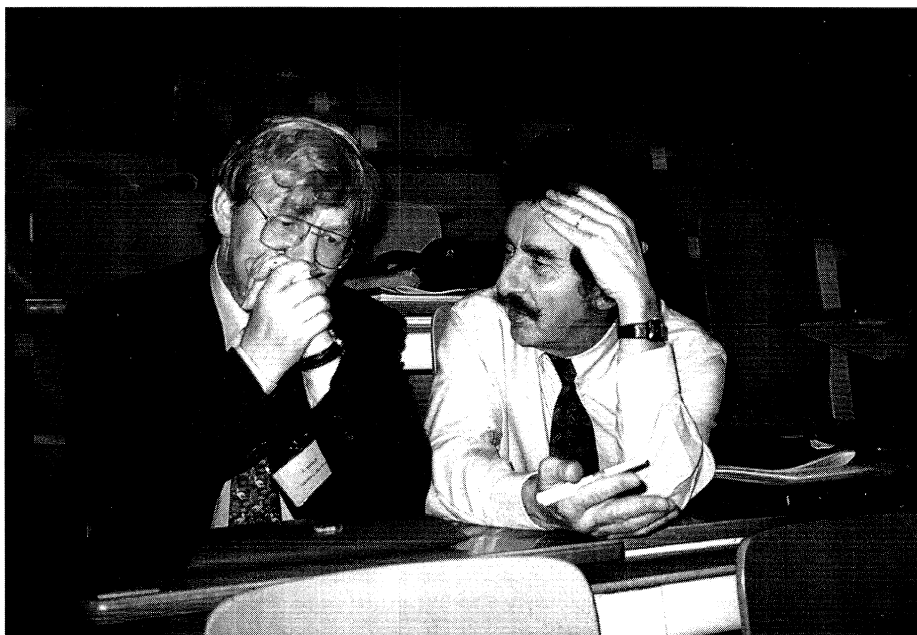
On 1 November, the European Physical Society (EPS) issued the following statement:

In the past 40 years, CERN, the European Laboratory for Particle Physics Research, has succeeded in bringing Europe to a position of leadership in the study of fundamental interactions. This is testified by the important number of CERN users coming from outside Europe, and in particular from the United States. At the same time, the number of users from the Member States has more than doubled over the past 20 years.

The next logical tool towards decisive progress in the field is the LHC. This is a 27 kilometre circumference superconducting proton collider which is foreseen to be installed in the same tunnel as the existing LEP machine. LHC would be the world frontier of high energy physics; with a 14 TeV collision energy it will be in a unique position to provide answers to new fundamental questions raised by the present great successes of particle physics and cosmology.

The European Physical Society strongly supports this essential project for Europe which will further the excellence of research on the ultimate constituents of matter and maintain the momentum of CERN and Europe in this area. Worried by recent delays, the EPS urges the CERN Member State governments to quickly take a positive decision to approve the LHC.

(signed) G. Jarlskog, Chairman of EPS High Energy Physics Division, and N. Kroo, EPS President.



University of Toronto
Department of Physics

TENURE TRACK FACULTY POSITION

Experimental or Theoretical Particle Physics

The Department of Physics plans to make a tenure track appointment at the rank of Assistant Professor, with a starting date of July 1, 1995.

We seek candidates with a Ph.D. in Physics, proven or potential excellence in both research and teaching whose interests lie in Experimental or Theoretical Particle Physics. Salary will be commensurate with qualifications and experience.

Applications, including a curriculum vitae and three letters of reference should be sent to Professor D. York, Chair, Department of Physics, University of Toronto, Toronto, Ontario, Canada, M5S 1A7. The deadline for the receipt of applications and letters of recommendation is Tuesday, February 28, 1995.

The University of Toronto is committed to employment equity and encourages applications from qualified women and men, members of visible minorities, aboriginal persons, and persons with disabilities.



University of Geneva

The Department of Physics of Condensed Matter announces an opening, beginning October 1st, 1995, for a position of

FULL PROFESSOR or ASSOCIATE PROFESSOR

in CONDENSED MATTER PHYSICS

Teaching in French of introductory physics and condensed matter physics; Research activity in the physics of metals or superconductors including studies at the mesoscopic and atomic scale.

