# CERN COURIER

INTERNATIONAL JOURNAL OF HIGH ENERGY PHYSICS

VOLUME 33 | 1 | JANUARY/FEBRUARY 1993

# CES PRESENTS:

## The VMDIS 8004 : a brand-new VME / VSB Display and Diagnostic Module, essential to monitor the backplane activity and measure the performance of modern VME / VSB systems

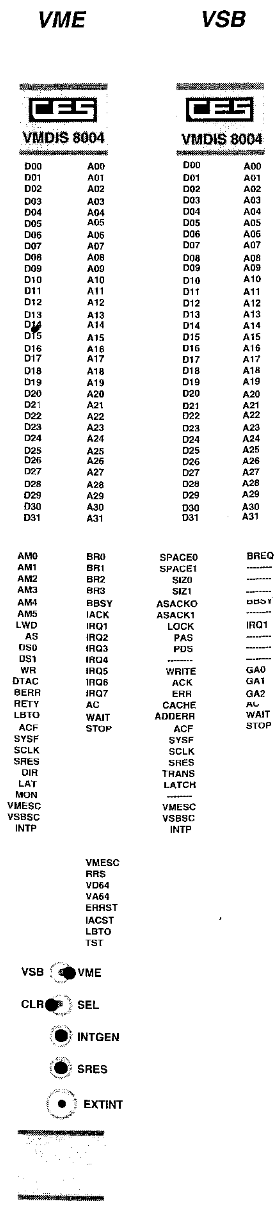
- Switch selectable VME or VSB Display
- VME mode displays :
  - Address Lines, including A64
  - Data Lines, including D64
  - Address Modifier Lines
  - Control Lines
- VSB mode displays :
  - Address Lines
  - Data Lines
  - Control Lines
- Direct, Latched or Monitor display modes
- Control and Status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

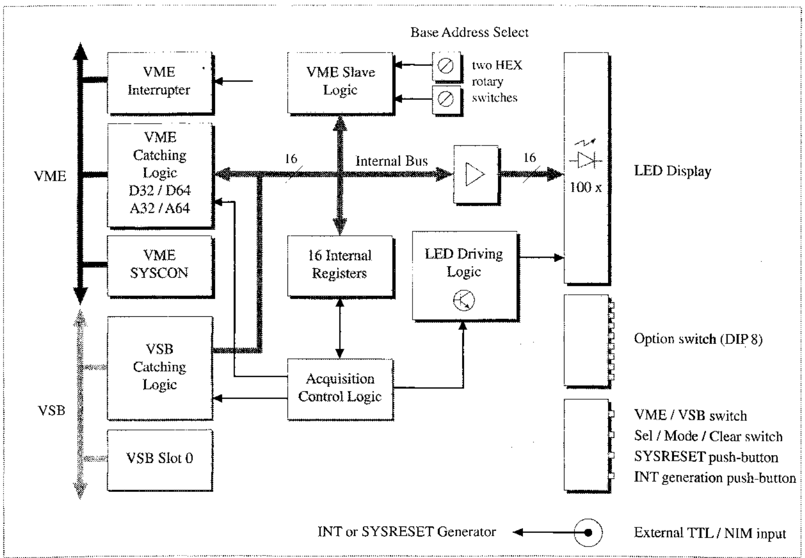
The VMDIS 8004 is an extension of the VMDIS 8003 Display and Diagnostic Module, providing additional visual and computer controlled test features. Among these features:

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

***Performance measurement section***

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




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

# CES, at the leading edge in system conception

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


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

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

## General distribution

Jacques Dallemagne
CERN, 1211 Geneva 23, Switzerland

In certain countries, copies are available on request from:

China

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

Germany

Gabriela Heessel
DESY, Notkestr. 85, 2000 Hamburg 52

Italy

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

United Kingdom

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

USA/Canada

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

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

Printed by: Drukkerij Lannoo nv
8700 Tielt, Belgium

Published by:

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

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

USA: Controlled Circulation
Postage paid at Batavia, Illinois



**Volume 33**
**No. 1**
**January/February**
**1993**


## Covering current developments in high energy physics and related fields worldwide






***Reader service form, page 29.***


*Cover photograph: View taken during scaffolding-cluttered construction of the 30-metre diameter Experimental Hall B at CEBAF, the Continuous Electron Beam Accelerator Facility now nearing completion at Newport News, Virginia. Hall B will house CLAS, the CEBAF Large Acceptance Spectrometer (Photo Frank Hoffman).*

# READER SERVICE FORM
# CERN COURIER

**JANUARY/FEBRUARY 1993**

Please send information on items circled:

**1 2 3 4 5 6 7 8 9 10**
**11 12 13 14 15 16 17 18 19 20**
**21 22 23 24 25 26**

*Please send to:*

Judy Pray, **CERN COURIER**
Gordon & Breach Science Publishers
Frankford Arsenal, Building 110
5301 Tacony Street, Box 330
Philadelphia, PA 19 137
USA

Name ________ Title ________

Employer ________ Dept. ________

Address ________

City ________ State ________ Zip ________

Telephone (   ) ________ Country ________

**ORGANISATION EUROPÉENNE POUR LA RECHERCHE NUCLÉAIRE**

**EUROPEAN ORGANIZATION FOR NUCLEAR RESEARCH**

# MOVING?

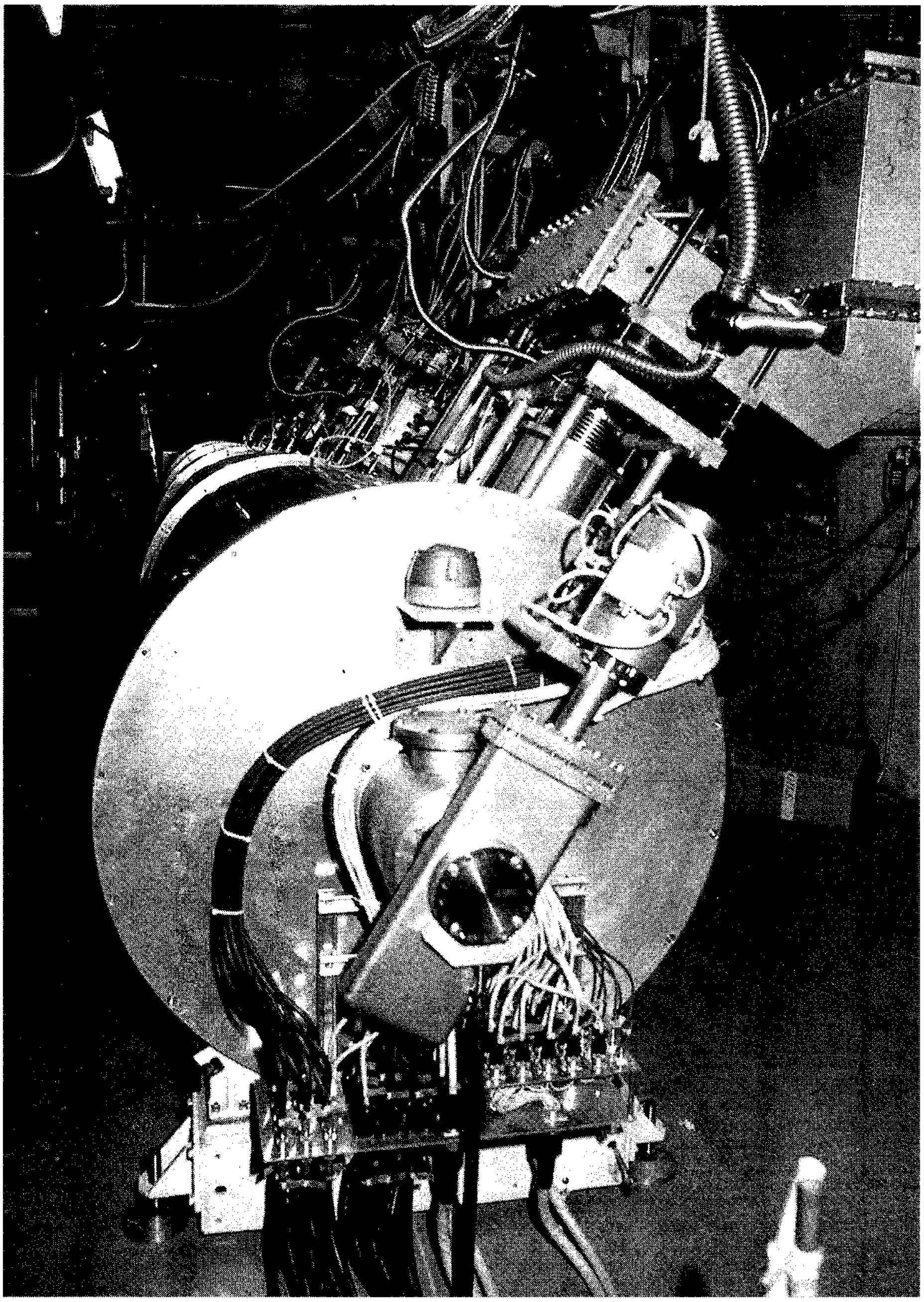
Please remember to let us know in good time. All notices of change of address must be accompanied by old and new addresses. (Include label from magazine wrapper.)

Any enquiries regarding subscriptions should be addressed to:

**Jacques DALLEMAGNE**
**CERN COURIER/CERN**
**1211 Geneva 23 Switzerland**

# LEP for twice the energy

Superconducting cavity for LEP 200 ready for high power testing.



In 1995, CERN's 27-kilometre LEP electron-positron collider should start operating for physics at considerably higher energy. Since its commissioning in 1989, the machine has been operating around 45.5 GeV per beam to give collision energies that home in on the Z particle – the electrically neutral carrier of the weak nuclear force, with a mass of 91 GeV.

The Z, discovered at CERN in 1983 by Carlo Rubbia's UA1 proton-antiproton tour de force, was for a long time a rare physics jewel. Until LEP came along, only a handful had been seen. With millions now captured by the four LEP experiments – Aleph, Delphi, L3 and Opal – the Z has become everyday physics, and the accumulated precision Z data give an incisive view inside today's Standard Model. The self-consistency of these measurements make physicists confident that the sixth ('top') quark should turn up around 150 GeV.

But the Z is only one side of the picture. For the self-consistency of the Standard Model to become really watertight, a precision fix is also needed on the W at 81 GeV, the electrically charged companion of the Z.

While the neutral Z can be produced directly in electron-positron annihilations, the charged Ws can only be produced in pairs, hence the call for higher energies at LEP. (The project is known as LEP200, but 200 GeV is acknowledged as an optimistic energy target.) To roughly double beam energy from around 45 GeV for Z physics to the level needed for W production calls for an additional 1900 Megavolts of accelerating voltage.

To drive this much accelerating power economically requires superconducting accelerating cavities, and throughout the LEP project work has been going on in the background to develop the required technology. The first unit was installed in the ring in 1990 (September 1990, page 24).

But LEP 200 is more than just the supply and installation of 192 superconducting accelerating cavities. According to LEP200 project leader Carlo Wyss, work on the cavities represents only 22% of the total budget. Among the other LEP200 activities, cryogenics, radiofrequency power and controls, civil engineering, electricity distribution and cooling equipment together represent a significant fraction of the total effort invested in LEP.

Manufacture of the superconducting cavities to precise specifications is an exacting task for industry. Supply is running some eight months behind the very ambitious original schedule, but Wyss, Philippe Bernard and their team are confident that some of this delay can be clawed back. Acceptance tests are also encouraging, practically every unit comfortably exceeding the stipulated resonance quality (Q) and accelerating voltage requirements.

Tests of the prototype cavities mounted in situ, together with all their complicated radiofrequency plumbing and attendant cooling, have identified and understood problems pulling performance 20% below its nominal value.

After implementing the necessary improvements and with increased experience of mastering the tricky business of conditioning radiofrequency superconducting equipment, the LEP200 team is confident that procedures will soon be found to ensure optimal performance.

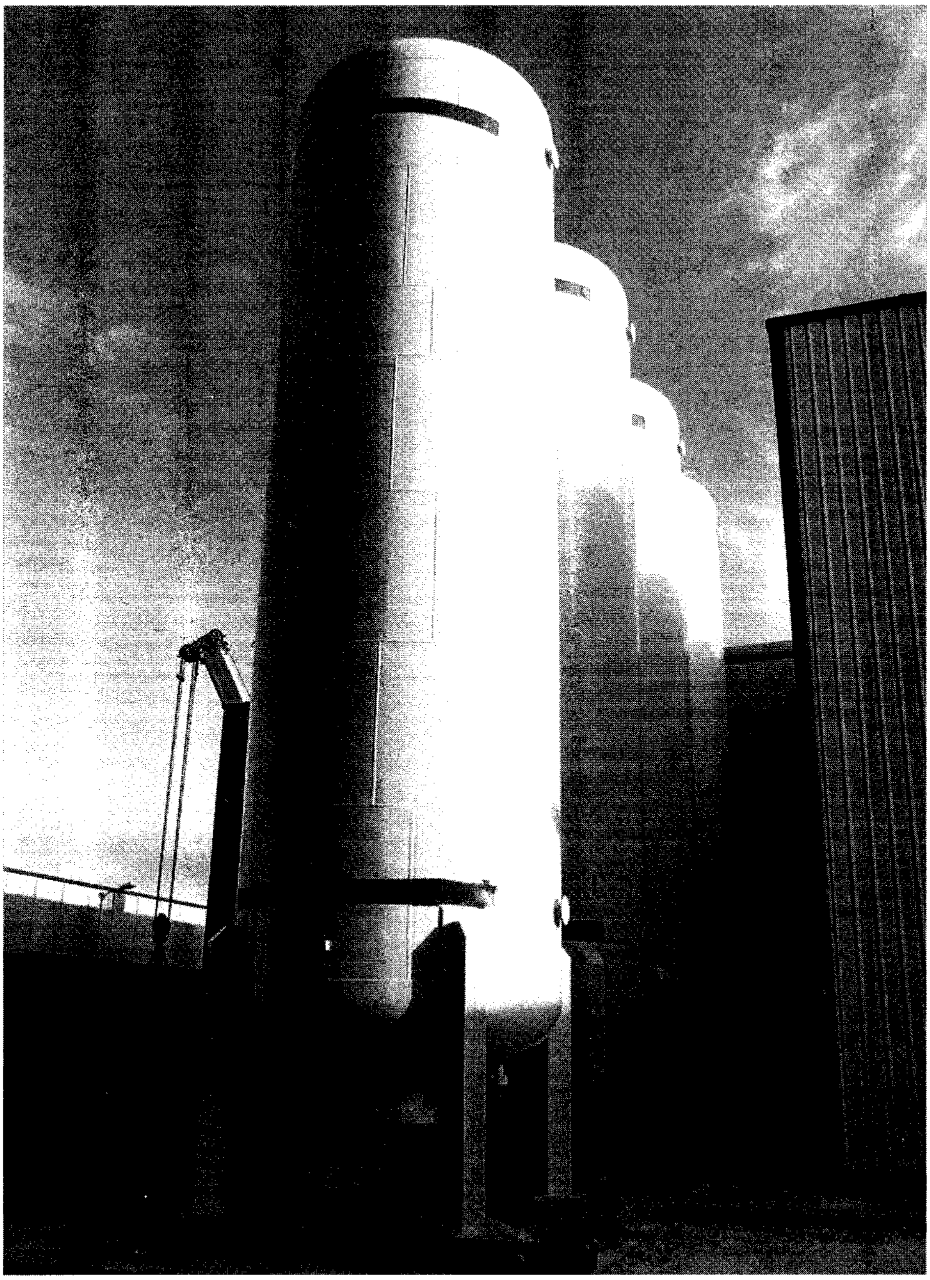
So far, LEP200 cryogenics have been confined to one site, Point 2, in the ring, but next year superconducting cavities should make an appearance at Point 6, while new twin 230-metre klystron galleries will be equipped at Points 4 and 8.