The applicant should have a PhD in physics - or an equivalent degree - and experience in physics teaching and in leading a research group in condensed matter physics.

Letters of application, including a curriculum vitae and a list of publications, should be addressed before February 28, 1995 to: Décanat de la Faculté des Sciences, 30, quai Ernest-Ansermet, CH - 1211 Genève 4, Switzerland, where additional information may be obtained.

NB: Qualified women are encouraged to apply.

POSTDOCTORAL RESEARCH IN EXPERIMENTAL HIGH ENERGY PHYSICS DEPARTMENT OF PHYSICS UNIVERSITY OF CALIFORNIA, RIVERSIDE

The Department of Physics invites applications for Postdoctoral Research positions in experimental high energy physics. The appointed individual is expected to participate in the on-going research projects of the group, which include the e^+e^- experiment OPAL at LEP and the CMS experiment at LHC. Candidates, who are recent recipients of the Ph.D. degree, should submit a résumé and arrange for three letters of recommendation to be sent to professor Benjamin C. Shen, Department of Physics, University of California, Riverside, CA 92521. The University of California is an Equal Opportunity, Affirmative Action Employer.

Associate Scientist

Fermi National Accelerator Laboratory, located 40 miles west of downtown Chicago, is the most advanced high-energy physics research facility in the world. An exceptional opportunity is available with our sophisticated KTeV project for an individual to participate in major detector system construction/commissioning, pursue data collection and analyze particular physics processes through publication, assist in studies of CP violation and measure rare processes in Kaon decay.

Qualified candidates will have a Ph.D. in experimental high-energy physics and at least 3 years post-doctoral research experience with proven field expertise in construction of large wire chambers for transition radiation detection, hardware system integration and data collection/analysis for publication. Solid communication and coordination skills and the ability to initiate and handle hardware/software projects is essential.

We provide our employees with opportunities for personal and professional growth, competitive salaries and an attractive benefits package. Please forward CV and three letters of recommendation to: **James L. Thompson, Employment Manager, Fermi National Laboratory Accelerator, P.O. Box 500, Batavia, IL, USA 60510-0500.** Equal Opportunity Employer M/F/D/V.



Fermilab

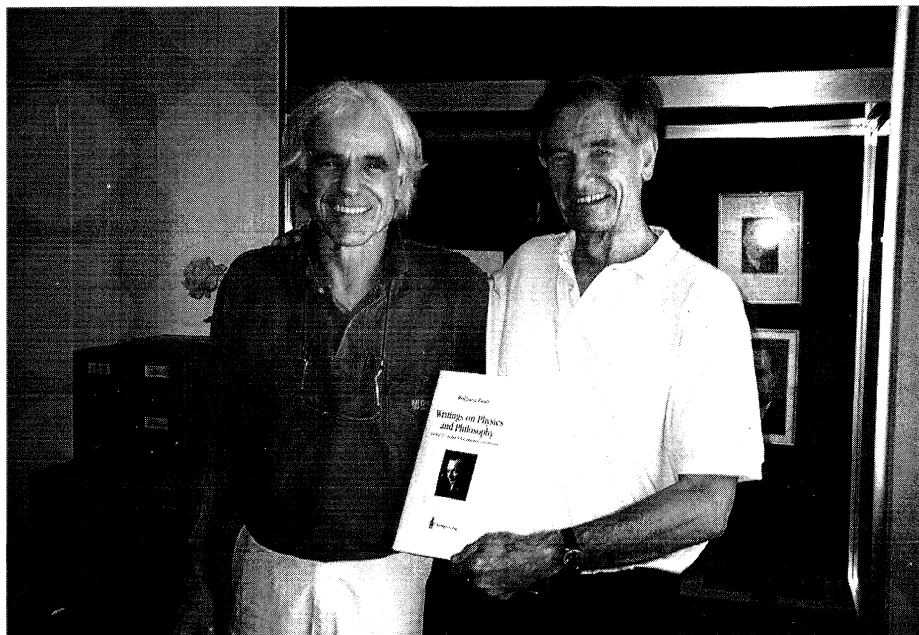
Karl Von Meyenn, left, who has long been assisting with the editing of Wolfgang Pauli's scientific correspondence, has joined the Pauli Committee at CERN as a full member. He is seen here with fellow committee member Charles Enz of Geneva, who was Pauli's last assistant, and who is holding a copy of Pauli's 'Writings on Physics and Philosophy', published under the auspices of the Committee.

(Photo Maurice Jacob)

Half a century of phase stability

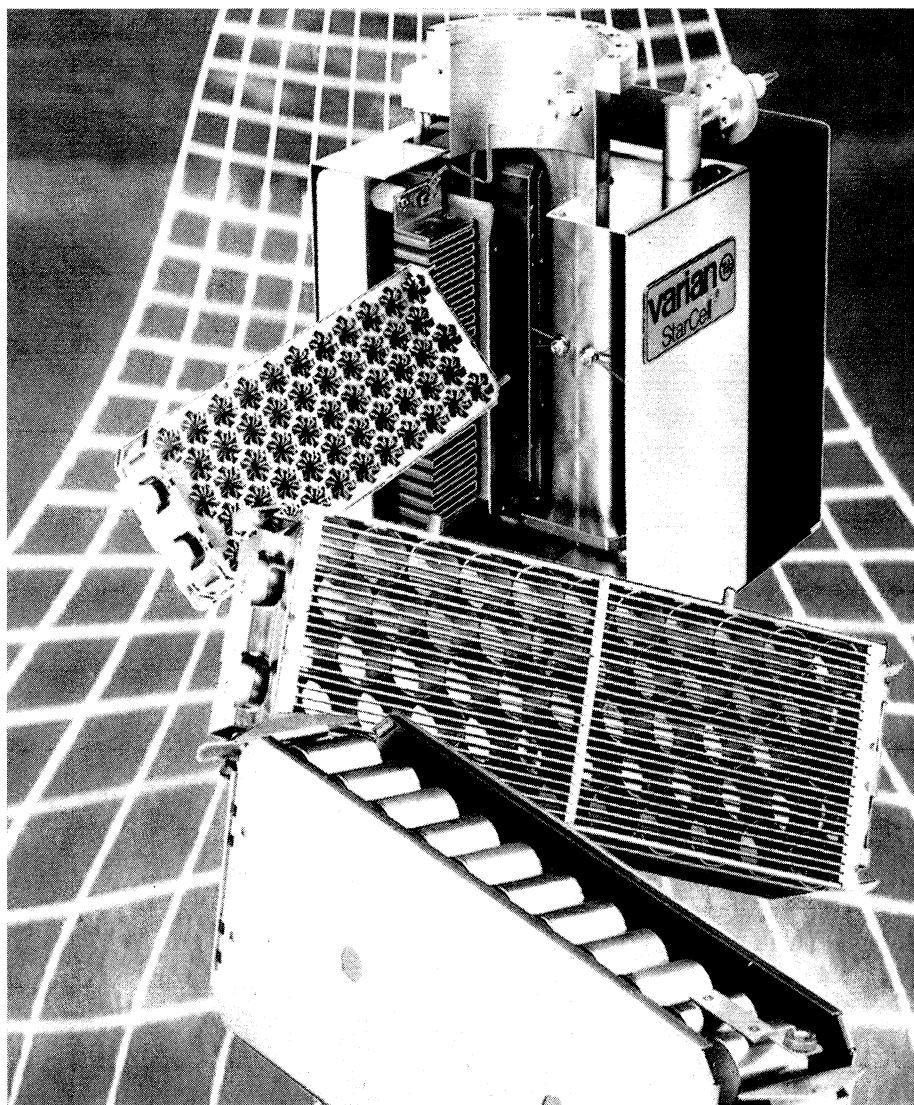
This summer an International symposium at the Joint Institute of Nuclear Research, Dubna, and Moscow's Lebedev Physical Institute marked the 50th anniversary of the discovery of the principle of phase stability, made in the former Soviet Union by Vladimir Iosiphovich Veksler and independently by Edwin McMillan in the USA. This technique, known as the synchrocyclotron in the West and the synchrophasotron in the former Soviet Union, compensated for the increase in mass due to relativity which had restricted the classic cyclotron design.