When complete, LEP200's cryogenic system, with four 12kW refrigeration plants, will be considerable, about half as big again as that installed at the HERA electron-proton collider at DESY, Hamburg, with its totally superconducting proton ring. The LEP200 cryogenic plant includes liquid helium transfer lines and high pressure helium storage vessels supplied by Russia.

As well as the cavities and the means to cool and drive them, LEP 200 also calls for considerable upgrades in LEP vacuum system, power converters, separators, etc. All this work is carefully phased so that the full complement of superconducting cavities should be installed and tested late in 1994, ready for physics operation in 1995.

With LEP finally running at its full energy, its experiments should reap their first samples of W pairs. However while LEP Z samples are counted in millions, Ws, produced off resonance, will be counted in thousands. Machine performance will therefore be critical, and ways of improving the luminosity are being looked at.

*Liquid helium reservoirs from Russia have been installed as part of LEP 200 cryogenics.*



The W pairs at LEP will be formed via an intermediate invisible 'virtual' Z. However the W production will still bear the stamp of this intermediate particle, providing valuable information about the coupling of a Z to a W pair, another incisive test for the Standard Model.

If the sixth quark is found at Fermilab's proton-antiproton collider, and if the precision on the W mass could attain ±50 MeV at LEP, then the veil could at last start to be lifted from the Higgs particles, the mysterious symmetry breaking mechanism at the heart of the electroweak unification picture.

## LEP at 90°

With twice as many Z particles logged this year, the performance of CERN's LEP electron-positron collider continues to improve. Paradoxically, the improvement would have been even better had it not been for teething problems with new operating conditions which will eventually boost performance still higher.

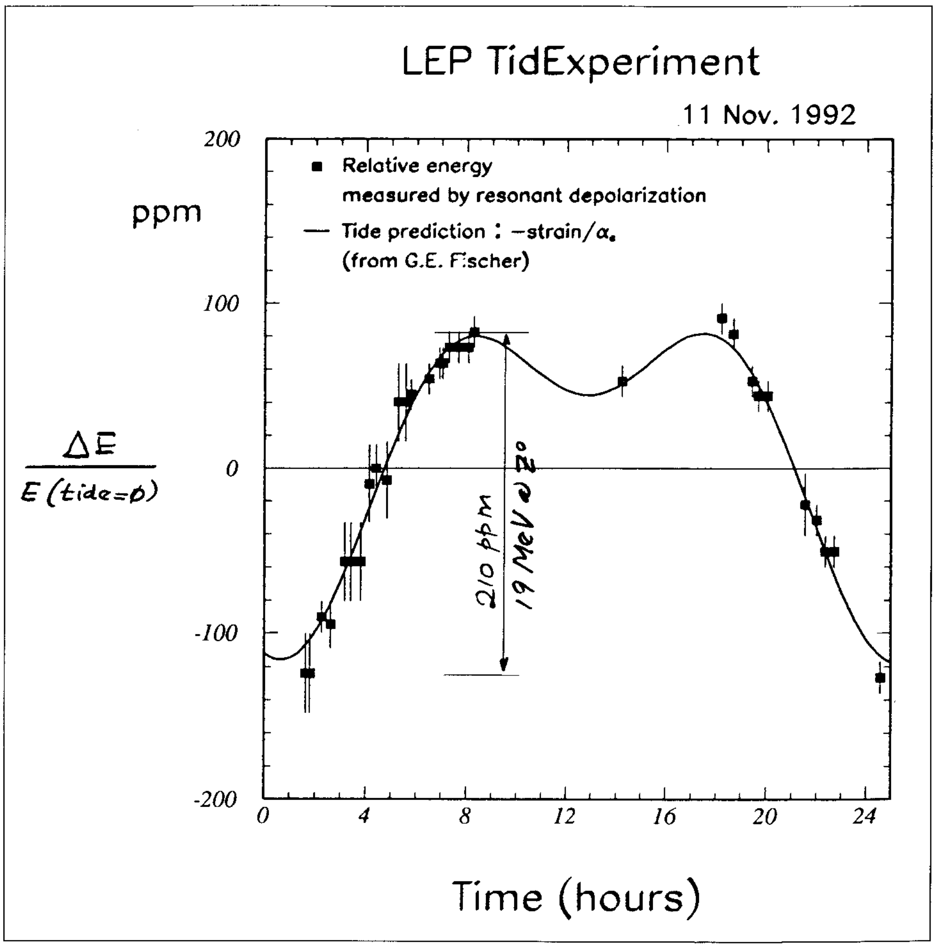
Now solidly established, these new conditions, notably the 90° (instead of the previous 60°) phase for transverse betatron oscillations, and the 'pretzel' scheme for eight bunches per beam instead of four (October, page 17), first had to be assimilated, and it took a few weeks before the LEP operating crews could add them to their full repertoire.

Collision performance (measured by 'luminosity') continues to improve. Although in principle LEP has yet to deliver its 'design' luminosity of $1.3 \times 10^{31}$ per sq cm per s at any one time, its best performance to date is not far off – $1.1 \times 10^{31}$. The crews have become very skilled at optimizing conditions during each beam coast, with continual careful grooming of the beams ensuring high collision rates. This, together with improved performance at the four detectors – Aleph, Delphi, L3, and Opal – have led to average efficiency increasing to 57% from 44% in 1991, so that the luminosity delivered over a day has exceeded what could have been expected initially, says Steve Myers.

The main LEP limitations, as measured by the machine's beam current, are still the transverse coupling instabilities inherent for single beam operation, compounded with unwelcome beam-beam interactions once electron and positron beams are in the ring together.

Some of the former is caused by the inevitable transverse impedance of the copper radiofrequency cavities used to accelerate the LEP beams. With superconducting radiofrequency cavities now being installed as part of the LEP200 programme to push the

*High tide at CERN. Due to the moon's gravity, the circumference of CERN's LEP electron-positron collider varies by about a millimetre over 27 kilometres. These tiny effects are amplified by LEP, producing detectable changes in the beam energy, which is measured to 20 parts in a million using polarized (spin-oriented) beams*



beam energy from 45 GeV towards 90 GeV (see page 1), some conventional cavities could eventually become redundant. Removing them should improve single beam conditions, at the same time liberating valuable additional klystron power for LEP200. Increasing the LEP injection energy from the current 20 GeV level delivered by the SPS should also help.

Beam-beam limitations are ascribed to insufficient beam separation as the beams get larger, to subtle differences between electron and positron behaviour, and possible orbit influence from the electrostatic separators. Beam current could also be pushed higher by increasing the beam emittance, but this would also increase the level of unwelcome background photons seen by the detectors.

The 'pretzel' scheme for eight bunch operation was first used for physics in August, but became routine in October, hopefully for the remainder of LEP's career. In principle doubling the effective electron-positron collision rate, its introduction briefly slowed the Z scoring rate as the crews had to learn new tricks, but the break-even point was soon quickly passed.

One unwelcome detail is that electron-positron differences are accentuated in pretzel mode, and additional sextupoles are being installed to compensate. Eight-bunch operation could be further optimized if it became standard right through the complicated LEP injector chain.

One disappointment this year has been the absence of polarized beams from the 90° optics. Significant polarization (spin orientation) had been seen last year (November 1991, page 12) using the old 60° optics, and opened the door to valuable precision measurements of the beam energy. To retain this capability, a 90°/60° horizontal/vertical split could be tried, and a recent pretzel test gave encouraging results.

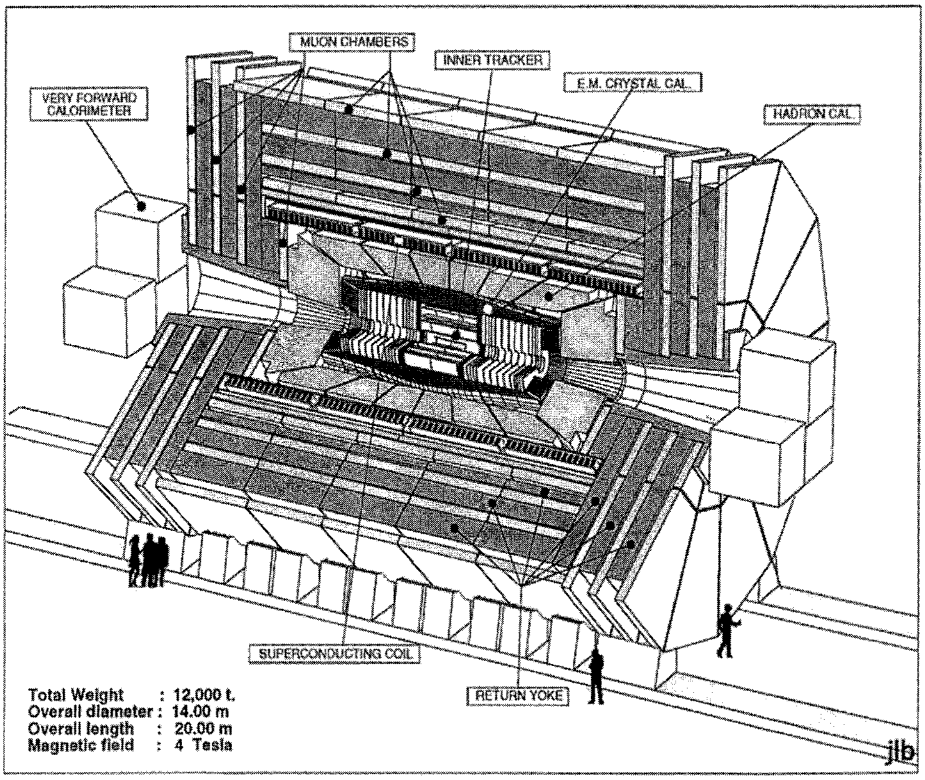
# Letters of intent

Thursday 5 November was another major milestone en route to the establishment of the experimental programme for CERN's LHC proton-proton collider to be built in the 27-kilometre LEP tunnel.

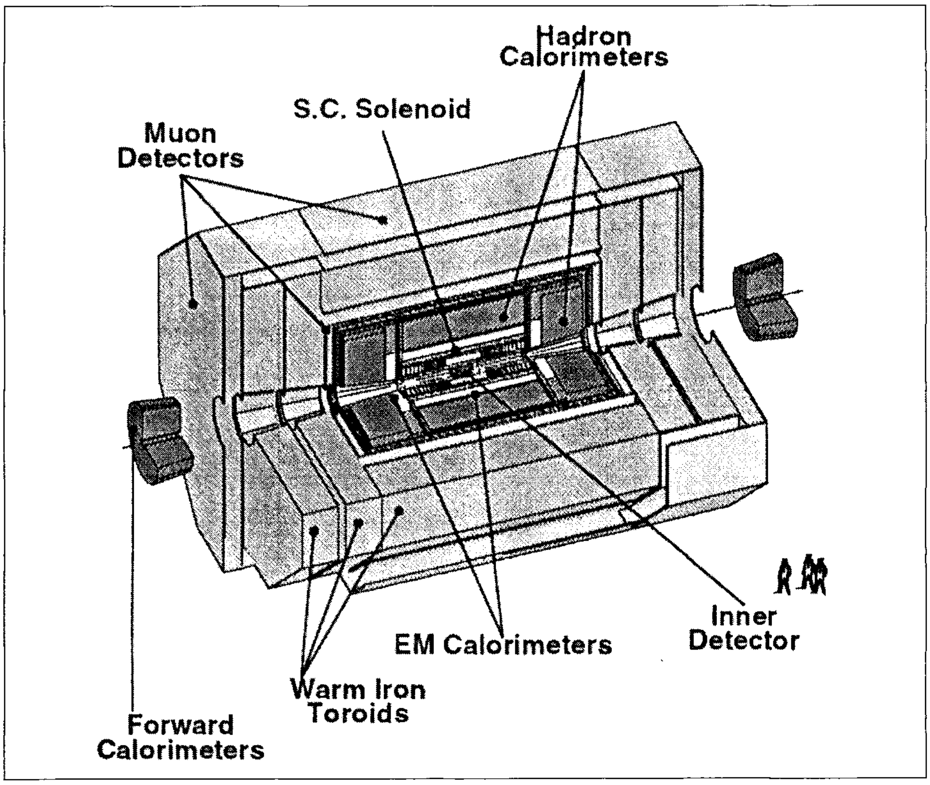
After initial discussions of 'Expressions of Interest' at the specially-arranged meeting at Evian-les-Bains, France, earlier this year (May, page 1), three Letters of Intent have emerged, together involving nearly 2000 physicists from research institutes all over the world. As well as these researchers listed on the documents, the plans in fact involve many additional technical specialists who work behind the scenes.

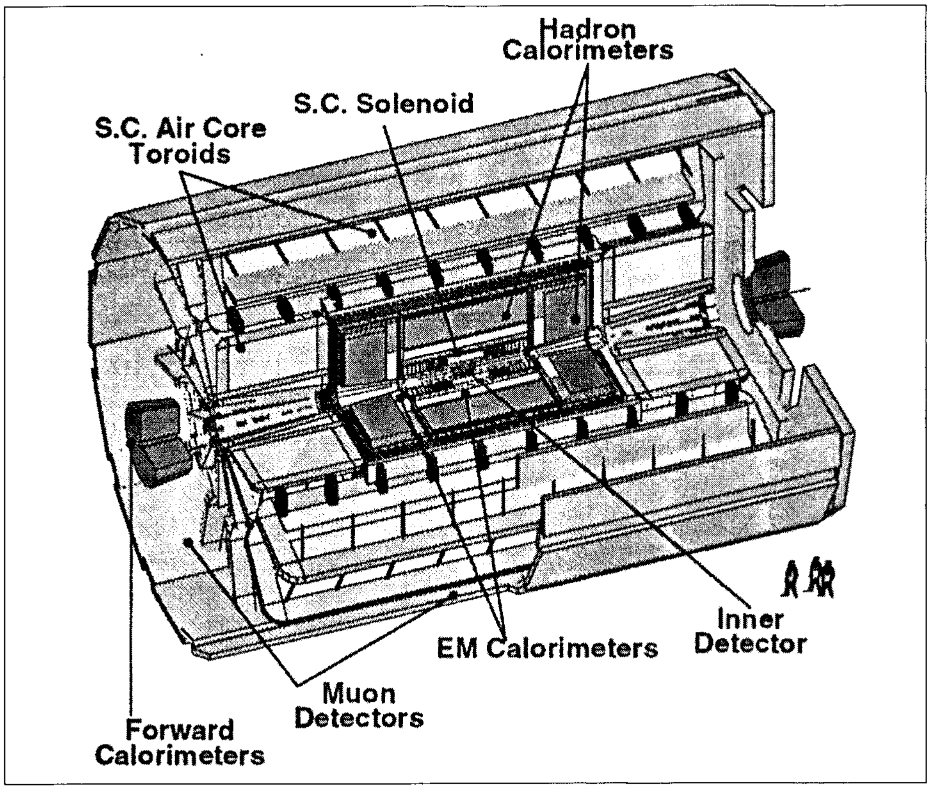
It was a historic moment as these three detector proposals were aired at the first open meeting of the new LHC Experiments Committee. CERN's main auditorium and a large overflow room receiving relayed video pictures were both packed.

*The compact CMS design*



*The ATLAS scheme for an LHC detector has two options: a conventional iron-core magnet (top), and a superconducting air-core (below).*




From these three schemes – ATLAS, CMS and L3P – and the first reactions to their letters of intent, eventually two projects will emerge, for which full technical proposals will be prepared, including construction plans and credible costings.

In this early phase exact specification of the detector elements is in many cases left open, pending the outcome of the vigorous ongoing detector R&D programme for generic systems to handle LHC extremely high event rates. The detector plans also reflect the potential to carry out unique and ambitious physics with initial LHC luminosities of about $10^{32}$ per sq cm per s before the machine is cranked up to its design goal above $10^{34}$.

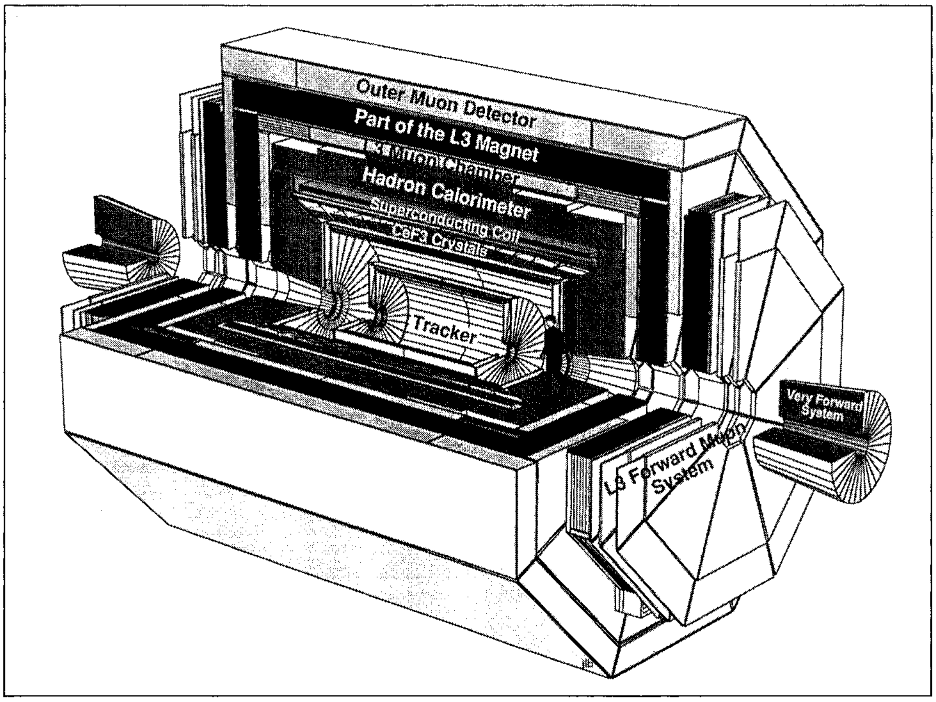
ATLAS, described at the CERN meeting by Peter Jenni, is a merger between the ASCOT and EAGLE schemes launched earlier this year at Evian and brings together some 850 researchers from 88 institutes in 24 countries. The aim is to exploit the full LHC discovery potential, with full coverage of photon, electron, muon and hadron jets, together with 'missing energy' indicative of invisible particle such as neutrinos, over a wide range of LHC luminosities, and with 'robust' muon and electron coverage at the very highest collision rates.

ATLAS proposes an outer 26 metre-long toroid magnet for muon measurements, with an inner 2T superconducting solenoid. The former could be superconducting air core or conventional iron core, or a combination of the two, with a superconducting barrel and warm iron for the end-cap regions.

The toroidal magnet muon detector would allow triggering and identification outside all calorimetry, with substantial thicknesses of absorber, without using the inner detector. The

*13 Circle advertisement number on reader service form*

*The L3P scheme would inherit part of the infrastructure from the existing L3 detector at LEP.*




superconducting solution would provide better physics capability.

Inside the muon system, calorimetry would use a highly granular lead/liquid argon approach for the electromagnetic part, and iron absorbers for the hadron part, where the active medium could be liquid argon or scintillating tiles or fibres.

At the heart of the detector, the interaction region would be surrounded by silicon and gallium arsenide microstrip and pixel detectors to provide a precision initial track segment, with supplementary instrumentation farther out for the bulk of pattern recognition, tracking, momentum measurement and identification.

While ATLAS has several options open at this stage, the vigorous ongoing R&D programme should result in many of these positions being closed by the time the full technical proposal is presented.

CMS – Compact Muon Solenoid – includes over 400 collaborators from some 60 institutes in 23 countries, including a sizeable Russian contingent and representation from all the Baltic states. As well as proton-proton collisions, CMS is also designed to look at aspects of the alternative LHC diet of heavy ion collisions.

Spokesman Michel Della Negra pointed out how the CMS design for a compact, minimal cost detector starts with the magnet, which influences the rest of the design. The 14-metre CMS superconducting solenoid would provide 4T inside a radius of 2.9 metres. Muon momentum would be measured several times, both outside the coil and in the inner tracking volume. The magnet would be covered with several planes of drift chambers for muon identification and measurement.

Inside the magnet, the powerful field would give high momentum precision. Solid state and gas microstrip techniques would be able to provide the required level of tracking performance. Calorimetry would be mainly inside the magnet coil, with the electromagnetic part using either cerium fluoride or a lead/scintillator 'Shashlik' design being developed in Russia, while hadron energy would be handled by copper absorber with scintillating tiles.

L3P – Lepton and Photon Precision Physics – is the LHC reincarnation of the L3 experiment at the LEP electron-positron collider, and nearly all the contributors to the L3P letter of intent have participated in L3.

L3P is designed to complement other detectors, both at LHC and at the SSC Superconducting Supercollider in the US. Sam Ting's presentation at CERN recalled past and sometimes painful experience with experiments using high intensity beams, and went on to explain how detectors relatively far from the target/interaction point with a lot of magnetic power could provide an optimal solution.

L3P would be phased with LHC progress. Detector R&D work has benefited from work in the framework of CERN's detector R&D programme.

The detector, at Point 2 in the ring, would use part of the L3 infrastructure, muon chambers and magnet frame. With its goal of precision electron, muon and photon measurements, elements are placed far from the beam intersection. Most inner central tracking, with proportional chambers, drift tubes and gas microstrip detectors would be at least 1.65 m from the proton beam. The entire tracker could be removed and a new one fitted for specialized LHC research topics.

Outside the tracker will be the electromagnetic calorimeter, made of cerium fluoride crystals. Like the BGO crystals used in L3, these would include a significant Chinese effort.

Moving away from the beam, the

# Physics monitor

next element would be a superconducting solenoid, where several designs are under study. The hadron calorimeter with iron absorber and gas active medium would surround the magnet.

Muons would be measured by an outer layer of drift tubes, by the existing L3 muon chambers outside the hadron calorimeter and by the central tracker, with its ultimate resolution of 3.6 parts in a thousand.

With the LHC Experiments Committee now in business, the overall goal is to present a fairly detailed description of the LHC experimental programme, including machine, detectors and the relation to the rest of CERN's experimental programme, to CERN's governing body, the Council, at the end of 1993. Council would then be in a position to start the approval procedure for the whole LHC project. However the broad outline should be clear enough for a preliminary report on the emerging plans for the experimental programme early this year.

## DPF Big One

At its latest venue at Fermilab from 10-14 November, the American Physical Society's Division of Particles and Fields meeting entered a new dimension. These regular meetings, which allow younger researchers to communicate with their peers, have been gaining popularity over the years (this was the seventh in the series), but nobody had expected almost a thousand participants and nearly 500 requests to give talks.

Thus Fermilab's 800-seat auditorium had to be supplemented with another room with a video hookup, while the parallel sessions were organized into nine bewildering streams covering fourteen major physics topics.

With the conventionality of the Standard Model virtually unchallenged, physics does not move fast these days. While most of the physics results had already been covered in principle at the International Conference on High Energy Physics held in Dallas in August (October, page 1), the Fermilab DPF meeting had a very different atmosphere.

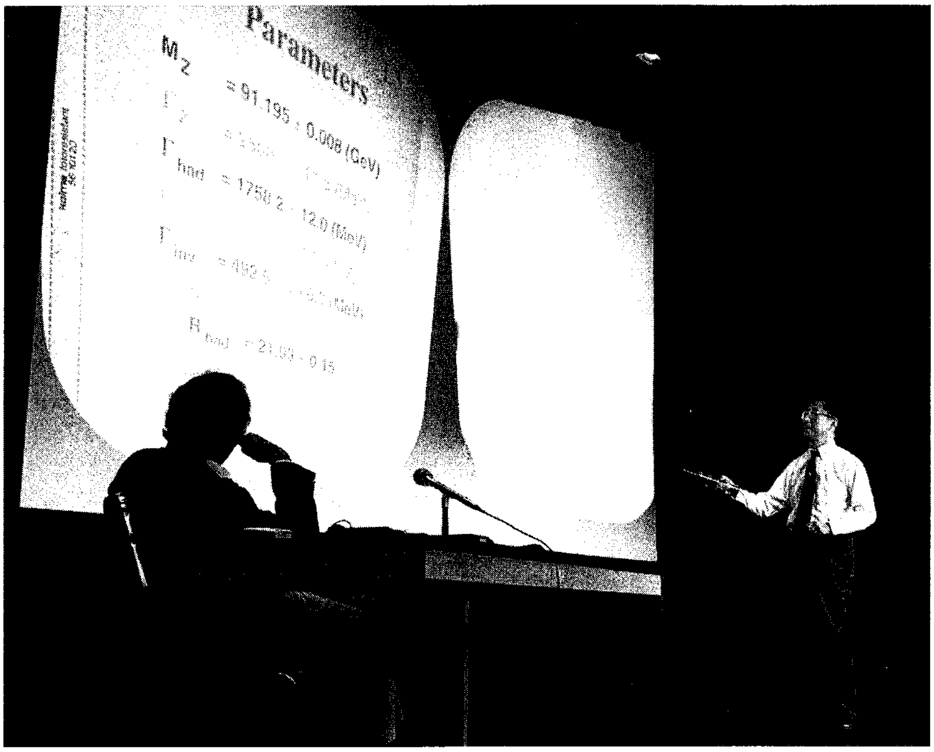
Major international meetings like Dallas attract big names from far and wide, and it is difficult in such an august atmosphere for young researchers to find a receptive audience. This was not the case at the DPF parallel sessions. The meeting also adopted a novel approach, with the parallels sandwiched between an initial day of plenaries to set the scene, and a final day of summaries.

With the whole world waiting for the sixth ('top') quark to be discovered at Fermilab's Tevatron proton-antiproton collider, the meeting began with updates from Avi Yagil and Ronald Madaras from the big detectors, CDF and D0 respectively. Although rumours flew thick and fast, the Tevatron has not yet reached the top, although Yagil could show one intriguing event of a type expected from the heaviest quark.

Frank Sciulli of Columbia presented initial results from the HERA electron-proton collider at DESY Ham-

*At Fermilab in November, the American Physical Society's Division of Particles and Fields meeting attracted about a thousand scientists.*

*At the Fermilab DPF meeting, Sam Ting summarizes the findings of the experiments at CERN's LEP electron-positron collider. (Photo Reidar Hahn)*




burg. These initial snapshots of an intriguing new experimental conditions have been aired several times already (December 1992, page 11), but Sciulli could show HERA's first charged current event.

The physics from CERN's LEP electron-positron collider was described by Sam Ting of MIT, abandoning temporarily his traditional role as spokesman of the LEP L3 experiment to do an excellent job in assembling the contributions from Aleph, Delphi, and Opal as well.

After a well-balanced presentation of LEP's considerable contribution to orthodox electroweak and quark physics, Ting could afford the luxury of pointing to possibly unorthodox LEP Z decays producing a pair of leptons (electrons or muons) accompanied by two high energy photons. Curiously, four such decays from L3 and now two from Delphi report photon pairs carrying about 60 GeV of energy. The events were subsequently described in detail in the parallel sessions by Boleslaw Wyslouch of MIT for L3 and Jesus Marco of Santander for Delphi, who were carefully questioned (see page 9). These LEP photon pairs quickly became the meeting's talking point.

Charles Baltay of Yale had a sample of 10,000 Zs produced using polarized beams at Stanford's SLC linear collider and collected by the SLD detector. Knowing the spin orientation of the decaying Zs makes for a particularly rich data sample, which will be augmented next year when the SLC resumes running.

Speaking on the high energy physics-astrophysics connection, Daniel Sinclair of Michigan concentrated on high energy gamma sources and on atmospheric neutrinos.

High energy gamma rays from massive stellar synchrotron radiation emission were first seen in secret data from satellites looking for nuclear tests. It was soon established that the bursts came from outside the solar system but nevertheless the data still stayed secret for a while. However sightings began to accumulate and with NASA's GRO satellite in orbit, gamma astronomy has now become big business (July 1992, page 20).

For atmospheric neutrinos, Sinclair underlined the discrepancy between muon-type and electron-type signals seen in big underground detectors (September 1992, page 4). However the traditional difficulty of compiling solid neutrino data suggests other types of experiment are needed for to complement the traditional water Cerenkov readings.

On non-accelerator experiments, John Wilkerson of Los Alamos read the death sentence for the 17 keV neutrino, explaining how pioneer 17 keV neutrino 'findings' had now been explained by multiple scattering. This was covered in detail later in the parallels by Andrew Hime, who pointed out that some 17 keV results nevertheless still stand. In the same session, David Caldwell of Santa Barbara underlined the difficulty of these neutrino measurements – 'everybody has found this to be a difficult business'.

Speaking on accelerator developments, Maury Tigner of Cornell explained how the initial 1980s euphoria on possible new accelerator developments has largely evaporated, with the emphasis now more on traditional approaches to new energy and luminosity frontiers. For detectors, Murdock Gilchriese of Berkeley remarked how luminosity ceilings have been lifted, with $10^{33}$ apparently no longer the problem it appeared ten years ago.

The final day's plenary sessions started with coverage of the sacro-

Former Fermilab Director Leon Lederman called for improved public awareness of particle physics.
(Photo Reidar Hahn)

sanct Standard Model, with Keith Ellis of Fermilab in the quark corner, and William Marciano of Brookhaven as the electroweak contender. Ellis highlighted the consistent set of measurements now in place for the quark/gluon content of hadrons (structure functions), and how the kinematic coverage of these measurements is being extended with the advent of the HERA proton-electron collider at DESY, Hamburg.

With electroweak measurements appearing to confine where the sixth ('top') quark will turn up, Marciano warned against being too influenced by central 'predictions' for the top. Whatever its mass turns out to be, it will be much heavier than anything else, and this needs to be explained.

John Cumalat of Colorado (charm), David Cassel of Cornell (bottom) and Walter Toki of SLAC (tau leptons) summarized the wealth of detailed data now building up on flavour physics. The final afternoon turned to theory, with Stephen Sharpe of the University of Washington describing the aims and achievements of lattice theory, while David Gross of Princeton covered recent theoretical developments, including attempts to explain the existence of quantum chromodynamics.