As well as a full programme of talks, the symposium included also the visits to Dubna's recently commissioned superconducting Nuclotron (July/August 1993, page 9) accelerating a range of nuclei up to 6 GeV per nucleon, to the first Soviet synchrotron, S-3 at the Lebedev Institute which has been operating for 30 MeV electrons since 1948, and to Veksler's grave at Novodevitchy Cemetery.



This summer an International symposium at the Joint Institute of Nuclear Research, Dubna, and Moscow's Lebedev Physical Institute marked the 50th anniversary of the discovery of the principle of phase stability, made in the former Soviet Union by Vladimir Iosiphovich Veksler and independently by Edwin McMillan in the USA. Among those at the event were (first row, left to right) I.N. Semenushkin (Dubna), V.I. Kotov (Serpukhov), Ju. M. Ado (Serpukhov) K.P. Mysnikov (Serpukhov), A.N. Gorbunov (Lebedev Institute, Moscow), G.I. Batzckh (MRTI, Moscow) and A.M. Baldin (Dubna, Conference Chairman).

You Do Have a Choice



Vaclon Plus pumps can be customized for any application, with a choice of interchangeable pumping elements and controllers designed to meet specific ion pumping needs.

With Vaclon Plus Pumps

Vaclon Plus ion pumps are available with Diode, Noble Diode, Triode, and StarCell pumping elements, each optimized to pump specific gases. You can choose the pumping element that meets the requirements of your specific application.

Vaclon Plus pumps satisfy even the most rigorous UHV requirements, and are the most compact ion

pumps in each speed range. Vaclon Plus controllers include the MultiVac, which can power and monitor any two ion pumps simultaneously and independently, and the MiniVac, designed to cost-effectively power any ion pump. Whatever your ion pumping needs, Vaclon Plus pumps and controllers offer the complete solution.