Winding up the meeting, Leon Lederman was in fine form. After surveying the continued intactness of the Standard Model, he turned to the current level of support for high energy physics in the US. He deplored the general public's lack of information on science in general and high energy physics in particular, which according to Lederman translates into ignorance and apathy at congressional level. This should be countered, he urged, by well defined and thought out information campaigns organized by national science societies.

The meeting was organized by physicists from Fermilab and local universities. Chairmen of the local organizing committee were Rajendran Raja and John Yoh from Fermilab.

## CERN
## A tale of two photons

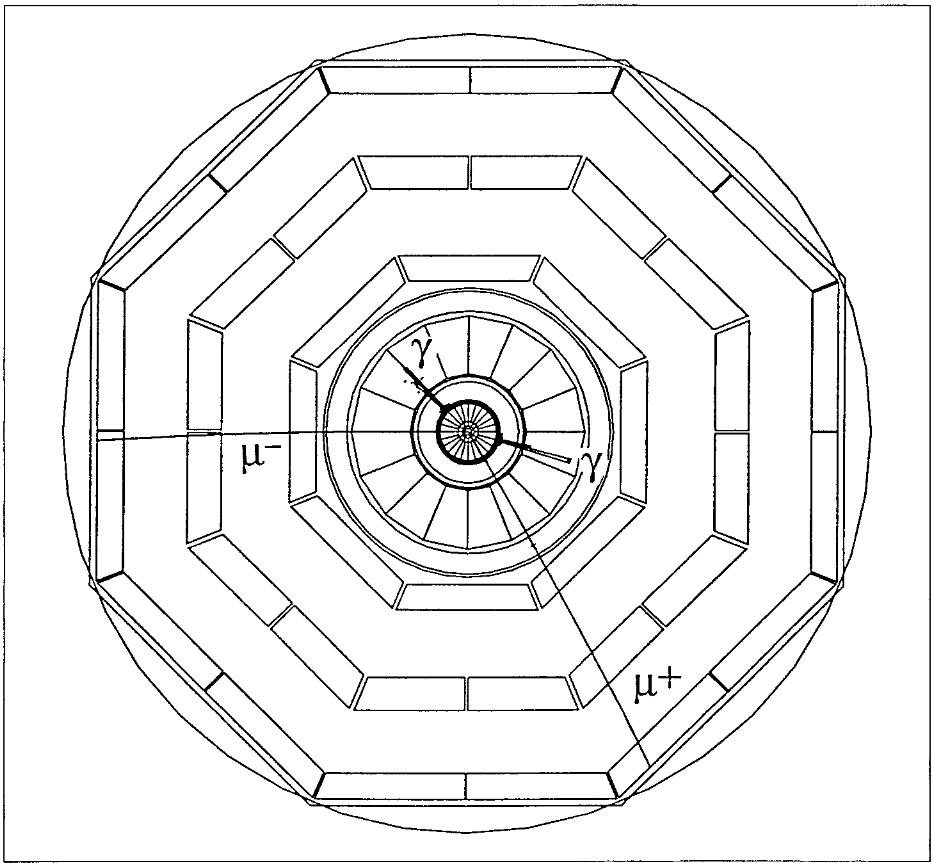
When precision data from the several million Zs carefully collected over several years by the four big experiments – Aleph, Delphi, L3 and Opal – at CERN's LEP electron-positron collider have otherwise consistently underlined conventional physics, a hint of something unexplained quickly packs the seminar rooms.

In 1991, the L3 experiment turned up two examples of Z decays producing a muon pair accompanied by a widely separated pair of high energy photons, with the photon pair in each case taking some 60 GeV of energy (actually 58.8 and 59.0 GeV). Nothing to get excited about at the time, but ongoing data analysis tuned into this channel. This year two more events turned up, one again with a muon pair accompanied by a 60 GeV photon pair, the other with an electron (electron-positron) pair and a 62 GeV photon pair.

At first L3 preferred to keep this quiet, and the news was not announced at the major international meeting in Dallas last August.

The first public announcement of the four unexplained events (out of a total of 1.6 million Z decays) came in a LEP Experiments Committee session at CERN in October.

At the same session, Delphi spokesman Ugo Amaldi publicly




*One of the unusual events seen by the L3 experiment at CERN's LEP electron-positron collider, producing a 12.7 GeV positive muon, a 16.9 GeV negative muon, and a pair of photons carrying between them 59 GeV.*

revealed that his experiment had recently turned up two similar events, while a few weeks later the continued analysis of Delphi data found the first example of an event with a 60 GeV photon pair accompanied by two confined 'jets' of hadrons. L3 sees 60 GeV photon pairs accompanied only by electrons or muons.

The L3 analysis of radiative background suggests that four events grouped round an energy of 60 GeV for the photon pair is highly unlikely, but spokesman Sam Ting says that a radiative fluctuation 'cannot be ruled out'. At the same time, the decay of some unknown heavy particle cannot be ruled out either. 'More data is needed,' he concludes. So far, Aleph and Opal have seen no excess of any such events. All four experiments have comparable Z samples.

While such a photon pair is one expected fingerprint of a Higgs particle, responsible for the symmetry breaking at the heart of the electroweak mechanism, a Higgs should also decay in other ways. These are not seen.

Intriguingly, the AMY experiment looking at electron-positron annihilation at the TRISTAN collider at the Japanese KEK Laboratory, which scans lower energies than LEP, several years ago saw a small fluctuation in hadron production at a single energy very close to 60 GeV.

## Gaps in understanding

A three-day workshop held at Fermilab last year highlighted what many physicists consider to be a new frontier area in strong interaction physics, loosely referred to as 'small-x ', involving constituents which carry only a small fraction of the total proton momentum. But the workshop demonstrated how this generally involves a wider range of topics, blurring the traditional distinction between 'hard' and 'soft' aspects of quark behaviour at high energy.

The ideas have evolved out of a combination of theoretical progress and a search for new experimental opportunities. The first workshop devoted exclusively to small-x physics was held at Hamburg and focussed on physics at the HERA electron-proton collider (July 1990, page 23). The focus of the latest (Argonne/Fermilab sponsored) meeting was the physics that could be explored at Fermilab's Tevatron proton-antiproton collider.

The success of Quantum Chromodynamics (QCD) as a theory of quark processes tends to hide the fact that its domain of applicability is limited – there are still many everyday strong interaction phenomena that cannot be explained in terms of interacting quarks and gluons.

The standard picture of a high momentum proton includes three 'valence' quarks plus an indeterminate number of evanescent quark-antiquark pairs (the 'sea') and gluons, each carrying a fraction x of the total momentum of the proton. The x distribution of the quarks and gluons – the 'structure function' – changes or 'evolves' as the momentum of the probing particle increases (i.e. its wavelength decreases). The

# LA FRANCE AU CERN
## 30 MARS - 2 AVRIL 1993

**ALCATEL CIT**
Division Technologie du Vide
98 al. de Brogny
F-74000 Annecy
Tél. : (33) 50 65 77 77
Fax : (33) 50 65 77 89

Please contact :
Mr della Faille

Pompes turbomoléculaires.
Pompes moléculaires.
Pompes hybrides.
Pompes sèches type " Drytel ".

*Turbomolecular pumps.*
*Molecular pumps.*
*Hybrid pumps.*
*Dry pump type "Drytel".*

---

**ATEA**
Société Atlantique de
Techniques Avancées
BP 225
F-44472 Carquefou Cedex
Tél. : (33) 40 30 36 02
Fax : (33) 40 30 16 53

Please contact :
Mr Lecuyer

Cavités supraconductrices en niobium.
Antennes RF pour chauffage plasma.
Soudage par FE de métaux exotiques.

*Niobium superconducting cavities.*
*RF antennae for plasma heating.*
*Electron beam welding of special materials.*

---

**CELDUC RELAIS**
F-42290 Sorbiers
Tél. : (33) 77 53 39 55
Fax : (33) 77 53 85 51
Télex : 330872 F

Please contact :
Mr Van Wijck

Sur catalogue, mais aussi sur cahier des charges, Celduc propose :
Les ampoules reed, à partir desquelles sont élaborés les relais reed, et les contacts de proximité.
Les relais statiques pouvant commuter de fortes puissances sans pièce en mouvement, sans parasite généré, avec une durée de vie illimitée.
Les interfaces d'automatismes traitant les problèmes d'acquisition et de commande à distance.
Les transformateurs de puissance.

*From its catalogue of standard products or according to customers specifications, the celduc group offers :*
*Reed switches which are used in reed relays, and proximity contacts.*
*Solid state relays able to switch high power without any moving parts, without generating interference and with an unlimited lifetime.*
*Serial interface systems dealing with data acquisition and remote control problems.*
*Power transformers.*

---

**CONVERGIE**
53, r du Cdt Rolland
F-93350 Le Bourget
Tél. : (33) 1 48 38 92 77
Fax : (33) 1 48 36 13 46
Télex : 233703 F

Please contact :
Mr Le Fevre

Alimentations synthétisées.
Alimentations de Laboratoire et Charges Electroniques.
Alimentations d'Equipement industriels et civils durcis.
Microconvertisseurs et Modules Convertisseurs.

*Synthetized Power Supplies.*
*Power Supplies for Laboratory and dynamic loads.*
*Industrial and Commercial grade Power Supplies.*
*DC/DC and MICRO DC/DC Converters.*

---

**CORECI S.A.**
2/4 rue Jean Desparmet
F-69008 Lyon
Tél. : (33) 78 77 03 00
Fax : (33) 78 77 03 20
Télex : 300314 F

Please contact :
Mr Ryan

Capteurs d'humidité, de température et de gaz.
Transmetteurs de mesure.
Régulateurs, Indicateurs, Enregistreurs.
Systèmes de surveillance.
Gradateurs de puissance thyristors.

*Humidity, temperature and gas sensors.*
*Measurement transmitters.*
*Controllers, Indicators, Recorders.*
*Monitoring appliances.*
*Thyristor power controllers.*

---

**CRYOMAT sarl**
B.P. 36
F-77720 Mormant
Tél. : (33) 1 64 06 59 04
Fax : (33) 1 64 06 59 05

Please contact :
Mr Heriche

Superisolation : Polyester 3,5 µ aluminisé et espaceur spécifique monofilament.
Magnétomètre - Susceptomètre MANICS, mod. DSM 8 permettant aussi des mesures d'anisotropie, totalement automatisé.
Mesures de températures CRISTEL et capteurs cryogéniques.

*PLATEST MLI superinsulation, 3.5 µ reflector and special monofilament spacer.*
*MANICS fully automatic DSM-8 Magnetometer - Susceptometer with anisotropy measurements.*
*CRISTEL Instruments for measurements. Cryogenic sensors.*

**SAPHYMO-PHY**
5, rue du Théâtre
F-91884 Massy
Tél. : (33) 1 60 13 14 13
Fax : (33) 1 60 13 14 10

Please contact :
Mr Moreau

Dosimètres électroniques et systèmes de dosimétrie individuels.
Systèmes pour le contrôle radiologique des accès de site nucléaire.
Balises pour les mesures dans l'environnement.
Radiamètres, Polyradiamètres.

*Electronic Dosimeters and individual dosimetry systems.*
*Radiological control systems for nuclear sites access.*
*Beacons for environmental measurements.*
*Radiameters.*

---

SCAIME
FORCE / PESAGE

**SCAIME**
Le Bois de Juvigny
B.P. 501
F-74105 Annemasse
Tél. : (33) 50 87 78 64
Fax : (33) 50 87 79 46
Télex : 309596 F

Please contact :
Mr Beroud

SCAIME propose une gamme complète de capteurs de pesage ou de force à jauges de contrainte (étendues de mesure : 30 g à 1000 t). Ces capteurs sont utilisés pour le pesage commercial homologué ou la mesure de force en milieu industriel ou en laboratoire (erreur combinée : 0,008 % à 0,05 %, suivant modèle).

*SCAIME offers a complete range of strain gages load cells (nominal capacities from 30 g to 1000 tons). Those load cells are used for approved commercial weighing or force measures in industrial set or in laboratory (combined error : 0,008 % to 0,05 % of full scale, depending on model).*

---

SDMS
*chaudronnerie blanche*

**SDMS**
B.P. 4
F-38160 Saint Romans
Tél. : (33) 76 64 99 99
Fax : (33) 76 64 99 98
Télex : 320190 F

Please contact :
Mr Gaillard

Réalisation de plusieurs milliers d'enceintes à vide.
Canalisations cryogéniques.
Chambres de simulation spatiale.
Réservoirs sous pression.
Conteneurs.

*Manufacturing of several thousand vacuum vessels.*
*Cryogenic pipes.*
*Space simulation chambers.*
*Pressure vessels*
*Containers.*

---

Sefelec

**SEFELEC**
19, rue des Campanules
Parc d'Activités du Mandinet
Lognes
F-77321
Marne la Vallée cedex 2
Tél. : (33) 1 60 17 54 62
Fax : (33) 1 60 17 35 01

Please contact :
Mr Danicourt

Alimentation haute tension régulée de 0-1 kV à 0-600 kV = régulation < 0,005 %.
Mégohmmètre picoampèremètre programmable de 100 ohms à $2.10^{15}$ ohms et de 0,01 pA à 20 mA sous une tension de 1 V à 1500 V.
Poste de rigidité diélectrique DC et AC, essais non destructifs de 0 à 6 kV, 0 à 12 kV, 0 à 50 kV.
Diélectrimètre (mégohmmètre + poste de rigidité diélectrique) programmable.
Microhmmètres programables de 1 microohm à 80.000 ohms, précision < 0,05 %

*Regulated high voltage power supplies from 0-1 kV to 0-600 kV = regulation < 0,005%.*
*Programable megohmmeter picammeter 100 ohms to $2.10^{15}$ and from 0.01 pA to 20 mA with a voltage from 1 V to 1500 V.*
*Dielectric strength testers DC and AC, non destructive tests from 0 to 6 kV, 0 to 12 kV, 0 to 50 kV.*
*Programmable dielectricmeters (megohmmeter + dielectric strength tester).*
*Programmable microhmmeters from 1 microohm to 80,000 ohms, accuracy < 0.05%.*

---

SICN

**SICN**
B.P. 2
F-38113 Veurey-Voroize
Tél. : (33) 76 86 90 00
Fax : (33) 76 86 90 20
Télex : 320714 F

Please contact :
Mr Beroud

Réalisation de pièces mécaniques de haute précision pour la Défense Nationale, les engins spatiaux, l'industrie nucléaire et les centres de recherche scientifiques (CERN). Exemple : Coupleurs, tuners.

*Fabrication of high precision components for the military, space and nuclear industries, for different scientific research centres (CERN). For exemple : Coplers, tuners.*

**L'AIR LIQUIDE**
Div. Techniques Avancées
B.P. 15 Les Engenières
F-38360 Sassenage
Tél. : (33) 76 43 60 85
Fax : (33) 76 43 61 31

Please contact :
Mr Marty

Réfrigérateurs et liquéfacteurs d'hélium.
Liquéfacteurs d'hydrogène.
Réservoirs fixes et transportables d'hélium et d'hydrogène liquides.
Centrales froides
Epurateurs cryogéniques de gaz rares, d'hélium et d'hydrogène.
Unités de récupération de solvants - Génie thermique dans le domaine -200° +100°.
Lignes de transfert sous vide.
Cryopompes.

*Helium refrigerators and liquefiers.*
*Hydrogen liquefiers.*
*Stationary and transportable liquid helium and liquid hydrogen vessels.*
*Cooling units.*
*Rare gas, helium and hydrogen cryogenic purifiers.*
*Solvent recovery cryogenic fluids.*
*Vacuum transfer lines.*
*Cryopumps.*

---

CARBONE LORRAINE
GROUPE PECHINEY

**LE CARBONE LORRAINE**
**CEFILAC ETANCHEITE**
90, rue de la Roche du Geai
F-42029 Saint-Etienne cedex
Tél. : (33) 77 25 22 77
Fax : (33) 77 37 18 14
Télex : 330697 F

Please contact :
Mme Dufour

Composants et systèmes pour applications industrielles.
Joints et systèmes de haute étancheité.

*Components and systems for industrial applications.*
*Sealing rings and systems for high performance sealing.*

---

LUZIESA

**LUZIESA**
Sainte Marie de Frugie
F-24450 La Coquille
Tél. : (33) 53 52 88 93
Fax : (33) 53 52 04 83

Please contact :
Mr Demoulin

Réalisation de DÉFAUTS ARTIFICIELS à façon et travaux spéciaux par Électro-Érosion - Ultrasons - Laser - Soudure par Diffusion.
Construction et diffusion d'une machine spécifique d'usinage par Électro-Érosion pour faire des DÉFAUTS ARTIFICIELS et tous micro usinages.
Puissance de travail : de 30 mA à 5 A.

*Allowance in machining ARTIFICIAL DEFECTS and special working by Ultrasonics - Spark-Erosion - Laser - Diffusion welfing.*
*Marketing of spark-erosion machine specifically intended for production of artificial defects and micro machining.*
*Working power : from 30 mA to 5 A.*

---

MERLIN GERIN

**MERLIN GERIN**
9, av du Pré de Challes
PAE des Glaisins
F-74940 Annecy-le-Vieux
Tél. : (33) 50 64 01 62
Fax : (33) 50 64 00 97

Please contact :
Mr Muller

Les activités de Merlin Gerin se répartissent dans plusieurs domaines :
Distribution Basse Tension (disjoncteurs, condensateurs, gestion d'énergie...).
Transport et distribution Haute Tension (transformateurs...).
Electronique industrielle (alimentations de sécurité, ...).
Réalisation d'ensembles (installations complètes, superviseurs...).

*MERLIN GERIN activities are divided in several sectors :*
*Low voltage distribution (circuit-breakers, capacitors, automatic and programmable functions, alarm systems... ).*
*Transport and high voltage distribution (switchgear SF6, power-transformer).*
*Industrial electronics (UPS, ...).*

---

**NEWPORT**
**MICRO-CONTROLE**
3 bis, rue Jean Mermoz
B.P. 189
F-91006 Evry cedex
Tél. : (33) 1 60 91 68 68
Fax : (33) 1 60 91 68 69

Please contact :
Mr Van de Vyvere

RTN : Plateau tournant de haute précision ($10^{-3°}$) destiné à des charges importantes (200 à 800 kg).
LAE 500 : Lunette autocollimatrice électronique de haute précision (0,1 µrad).
Goniomètre avec 3 à 6 axes de liberté.
Banc avec déplacement de grande précision sur coussin d'air pour des charges lourdes.
Verin installé sur LASER NOVA (Livermore) et PHEBUS (CEA Limeil).

*RTN : High precision ($10^{-3°}$) rotary stages designed to withstand heavy loads (200 to 800 kg).*
*LEA 500 : High resolution electronic autocollimators (0,1 µrad).*
*Goniometer with 3 to 6 axes of freedom.*
*High precision displacement bench on air bearings for heavy loads.*
*Actuator on NOVA LASER (Livermore) and PHEBUS (CEA Limeil).*

DRUSCH

**DRUSCH**
19, rue Ch. E. Jeanneret
Technoparc
F-78306 Poissy cedex
Tél. : (33) 1 39 11 31 31
Fax : (33) 1 39 11 11 10

Please contact :
Mr Bouhnik

Alimentation puissance classe 10-5 - 10-6.
Electro-aimant.
Système magnétique pour RMN.
IRM médicaux dédiés.
Gaussmètre RMN.

*10-5 - 10-6 power supplies.*
*Electromagnets.*
*Magnetic systems for MRI.*
*Magnetic systems for medical imaging.*
*MRI gaussmetres.*

---

effa

**EFFA**
116, avenue du Belvédère
F-93310 Le Pré St Gervais
Tél. : (33) 1 48 46 87 34
Fax : (33) 1 48 46 55 95

Please contact :
Mr Touzin

Transmetteurs de pression absolue - gammes couvertes $10^{-4}$ mbar a à 10 bars a.
Transmetteurs de pression différentielle ou relative - gamme de $10^{-4}$ mbar à 100 bars.
Baromètres de haute précision.
Temperatures de fonctionnement de 1k à 150°C.
Versions spéciales résistant aux radiations ionisantes.
*Absolute pressure transmitters : range from $10^{-4}$ mbar a up to 10 bars a.*
*Differential or gauge pressure transmitters : from $10^{-4}$ mbar to 100 bars.*
*High precision barometer.*
*Working temperatures from 1K up to 150°C.*
*Special equipments for ionizing radiations environments.*

---

EUROTHERM AUTOMATION

**EUROTHERM AUTOMATION**
6, chemin des Joncs
B.P. 55
F-69572 Dardilly cedex
Tél. : (33) 78 66 19 43
Fax : (33) 78 35 24 90
Télex : 380038 F

Please contact :
Mr Chaume

Régulateurs et régulateurs/programmateurs mono ou biboucle.
Systèmes de supervision.
Ensemble multiboucle de régulation et d'automatisme.
Contacteurs statiques et gradateurs de puissance.
Installations clé en main.

*Controllers/programmers (simple or dual loop).*
*Supervisory system.*
*Multiloop control system.*
*Solide state contactors and power controllers.*
*Turn key installation.*

---

GEC ALSTHOM

**GEC ALSTHOM et ALSTHOM INTERMAGNETICS**
3, av des 3 Chênes
F-90018 Belfort cedex
Tél. : (33) 84 55 10 00
Fax : (33) 84 55 16 15
Télex : 360965 F

Please contact :
Mr Grunblatt

Fil supraconducteur pour courant continu et alternatif.
Câble supraconducteur.
Aimants pour l'Imagerie par Résonnance Magnétique.
Aimants pour la Physique des Hautes Energies.
Aimants pour la fusion contrôlée.

*Superconducting wires for DC current and alternative current.*
*Superconducting cable.*
*Magnets for Magnetic Resonance Imaging.*
*Magnets for High Energy Physic.*
*Magnets for the controlled fusion.*

---

gf Garçonnet

**GF GARCONNET**
Route d'Envermeu
F-76510 Saint Nicolas d' Aliermont
Tél. : (33) 35 85 90 58
Fax : (33) 35 04 19 57
Télex : 180450 F

Please contact :
Mme Deseraud

Pièces de Découpage Fin, principal utilisateur : l'industrie automobile mais le Découpage Fin est aussi utilisé dans les domaines de l'aviation, optique, textile, armement. GARCONNET a découpé, entre autres, les colliers et les fers froids des quadrupoles de HERA.

---

HH HAZEMEYER

**HAZEMEYER S.A.**
Z.I. route de Grugies
F-02430 Gauchy
Tél. : (33) 23 50 36 36
Fax : (33) 23 08 80 72
Télex : 150685 F

Please contact :
Mr Pieranti

Hazemeyer, dans le cadre de son activité électronique de puissance, étudie et réalise des alimentations de puissance de haute stabilité.
Sa grande expérience en alimentations pour charge supraconductrice ou non place HAZEMEYER au tout premier plan des fournisseurs.

*As part of its electronic power supply activity, HAZEMEYER designs and manufactures power supplies of high stability.*
*Its great experience in power supplies for supraconductors puts HAZEMEYER amongst the most important suppliers.*

**THERMO-EST**
ZI du Malambas Hauconcourt
B.P. 340
F-57213 Maizieres les Metz
Tél. : (33) 87 80 68 18
Fax : (33) 87 51 72 04
Télex : 860664 F

Please contact :
Mr Lecomte

Cannes pyrométriques pour tous milieux industriels.
Etalonnage de capteurs de température.
Thermocouples chemisés.
Convertisseurs techniques 2 fils, 4 fils.
Usinage de pièces mécaniques de précision.

*Temperature sensors for industrial use.*
*Calibration of temperature sensors.*
*Mineral insulated thermocouples.*
*2 and 4 wires transmitters.*
*Processing of precision mechanical parts.*

---

**THEVENET+CLERJOUNIE**
22, av Franklin Roosevelt
F-69120 Vaulx en Velin
Tél. : (33) 78 49 54 64
Fax : (33) 78 49 62 93
Télex : 380544 F

Please contact :
Mr Pinet

Mécanique : travail à façon - CN et conventionnel. Forage - rodage.
Hydraulique : pompes à main, joints tournants, vérins.
Jonctions bi-métalliques : tous raccords et liaisons étanches (ultra-vide) de matériaux hétérogènes.

*Mechanics : sub-contractor, NCM and conventionnal. Deep boring - lapping.*
*Hydraulics : hand pumps, rotating manifold, cylinders.*
*Bi-metallic junctions : any joint and leak-tight assembly (UHV) of heterogeneous metals.*

---

**THOMSON**
**TUBES ELECTRONIQUES**
13, av Morane Saulnier
Bâtiment Chavez
B.P. 121
F-78148 Velizy Villacoublay
Tél. : (33) 1 30 70 35 00
Fax : (33) 1 30 70 35 35

Please contact :
Mme Bernier

Tubes à grilles et de commutation : triodes, tétrodes, thyratrons, etc. et équipements associés : cavités RF, émetteurs...
Tubes hyperfréquences : klystrons, gyrotrons, magnétrons, tubes à ondes progressives, ainsi que composants fenêtres et équipements divers.
Tubes intensificateurs d'images et de prise de vue, visualisation (tubes à rayons cathodiques panneaux à plasma).

*Products include :*
*Power-grid and switching tubes : triodes, tetrodes, thyratrons and associated equipment : FR cavities and generators.*
*Microwave tubes : klystrons, gyrotrons, magnetrons, traveling-wave tubes, as well as windows and accessories.*
*Image intensifier and display tubes : pick-up tubes, cathode-ray tubes, plasma display panels.*

---

**VERMETAL**
Rue Marcelin Berthelot
Z.I.
F-77550 Moissy-Cramayel
Tél. : (33) 1 64 88 46 01
Fax : (33) 1 60 60 42 55

Please contact :
Mr Louis

Traversées de courant, tension et signaux en verre-métal et céramique-métal.
Hublots scellés étuvables en verre, saphir, silice, germanium, $CaF_2$, $MgF_2$.
Lampes flashes pour pompage de Laser solides.

*Glass-to-Metal and Ceramic-to-Metal feedthroughs and adapters.*
*U.H.V. Glass, Silica, Sapphire, Germanium, $CaF_2$ and $MgF_2$ viewports.*
*Flashlamps for Laser pumping.*

---

*L'exposition La France au CERN est organisée par*
*le* **Comité Français des Manifestations Economiques à l'Etranger**
*et le* **Ministère de la Recherche et de l'Espace**

Pour plus d'information contacter :

Madame **KHAIAT** - CFME **(33) 1 40 73 32 42**
Monsieur **PEPY** - MRE **(33) 1 46 34 32 71**

FRANCE

Martin Block (left) and J.D. Bjorken at the recent Fermilab workshop on 'small-x' physics.
(Photo M. Albrow)

closer the proton is scrutinized, the more quarks and gluons are seen. As there are more of them, their average momentum fraction x must be smaller.

Quarks and gluons radiate 'soft' gluons in the very low x region (less than$10^{-3}$ or even$10^{-4}$). But new phenomena must occur with high gluon densities, such as recombination of gluons to form higher x gluons, or something akin to shadowing of gluons by each other, or perhaps collective effects like 'condensation' or superfluidity. Perhaps there are local regions of high density, which have become known as 'hot spots'.

As emphasized by J. Bartels the small-x region is a transition between perturbative (quark/gluon) hard scattering and the non-perturbative soft region traditionally described in 'Regge' language. One of the most challenging theoretical issues is to determine whether the small-x behaviour of the gluon distribution can be calculated from techniques originally developed to study the Regge limit.

Experiment has measured the proton structure function only down to about x = 0.01, and HERA will open up totally unexplored kinematical territory. However Fermilab's Tevatron, with proton-antiproton collisions at 1800 GeV, can also probe the gluon structure function at these very low values of x, although details have still to be studied.

The idea is to measure a high transverse momentum direct photon and the recoil hadron jet, when both are at small angles (a few degrees) in the same direction. This would pick up predominantly medium-x quarks hitting very low-x gluons. The resulting information on the low-x gluon density would also be useful for predicting heavy quark production at the LHC and SSC proton-proton colliders.

Another strong interaction physics frontier is the old but still not understood phenomenon of diffraction, traditionally described by exchange of a 'Pomeron' between two protons bouncing off each other. As well as producing elastic scattering, this process can also excite one or both of the protons.

When this was first seen at the CERN Intersecting Storage Rings (ISR) the effective masses of the excited protons ranged up to about 15 GeV. At CERN's proton-antiproton collider this range extended to about 150 GeV, while the Tevatron reaches about 430 GeV. These massive systems tell a lot more about the diffractive process.

By focussing on hard scattering processes within this heavy system, measurements can in principle extract an effective quark/gluon structure of the exchanged Pomeron. A 'perturbative Pomeron' could appear when the momentum transfer becomes large enough.

Experiment UA8 at the CERN collider found remarkably clean jet structures, convincingly interpreted as resulting from hard scattering between gluons or quarks in the struck (anti-)proton and the Pomeron (March 1992, page 4). Remarkably, J.C. Collins argued that this phenomenon would be absent in Pomeron-induced hard scattering processes at HERA.

Diffractive hard scattering has so far been neglected at the Tevatron, where the higher masses could give rise to more spectacular effects and the studies could be valuably extended. Although the Pomeron looks like a murky remnant of old (pre-1974) physics, it has yet to be understood.

The idea of 'rapidity gaps' in very high energy collisions has recently aroused considerable interest. A quark collision mediated by the exchange of a photon, W or Z should produce hadron jets, but since the exchanged particles do not carry the usual 'colour' quantum number of quark interactions, there would be no resultant central hadronization, leaving a kinematical range (a few units of 'rapidity') with no particles – a gap.

J.D. Bjorken, F. Halzen and others argued that rapidity gaps should be sought at the Tevatron. Such gaps are common in diffractive collisions, but the momentum transfer across the gap is always less than a few GeV if the conventional soft Pomeron is exchanged. However a wide gap might also be possible with a very large momentum transfer, say 50 GeV (a 'hard' Pomeron). Theorists are encouraging experimenters to look for events with balanced jets separated by a rapidity gap as a means of isolating 'hard diffraction', a quite new aspect of strong interactions.

There are also attempts to explain strange cosmic ray events such as 'Centauro', with a very large imbalance between electromagnetic and hadronic energy, in ways which relate to hard diffraction. At hadron colliders, the physics of particles coming out at large angles (the central region) has been so interesting and fruitful since the mid-late 70s that what comes out in the forward directions has been relatively neglected. The Fermilab workshop demonstrated this might be an oversight.