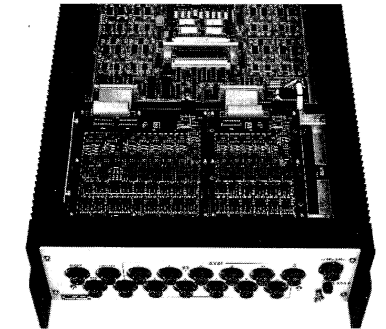
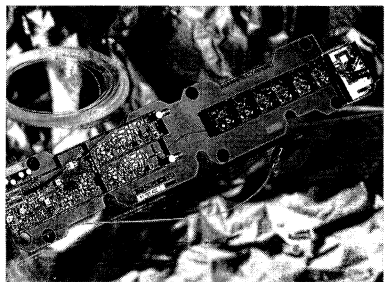
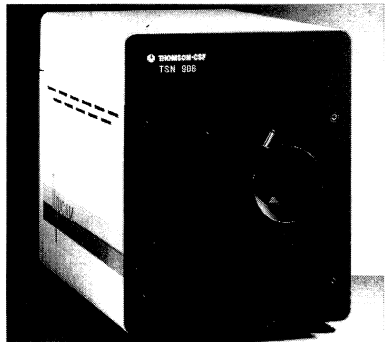
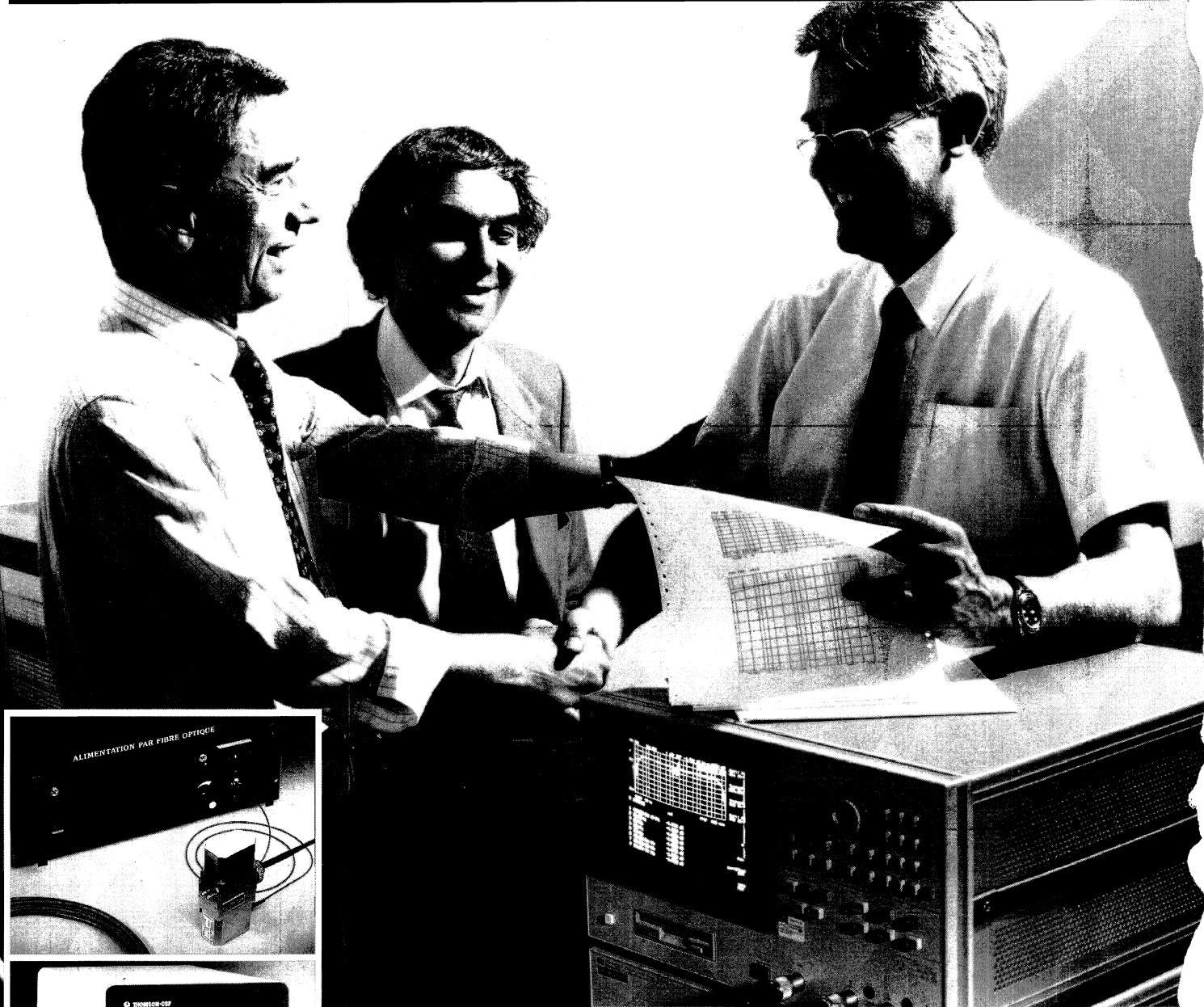
For more information please contact:

Varian SpA (European HQ)
Tel: (39) 11 - 9979 - 111
Fax: (39) 11 - 9979 - 350

Varian S.A. (France)
Tel: (1) 69 86 38 38
Fax: (1) 69 28 23 08

Varian GmbH (Germany)
Tel: (040) 6696033+34
Fax: (040) 6682282

Varian Ltd (UK)
Tel: (0932) 243 741
Fax: (0932) 228 769



Accelerating your success

Continuously defining the leading edge of performance, THOMSON-CSF has provided physicists with breakthroughs in electronic and optronic technologies for over 30 years--with particular emphasis on immunity to strong environment.

THOMSON-CSF is the leader in the measurement of ultra-fast phenomena, in single-shot or repetitive modes, with pico-second performance setting the pace.

This exclusive expertise, joined by proven industrial acumen, makes THOMSON-CSF the right partner for physicists seeking to accelerate the success of the most innovative projects.

To go further faster, contact THOMSON-CSF today.

 **THOMSON-CSF**

DIVISION RGS - DEPARTEMENT DEN