*From Michael Albrow and Alan White*

# Vancouver Cyclotron Conference

Although no longer on the high energy frontier, the cyclotron field is still a major scientific growth area. Its progress is highlighted at the international conference on cyclotron design, development and utilization held at intervals of about three years, under the auspices of the International Union of Pure and Applied Physics (IUPAP).

Vancouver, surrounded by mountains, water and some cyclotrons, provided a pleasant setting for the 13th Conference, held last summer. With over 200 cyclotrons in operation around the world, the attendance, 241 delegates and 26 industrial exhibitors, was a near record, reflecting the flourishing state of the field.

The early sessions covered the initial operation of new or upgraded cyclotron facilities. Major facilities completed since the previous Conference in Berlin in May 1989 included the 400 MeV ring cyclotron at Osaka, the U400M cyclotron at Dubna which will be coupled to the U400 to give 20 MeV nucleon uranium beams, the 130 MeV cyclotron at Jyvaskyla (in Finland, the furthest north!), the 110 MeV JAERI machine in Japan, and the 65 MeV proton therapy cyclotron in Nice.

Among the facility upgrades were the KFA cyclotron at Jülich which will inject the 2.5 GeV storage ring COSY, and the addition of an FM mode to the K=200 CW mode at Uppsala to give protons up to 180 MeV. The impressive current of 1.5 mA at 72 MeV obtained from the PSI Injector II will soon be injected into the 590 MeV ring.

Many new cyclotrons involve the use of superconducting magnets. For instance the rotatable 'flying cyclotron' built at Michigan State University is now treating cancer patients at Harper Hospital in Detroit. Superconducting cyclotrons of novel design are also moving in Europe; that begun in Milan is being completed in Catania, while one being built in


*Stan Hagen, leader of the Canadian delegation, and Kim Campbell, senior British Columbia federal minister push for the new KAON facility at the Vancouver TRIUMF Laboratory.*
*(Photo Tallulah)*

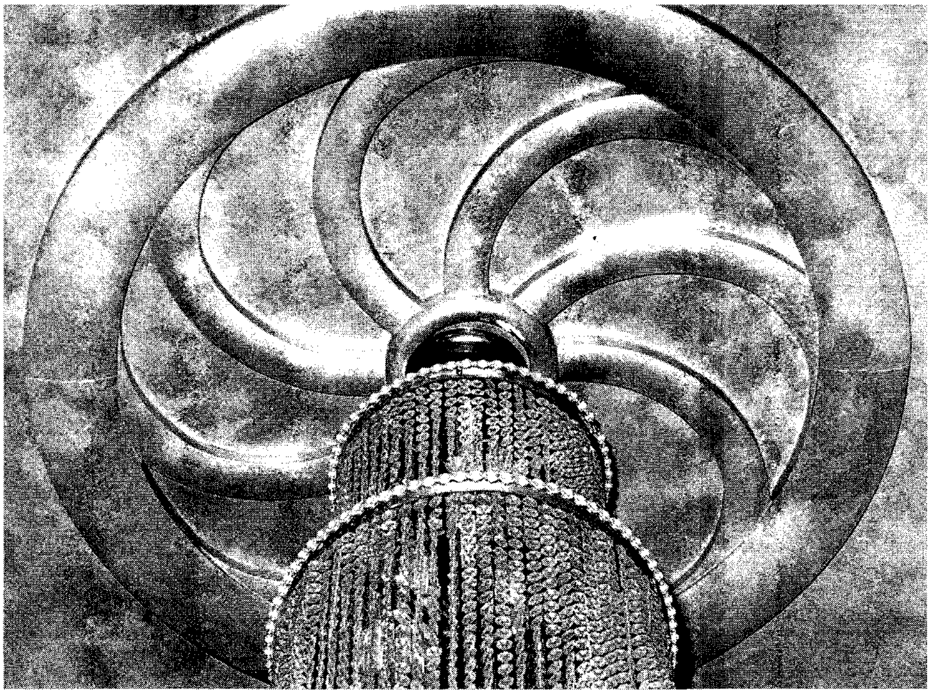
15 *Circle advertisement number on reader service form*



2 *Circle advertisement number on reader service form*



25 *Circle advertisement number on reader service form*



*Ceiling moulding in the Hotel Vancouver – very apt for a cyclotron conference. (Photo Tallulah)*

Orsay will be installed at Groningen. Several superconducting cyclotrons are developing higher deflector voltages to extract the highest energies.

One superconducting machine pushing the design frontiers is the TRITRON, described by Trinks of Garching, which will be the first separated orbit cyclotron (SOC), an idea that arose in the 1960s with the 'Beehive' three-dimensional design of Russell from the UK Rutherford Lab. The TRITRON orbits lie in a plane, and each has its own focusing and bending magnets, like a coiled up linac. TRITRON will also be the first cyclotron with superconducting r.f. Trinks also gave examples of designs up to 1000 MeV.

An ambitious new design described by Ziegler of the Hahn Meitner Institute is the superconducting FFAG ring proposed in Germany to accelerate 1.7mA protons from 500 MeV to 3 GeV for a spallation neutron source. This would be the highest energy cyclotron, actually a ring synchro-cyclotron. Another novelty is the S-coil configuration proposed for a 200 MeV superconducting proton cyclotron at NAC in South Africa, described by Jungwirth. Here the magnet coils are wound around the return yoke to provide the needed field increase with radius.

A fast-developing area in nuclear physics is the production and use of radioactive beams, pioneered by ISOLDE at CERN. Radioactive beams can be produced either by having a high-energy, high-power beam hit a thick target and then accelerating the radioactive species, or by having a high-energy heavy ion beam fragment in a thin target.

Cyclotrons, as well as other accelerators, are used or planned using both these methods. Radioactive beams are already in use at TRIUMF (Canada), Louvain (Belgium), GANIL (France), RIKEN (Japan) and MSU (US). Future cyclotron-based facilities are under construction at Oak Ridge, INS Tokyo, Osaka and Dubna, and are planned for Catania/Milan, GANIL, Grenoble, Moscow, PSI (Switzerland), TRIUMF (ISAC) and the North American IsoSpin Laboratory collaboration. The challenge is to provide usable beam intensities of a wide variety of radioactive species for use in interesting nuclear science and astrophysics experiments.

For heavy ion cyclotrons, injection with a high charge state ECR source can greatly increase performance, since energy is proportional to the square of charge. ECR developments were reviewed by Lyneis of Berkeley, including the unique high field 10 GHz source CAPRICE at Grenoble, the superconducting source at Michigan State, and electron injection with either a biased disk as at Grenoble or with an electron gun as at Berkeley.

Cyclotrons are injecting into storage rings or synchrotrons at Indiana, INS Tokyo and Uppsala. Similar systems are under construction at Jülich, and proposed at TRIUMF, Osaka, Kiev and Dubna. In these systems development is under way in electron and stochastic cooling, target systems, and upgraded control systems, so that the potential physics can be fully realized. A review of beam instrumentation for cooler facilities by Ellison described the feedback and operator assistance systems needed.

Reviews of medical and non-medical applications gave cyclotron designers an insight into the beam requirements in these fields. In his review of compact cyclotrons Bechtold (Karlsruhe) discussed the important application of cyclotron principles to compact commercial machines, where negative ion acceleration is becoming more important because of its easy extraction of high beam currents.

The talk by Blosser of Michigan State on future cyclotrons described the challenges of new designs and showed how a simple spread sheet program on a personal computer could do conceptual designs, parameter studies and preliminary cost estimates on proposed cyclotrons. The nuclear physics applications of cyclotrons and storage rings were described by Hardy (Chalk River)

and Pollock (Indiana University), respectively.

A tour of the local TRIUMF facility was preceded by orientation talks on the 520 MeV cyclotron and the proposed KAON Factory. Dutto mentioned that the cyclotron has been improved by the addition of a fourth-harmonic cavity at large radius, increasing the energy gain per turn and thus reducing electromagnetic stripping losses. It can also be used in the flat-top mode to improve beam quality and extraction.

Craddock described the KAON accelerators and how the TRIUMF beam will be matched to the succeeding rings at 3 and 30 GeV. He pointed out how the support for KAON has been growing with the assistance of Dr. KAON and friendly government officials Mr. KAON and KAON Kim (see photo). During the tour visitors were taken above the cyclotron to be shown a quarter and a dime suspended from another quarter, demonstrating the power of the TRIUMF magnet and the collective strength of Canadian currency!

At the Conference dinner, master of ceremonies Mike Craddock extended the congratulations of the cyclotron community to three American Physical Society prizewinners: Henry Blosser and Bob Pollock, for the 1992 Bonner Prize, awarded for design and construction of superconducting cyclotrons and a cyclotron-injected light-ion cooler respectively; and Reg Richardson of UCLA and TRIUMF for the 1991 Wilson Prize, for demonstrating phase focusing, the first synchrocyclotron and the first sector-focused cyclotron.

Craddock pointed out this research has revealed two classes of accelerators, 'proper' and 'improper'. The former are of course cyclotrons, with the perfect rotational periodic symmetry of their sector structure. Improper synchrotrons have frequent deviations from symmetry due to straight sections of unequal length.

The TRIUMF group put together an interesting and smooth-running conference, with Mike Craddock chairing the international and local organizing committees and Gerardo Dutto the scientific program committee. Details can be found in the 179 papers in the proceedings, published by World Scientific in December. The community looks forward to the next Conference, in 1995, to be hosted by NAC, in Cape Town, South Africa.

*David J. Clark, Lawrence Berkeley Laboratory*

## Heavy ion fusion

With controlled thermonuclear fusion holding out the possibility of a prolific and clean new source of energy, the goal remains elusive after many years of continual effort. While the conventional Tokamak route with magnetic confinement continues to hit the headlines, other alternatives are now becoming competitive.

One possible solution is to confine the thermonuclear fuel pellet by high power beams. Current research and perspectives for future work in such inertial confinement was the subject of the 'Prospects for Heavy Ion Fusion' European Research Conference held in Aghia Pelaghia, Crete, last year. Its main focus was on the potential of heavy ion accelerators as well as recent advances in target physics with high power lasers and light ion beams.

Carlo Rubbia declared that high energy accelerators, with their high efficiency, are the most promising approach to economical fusion energy production. However the need for cost saving in the driver accelerator requires new ideas in target design tailored to the particularities of heavy ion beams, which need to be pushed to the limits of high current and phase space density at the same time.

Dieter Möhl (CERN), describing performance achieved with CERN accelerators, showed that individual parameters have been close enough to what is needed for fusion, but no machine has pushed all parameters simultaneously to their limits, which is the real challenge.

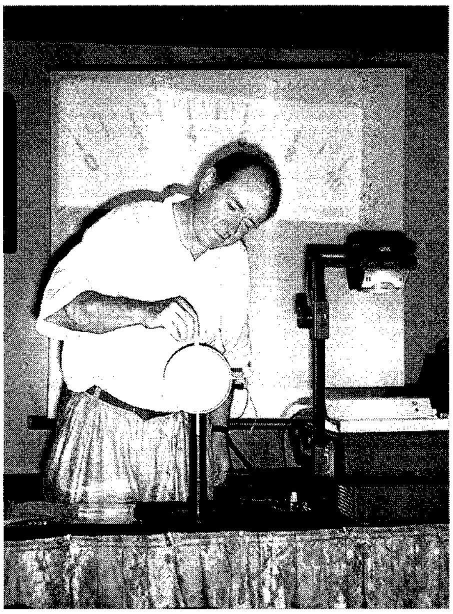
According to Ingo Hofmann (GSI, Darmstadt) the SIS heavy ion synchrotron and adjacent ESR cooling storage ring have just opened a new chapter in heavy ion fusion. These machines provide unique possibilities for machine studies for reactor drivers as well as target work with the first dense plasmas to be produced by heavy ions.

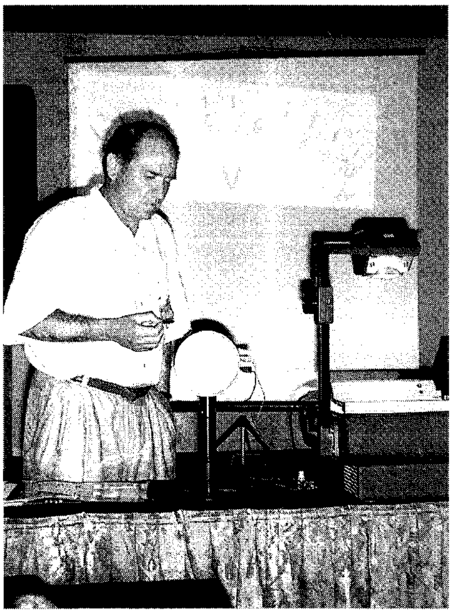
Problems of a full (five kilometre) reactor driver linac are under control, according to Horst Klein from Frankfurt, provided that target designers are not going to push the normalized emittance further down.

Parallel to the European efforts with radiofrequency linac and storage ring technology, the technologically innovative induction accelerator approach is pursued by Lawrence Berkeley Laboratory (presented by Tom Fessenden).They are awaiting funding of their next $60M ILSE project.

Conversion of beam energy into soft X-rays ('indirect drive') seems to be the magic key now for target physicists. The X-rays are confined in a radiation case ('hohlraum') with the actual fusion pellet at its centre. Due to multiple reflections the X-rays

At the 'Prospects for Heavy Ion Fusion' European Research Conference held in Crete last year, laser physicist Richard Sigel of Munich's Max Planck Institute for Quantum Optics demonstrates the principle of indirectly driven 'hohlraum' (radiation enclosure) targets by a simple optical analogue – the radiation near a lamp, measured by a photocell, increases dramatically inside a highly reflecting cavity.





'forget' the spatial nonuniformity of primary heavy ion or laser beams, and a spherically symmetric compression of the pellet becomes possible.

The physics of radiative hydrodynamics under conditions normally present in stellar matter is now a great challenge for theorists developing simulation programs, evidenced by Jürgen Meyer-ter-Vehn (Munich), Stefano Atzeni (Frascati) and Mihail Basko (Moscow).

The biggest obstacle having to wait for declassification of US work in inertial fusion, but this could be relativity imminent. The relative openness of presentations by leading physicists from classified laser laboratories (Livermore, Sandia and Rochester in the US and Limeil in France) was surprising and welcome.

Milestones were reported by C. Yamanaka from Osaka, home of the only unclassified dedicated inertial fusion programme. They have achieved 600 times compression of solid matter (producing $10^{13}$ neutrons), near to what is required for fusion.

According to Erik Storm from Livermore an upgrade of their existing NOVA laser facility could achieve ignition (by indirect drive) with fusion gain exceeding 10 by around the year 2000, provided the required $400M were made available in time. Inertial fusion with lasers is now as close to reaching ignition as magnetic fusion.

More good news came from D. Cook, Sandia Laboratories (New Mexico), who reported on recent success with the PBFA II pulsed power facility shooting about 50 kilojoules of 9 MeV lithium on hydrocarbon foam obtaining conversion into X-rays. The need for reducing beam divergence is a major issue for future development.

With European collaboration in magnetic confinement well established, and with a strong interregional collaboration in magnetic fusion heading towards ITER as a next step, collaboration in inertial fusion does not yet exist on any international scale. 'Should there be a European programme on inertial fusion?' asked a panel discussion chaired by Rudolf Bock (GSI). There was a consensus that lasers to demonstrate ignition and heavy ions to make an efficient driver are in the same boat – yet there was no doubt that coming together doesn't necessarily increase the funds. Who would lead such a programme in Europe? What is the cost of a dedicated heavy ion accelerator facility to study target physics close to fusion parameters?

The meeting was in the spirit of traditional US Gordon conferences with no proceedings, tutorial introductions encouraged before each talk and enough time for discussion. About 70 people attended, with a good number of younger people bringing in new blood. The chairman was J. Meyer-ter-Vehn, Max-Planck-Institute for Quantum Optics, Munich, and the meeting was sponsored by the European Science Foundation in association with the European Physical Society.

A tribute was made to strong focusing pioneer Nick Christophilos in whose home country the conference took place. Strong focusing and later on construction of the Astron (electron) induction accelerator have both been fruits of his inventive mind.

*From Ingo Hofmann*

*The 1992 workshop on Recent Developments in the Phenomenology of Particle Physics, held in October at the International Centre for Theoretical Physics, Trieste, Italy, and locally organized by Faheem Hussain (left) and by Nello Paver (right, of Trieste University), covered all aspects of modern quantitative research.*

# TRIESTE
## Feet on the ground

Established in 1964 by Abdus Salam, the International Centre for Theoretical Physics (ICTP), in Trieste, Italy, has naturally become one of the world's leading centres of particle physics theory. Attracting distinguished senior visitors from all over the world and with a full programme of regular symposia and workshops, it provides a valuable stepping stone to frontier research for young researchers, particularly those from the developing countries, who would otherwise find it tough to make headway in this competitive field.

Initial ICTP research interests concentrated on particle physics and plasma physics, but as interest, support and infrastructure steadily expanded, these interests widened to give a truly interdisciplinary centre with active groups in fundamental physics, condensed matter physics, mathematics, plasma physics, superconductivity, aeronomy, microprocessors, climatology, and in laser, atomic and molecular physics.

Originally set up under the auspices of UNESCO and the International Atomic Energy Agency, ICTP has in recent years been funded mainly by Italy. 1991 saw a hiatus in ICTP funding (December 1991, page 30). However the financial status of the Centre is now secure as the Italian government has approved support for the next eight years. With the International School for Advanced Studies a close neighbour and the university a short distance away, Trieste will surely remain an important research centre.

In spite of having no major experimental physics activity on site, ICTP has always been at the forefront of fundamental physics, be it the genesis of the Standard Model in the 1960s, or supersymmetry in the 70s, to the more esoteric recent developments. In the 1980s, when superstrings and other ambitious schemes for a grand picture of fundamental interactions were in vogue, it was natural and welcome for ICTP to concentrate its efforts in these fields.

But times have changed. Like the downbeat world in which it lives, 1990s physics has discarded, at least temporarily, many luxuries and frills to concentrate instead on basics. Spearheaded by the precision measurements at CERN's LEP electron-positron collider, there is a resurgence of worldwide interest in numerical accuracy and the productive phenomenology which comes in its wake. With experiments increasingly encountering complicated analyses, there is ample room for phenomenologists to get aboard.

To underline and encourage this shift in emphasis, in 1991 ICTP launched a workshop on phenomenology, the idea being to bring together the results and implications of modern precision measurements and encourage participation in this new style of 1990s research.

The 1992 workshop, held in October in collaboration with the Italian INFN and locally organized by Faheem Hussain and by Nello Paver (of Trieste University), provided an impressive scientific programme covering all aspects of modern quantitative research. Young researchers emerged with a well-rounded picture of frontier phenomenology and collected many useful indications of where contributions are welcome.

The programme covered neutrino physics, LEP results and their implications as tests of the Standard Model and indications of any physics beyond, and heavy quark physics, particularly the 'effective theory' for calculations. With a formalism constructed from general symmetry principles, this approach sets out to make calculations based on a series expansion in the reciprocal of the quark mass, so that the heavier the quark, the faster the expansion converges.

While heavy quark effective theory brings no new physics, it greatly simplifies the description of heavy flavour reactions. It was singled out by Steve Weinberg in his summary at the major international meeting in Dallas last year (October 1992, page 1) as being particularly promising.

Highly relevant in this context was a measurement (presented by Giorgio Romano) from the WA75 emulsion experiment at CERN of the purely leptonic branching ratio of mesons carrying both charm and strange quantum numbers ($D_s$).

## FERMILAB
## Tevatron upgrade

The Fermilab accelerator complex is in the middle of a major upgrade to increase the luminosity beyond the original design goal. During Phase I of this upgrade, there have been major modifications to the Tevatron. These modifications were commissioned at the start of the latest collider run and include the installation of electrostatic separators to separate the orbits of the stored beams and new low beta insertions to squeeze the colliding proton and antiproton beams at both experiment interaction regions.

These modifications have already enabled the Tevatron to achieve a record peak luminosity of $6.93 \times 10^{30}$ per sq cm per s and a record weekly integrated luminosity of $10^{60}$ inverse nanobarns. The peak goal for the present run of $5.0 \times 10^{30}$ has already been exceeded.

In the 1989 collider run the record luminosity was $2.07 \times 10^{30}$. The Tevatron was operated with six bunches colliding head-on in all locations (twelve collision points). One of the luminosity limiting factors was a maximum sustainable tune shift of .025 due to the beam-beam interaction. A similar value has also been achieved at CERN with a different working point in the tune diagram and with different bunch parameters. In addition to a tune shift, the beam-beam interaction causes a tune spread across the beam and enhances the strength of various destructive non-linear resonances. In the Tevatron, resonances up to 12th order must be avoided. An orbit separation scheme was developed to eliminate the unnecessary collision points (there are only two experiments) as well as total separation during injection, acceleration and low beta squeeze. The beams are brought into collision at only two points when low beta is reached.

In contrast with LEP at CERN and Cornell's CESR ring (both electron-positron colliders), the Tevatron uses separators in both the horizontal and vertical planes to produce a helical orbit. A helical orbit is accomplished by creating a betatron oscillation in the horizontal and vertical plane such that the phase between the two oscillations is $n\pi/2$ where n is an odd integer. Helical orbits were chosen to keep the beams separated everywhere in the ring so that when the position of the bunches was cogged from the injection location to the collision location the beams remain separated.

The design goals were a minimum separation of 5 sigma and a maximum separation of 15 mm between beam centres. This goal has been met. Operation has used separators as small as 3 sigma with no problems. The separators have been very reliable. There has been only one separator spark during operations to date (1000 hours). The observed spark did not appreciably affect the store in progress.

During injection, acceleration and the low beta squeeze separation is achieved using the horizontal separators at B17 and vertical separators at C17. During the injection process the horizontal separator at B11 is used to adjust the phase of the helix through the injection Lambertson. Finally, the beams are brought into collision at B0 and D0 and kept apart everywhere else with local electrostatic three bumps in each plane. One pair of bumps creates a helical orbit from B11 to C49. The other pair of bumps keeps the beam apart from D11 to

READER SERVICE FORM

# CERN COURIER

**JANUARY/FEBRUARY 1993**

Please send information on items circled:

| | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| **1** | **2** | **3** | **4** | **5** | **6** | **7** | **8** | **9** | **10** |
| **11** | **12** | **13** | **14** | **15** | **16** | **17** | **18** | **19** | **20** |
| **21** | **22** | **23** | **24** | **25** | **26** | | | | |

*Please send to:*

Judy Pray, **CERN COURIER**
Gordon & Breach Science Publishers
Frankford Arsenal, Building 110
5301 Tacony Street, Box 330
Philadelphia, PA 19 137
USA

Name ____________ Title ____________

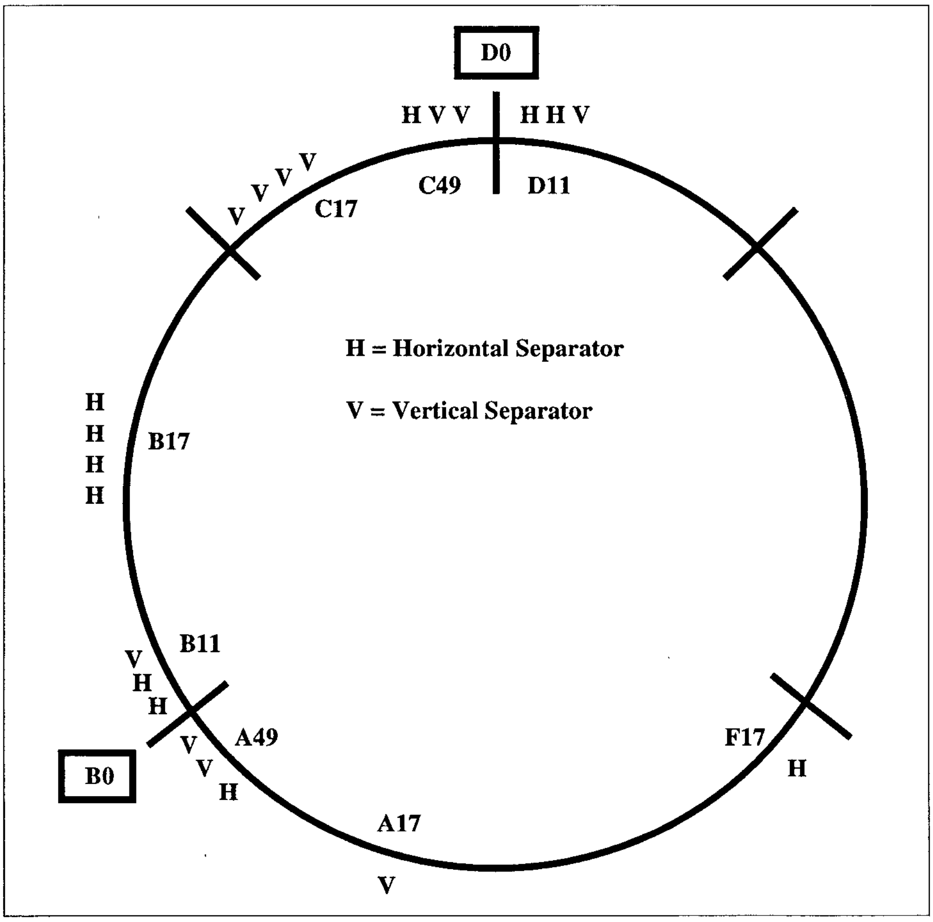
Employer ____________ Dept. ____________

Address ____________

City ____________ State ____________ Zip ____________

Telephone (   ) ____________ Country ____________

*Location of electrostatic separators at Fermilab's Tevatron proton-antiproton collider.*




A49. This results in 6.5 betatron oscillations in the third of the ring between B0 and D0 and 13 betatron oscillations in the remaining two-thirds of the ring. Since the number of betatron oscillations in these bumps is only approximately integer or half-integer, the local bumps require 3 elements. The location of the middle element of the 3- bumps in the vertical plane is C17, A17, and B17, F17 in the horizontal plane.

Since the protons and antiprotons are traveling on different orbits they experience different nonlinear fields and therefore have different tunes, coupling, and chromaticities. These differential effects were measured and it was found that the produced differential tune and coupling could be explained by persistent currents in the main bending dipoles (B2) and the chromaticity sextupoles. However, no differential chromatic effects were observed.

A correction scheme was designed to correct these differential effects using existing sextupoles in the secondary correction spool packages in the Tevatron. The idea is to create three circuits, two for adjusting the tunes and one to correct coupling. The correction scheme consists of 46 sextupoles distributed around the ring, 16 normal sextupoles and 30 skew sextupoles. The tune adjusting sextupoles are connected in pairs such that their chromatic effects cancel. The three correction circuits are configured by controls software.

It is necessary to reconfigure the 23 hardware circuits into three software circuits whenever the lattice changes; i.e. at each step in the squeeze. The system (46 sextupoles) has more than enough strength to correct any differential effect. In fact the system was designed to also compensate for the beam-beam tune shift created by the head on collisions at B0 and D0. It was designed to compensate beam-beam tune shifts up to 0.020. However, it is not known if such strong sextupole fields will cause problems related to dynamic aperture effects. Part of the system has been tested and shown that a field strength can be achieved which allows correction of beam-beam tune shifts of 0.010. The partial system is currently being used to control the antiproton tunes at energies up to 500 GeV.

The construction of a colliding beam facility at the D0 long straight section section of the Tevatron, coupled with the presence of the CDF detector at the B0 straight section, has produced the need for a low beta insertion that unlike the old system, permits the simultaneous and essentially independent operation of more than one interaction region. The new low beta insertion enables simultaneous operation of a multiple of such systems by matching each insertion to the arcs of the machine in betatron and momentum space. Matched insertions in collider mode are independent except for the need to maintain a constant tune with distributed tune correction quadrupoles in the rest of the accelerator. The addition of each low beta insertion to the accelerator lattice raises the tune of the accelerator approximately a half unit unless compensated. The operating point of the collider has vertical and horizontal tunes with

**UNIVERSITÄT HEIDELBERG**

Das **PHYSIKALISCHE INSTITUT**
sucht ab **sofort** einen/eine

**Physiker(in)**
===========

oder

**Ingenieur(in) der Fachrichtung Technische Informatik**

für die Betreuung und den Ausbau der Rechner und des Lokalen Netzwerkes des Physikalischen Institutes der Universität Heidelberg sowie für die Installation und Wartung von Standard-Softwarepaketen am Institut.
Das Physikalische Institut hat eine hetrogene Rechnerinfrastruktur, die aus UNIX Rechnern verschiedener Hersteller (Hewlett Packard, Sun, Silicon Graphics), VAX-VMS Workstations und einer grossen Anzahl Personalcomputern (vornehmlich Apple Macintosh) besteht. Im Haus sind alle Rechner mittels Ethernet und Apple Localtalk vernetzt. Ein Anschluss an den FDDI-Ring der Universität Heidelberg (HD-net) führt auf überregionale Netze. Es werden verschiedene Netzwerkprotokolle benutzt (TCP/IP, Decnet, Apple Localtalk).
Vorausgesetzt werden Erfahrungen bei der Installation und Betreuung von Lokalen Netzwerken, eine Einarbeitung in das Arbeitsgebiet kann jedoch in gewissem Umfang geboten werden.
Die Stelle ist an die Gruppe "Hochenergiephysik" des Physikalischen Institutes angeschlossen. Eine Mitarbeit an den Forschungsprojekten in der weiter zur Verfügung stehenden Zeit ist möglich und erwünscht.
Die Vergütung erfolgt nach BAT.
Anfragen und Bewerbungen sind zu richten an :
**Physikalisches Institut der Universität Heidelberg,**
**Philosophenweg 12, D - 6900 Heidelberg.**

42ND SCOTTISH UNIVERSITIES SUMMER SCHOOL IN PHYSICS

SUSSP 93

"High Energy Phenomenology"

August 1-21, 1993; St. Andrews, Scotland, UK

Aimed at senior postgraduates, research fellows and senior staff looking to change fields. Lecturers include: –
I. J. R. Aitchison (Oxford), S. Bethke (Heidelberg)
A. Blondel (Ecole Polytechnique), P. Jenni (CERN),
E. Kolb (FermiLab), R. D. Peccei (UCLA),
W. J. Stirling (Durham) and G. Wolf (DESY).

Deadline for applications: March 31, 1993.
Fees including full board accommodation: £725 UK.
*Some financial assistance may be available to participants.*

Further details from School Secretary:
A Walker, Room 4409, Department of Physics,
The University of Edinburgh, Edinburgh EH9 3JZ, Scotland.
Tel: +44-31-650-5237 Fax: +44-31-662-4712
Telex: 727442 (UNIVED G) Email: SUSSP93@ed.ac.uk

A NATO ADVANCED STUDY INSTITUTE

# MIT

## ASSISTANT/ASSOCIATE DIRECTOR
### Laboratory for Nuclear Science

The responsibilities of this position include the following: broad, comprehensive responsibility for independently directing all administrative functions of the organization; assisting the Director and senior research management in implementing the goals of the Laboratory, which supports a large program in High-Energy and Nuclear Physics with $30M annual research volume; on behalf of the Director acting as key administrative liaison both inside and outside MIT; assisting in the development of long-range plans for research and staffing levels; analyzing fiscal status of the Laboratory, assisting faculty and staff in developing grant or contract proposals and in meeting reporting requirements; providing interface and promoting effective relationships with sponsors, MIT administration, affiliated organizations, and national and international collaborative efforts; overseeing all administrative elements within the Laboratory, including budgets, purchasing, personnel, public relations and other outreach programs, and resource allocation; and initiating and coordinating the preparation of special reports such as reports to sponsors, five-year plans, reports to the president, and public relations documents.

**Requirements:** an advanced degree in a science-related field or equivalent combination of education and experience, and significant experience in research administration highly desirable. Familiarity with a scientific research environment is necessary, as is the proven ability to interact effectively with sponsors and other offices in an MIT-like administrative environment.

Interested candidates should send two copies of both cover letter and resume referencing **Job No. R92-199** to: **Mr. Kenneth Hewitt, MIT Personnel Office, Bldg. E19-239, 77 Mass. Avenue, Cambridge, MA 02139-4307.**

MIT is an Equal Opportunity/Affirmative Action Employer
MIT is a non-smoking environment

**Massachusetts Institute of Technology**

# Super Collider Laboratory

## Experimental Particle Physics

The Physics Research Division of the Superconducting Super Collider offers positions in Experimental Particle Physics at levels ranging from Research Associate to Senior Scientist. Salary, term of appointment and level are commensurate with experience.

The SSC Laboratory supports research in particle physics at the SSC accelerator complex presently under construction. Physicists at the SSC Laboratory will play a key role in its experimental program, consisting of two major and several smaller experiments. The two larger detector projects, SDC and GEM, are presently in the detailed design and prototyping phase, with construction expected to begin in 1993. The smaller experiments are still the early phases of study and design.

Two research groups associated with each of the large experiments have formed and are looking for physicists with interest and experience in high energy physics, detector design, fabrication and operation, including electronics, data acquisition and software development. There are also opportunities to pursue detector R&D, to work as a liaison between the accelerator and experiments or on the design and operation of test beams.

During the next few years, scientists at the SSC Laboratory may be given the opportunity to participate on a part-time basis in external research activities. At present SSC physicists are collaborating on the CDF and DO experiments at the Fermilab Tevatron Collider.

**All applications including a statement of interest, curriculum vitae and three letters of reference, should be sent by March 1, 1993 to:**

**Dr. Vera Lüth**
**Scientific Appointments, MS 1999**
**SSC Laboratory**
**2550 Beckleymeade Ave.**
**Dallas, TX 75237-1997**

*The SSC Laboratory is an Equal Opportunity/Affirmative Action Employer and specifically invites and encourages applications from women and minorities.*

two collision regions of 20.576 and 20.585 respectively.

The insertions at both experimental regions are to be optically identical. The original low beta region at B0 was unmatched and produced a large beta and dispersion wave in the rest of the accelerator and was replaced. Each insertion is composed of 18 quadrupoles that are physically located symmetrically around the straight section region and in the arcs. The magnetic gradients are antisymmetric relative to the centre. A field free region, 15.24 m long, is available for each detector between the final quadrupoles. The lattice design is a relatively conventional one; the low gradient quadrupoles are used to provide the matching into the arcs, the high gradient ones provide the strong focussing close to the interaction point to give the small beam size. Nine independent circuits are used to vary the insertion optics. The inclusion of an extra circuit beyond the minimum of eight results in a reduction of the maximum values of both the dispersion and the beta functions in the arcs. The beta* at injection is 170 cm. Currently the beta* at the end of the squeeze is 50cm. The magnets are capable of going to 25cm.

Both the separators and the low beta insertions were commissioned at the beginning the current collider run which started last May. Both systems have performed reliably.

Further upgrades to the Fermilab accelerator complex include upgrading the linac to 400 MeV from 200MeV, improvements to the antiproton source, and construction of the Main Injector which will replace the Main Ring. These improvements are expected to yield another factor of ten improvement in the luminosity which can be delivered by the Tevatron collider.

## Magnetic precession in bent crystals

At Fermilab physicists have observed the magnetic swing (precession) of a fundamental particle 'channeled' in a bent crystal. In channeling electrically charged particles are gently steered by the planes of a perfect crystal, and a bent crystals can be used instead of magnets to deflect particle beams, for instance to extract them from an accelerator orbit. This latest experiment now shows another magnetic effect of a bent crystal – two 45 mm silicon crystals bowed through a tenth of a degree rotated particle axes through sixty degrees.

Many fundamental particles have magnetic moments associated with their intrinsic angular momentum (spin). For a stable particle such as the proton, this magnetic moment is measured using resonance techniques – with the tiny individual magnets lined up in a magnetic field, a supplementary modulating field can flip them over. Using protons, this is an important element in magnetic resonance imaging, now widely used for medical scanning.

However such traditional resonance techniques are not suitable for highly unstable particles such as sigma hyperons. If a hyperon is produced with its spin pointing in a particular direction, a magnetic field applied along a different direction will make that spin wobble (precess). This precession is seen in the resulting decay distribution, making it possible to measure the magnetic moment of the hyperon.

Due to the laws of electromagnetism, a particle moving fast through the internal electric field of a crystal 'sees' a strong magnetic field. Although the experiment at Fermilab gives a relatively coarse magnetic moment measurement, it opens up the possibility of magnetic moment measurements of charm and beauty baryons, with lifetimes a thousand times shorter than those of the hyperons. Knowledge of these magnetic moments would give valuable information about the charm and bottom quarks.

The experimental collaboration was drawn from institutions in four continents: four in Brazil, two from Russia and one from the UK, a team from China, and six groups in North America. The original idea for spin precession in a curved channeling crystal was suggested independently by V.G. Baryshevskii in Byelorussia and Lee Pondrom of Wisconsin. Vladimir Samsonov of the Institute of Nuclear Physics in St. Petersburg proposed the idea of carrying out the measurement at Fermilab.

## CERN/KEK Very high accelerating gradients

A world-wide effort is under way to develop linear electron-positron colliders so that physics experiments can be extended into a range of energies where circular machines (necessarily much larger than CERN's 27-kilometre LEP machine) would be crippled by synchrotron radiation.

CERN is studying the feasibility of building a 2 TeV machine called CLIC powered not by individual klystrons, but by a high intensity electron 'drive' linac running parallel to the main linac (November 1990, page 7). This drive linac will itself be powered by similar superconducting cavities to those developed for LEP.

# ATOMIC PHYSICIST

Lawrence Berkeley Laboratory (LBL) has an outstanding opportunity available for an experienced Atomic Physicist.

Working in collaboration with scientists from LBL and other institutions, the qualified candidate will develop, build and operate experiments to measure electron capture from pair production using relativistic heavy ion accelerators such as the Brookhaven AGS and RHIC. Will be responsible for the day-to-day progress of the research, including coordination of design, fabrication, assembly, installation and testing. Will participate in preparing proposals, operating the experiment, collecting and analyzing data, preparing journal articles and reports, making presentations and any duties incidental to the above responsibilities. Where possible, will collaborate with theorists to help develop a theoretical understanding of the phenomena being measured.

Applicants must have experience in measuring electron capture from pair production. Expertise in relativistic atomic collisions, as demonstrated by, among other things, publications in refereed journals, and demonstrated experience in completing atomic physics experiments with heavy ions at relativistic energies required. Expert knowledge of atomic collision processes involving atomic charge changing collisions of heavy ions, capture from pair production and resonant processes also required. Ph.D. in Atomic Physics or equivalent preferred.

Please send your resume and salary history to: **Lawrence Berkeley Laboratory, Staffing Office, Job# G/7378, One Cyclotron Road, MS 90/1042, Berkeley, CA 94720.** An equal opportunity employer.

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

# Massachusetts Institute of Technology
## Theoretical Nuclear Physics

Applications are invited for a junior faculty appointment in theoretical physics to work in the broadly defined area of hadronic physics and QCD. Candidates will be evaluated on the basis of potential contribution to both the undergraduate and graduate teaching programs of the Department of Physics, and to the research programs carried out in the Center for Theoretical Physics. The Center maintains a broad research effort at the interface of nuclear and particle physics and is participating in a major initiative to build a teraflops computer dedicated to QCD which, if successful, will offer outstanding opportunities to apply lattice gauge theory to hadronic physics and QCD. The Department of Physics supports large experimental research programs in hadronic structure and relativistic heavy ion physics. Women and under-represented minority candidates are particularly encouraged to apply. For exceptional candidates, a senior appointment may be considered. **Please send resumes and three letters of reference to Professor Kenneth Johnson, Department of Physics, 6-315, MIT, Cambridge, MA, 02139, USA.** MIT is an Affirmative Action/Equal Opportunity Employer.

Carleton
UNIVERSITY

## Research Associates in Experimental Particle Physics

The Centre for Research in Particle Physics (CRPP) and the Department of Physics at Carleton University invite applications for several Research Associate positions with the OPAL and SDC groups from candidates who have received their Ph.D. degrees in physics preferably within the last three years.

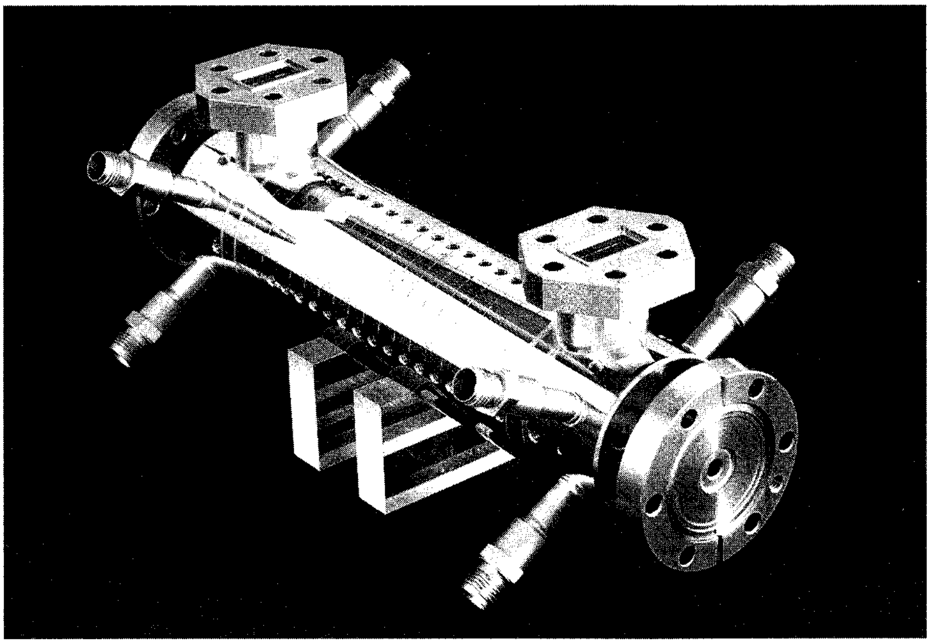
OPAL is a multi-purpose detector at the LEP electron-positron collider at CERN. Our responsibilities in OPAL include operating the vertex drift chamber and a cylindrical barrel of z-measurement drift chambers, components of the central track detector system. We are also involved in software development and physics analysis topics. The SDC (Solenoid Detector Collaboration) is one of two large experiments being built to operate at the SSC (Superconducting Super Collider). Our groups are involved in the development of the new technology of Gas Microstrip detectors for use in the intermediate tracking detector of the SDC experiment.

Please send resumé and the names and addresses of 3 references by March 30, 1993 to:

**M. McGregor**
**Centre for Research in Particle Physics**
**Carleton University**
**1125 Colonel By Drive**
**Ottawa, Ontario, Canada K1S 5B6**
**Fax: 613-788-7546**

*In accordance with Canadian immigration requirements, this advertisement is directed to Canadian citizens and permanent residents. Carleton University is committed to equality of employment for women, aboriginal peoples, visible minorities and disabled persons. Interested persons from these groups are encouraged to apply.*

*This short (20-cell) accelerating section developed by CERN's linear collider study group produced accelerating fields in excess of those required for CERN's CLIC linear electron-positron collider scheme when tested at the Japanese KEK Laboratory. (Photo CERN AC38.4.1992)*



A high gradient is an obvious design aim for any future high energy linear collider because it makes it shorter and therefore cheaper – the design figure for the CLIC machine is 80 MV/m.

The CLIC study group has taken a significant step forward in demonstrating the technical feasibility of their machine by achieving peak and average accelerating gradients of 137 MV/m and 84 MV/m respectively in a short section of accelerating structure during high gradient tests at the Japanese KEK Laboratory last year.

This result obtained within the framework of a CERN/KEK collaboration on linear colliders was obtained using a 20-cell accelerating section built at CERN using state-of-the-art technology which served both as a model for CLIC studies as well as a prototype for the Japanese Linear Collider studies.

The operating frequency of the model accelerating section is 2.6 times lower than the CLIC frequency but was chosen because a high power r.f. source and pulse compression scheme has been developed for this frequency at KEK. Testing CLIC models at 11.4 GHz is however more stringent than at 30 GHz because the chance of electrical breakdown increases as the frequency is lowered. This recent result clearly demonstrates that a gradient of 80 MV/m is feasible.

## CERN Accelerator school

Jyvaskyla, a university town in central Finland, was the setting for last year's General Accelerator School organized by the CERN Accelerator School. Well over a hundred students – more than for some time – followed two weeks of lectures on a broad spectrum of accelerator topics, the first step en route to becoming the designers, builders and operators of the surprisingly large number of, accelerators of all kinds either built or planned throughout Europe and further afield.

This was the fifth such school organized by CAS in a biennial cycle which alternates this introductory level with more advanced tuition. The next, advanced, school will be from 20 October – 1 November, hosted by

*Albert Hofmann of CERN and CERN Accelerator School Secretary Suzanne von Wartburg at the recent CAS General Accelerator School in Jyvaskyla, Finland. How to get out of the capsized kayak position was not part of the formal curriculum but nevertheless was extensively studied.*

Athens University on the Greek Island of Rhodes. (Application details will become available in Spring but would-be participants should already reserve the dates.)

After Finland, the CAS caravan moved to Benalmadena near Malaga in Spain where, together with Seville University, they organized one of the joint US-CERN schools held every two years and focusing on frontier accelerator topics. This time the subject was electron-positron factories – machines for high luminosity experiments in phi, tau-charm, beauty and Z physics. Experts from both sides of the Atlantic and from Japan shared their knowledge with an equally representative audience and probed the many intensity-related phenomena which must be mastered to reach design performance.

A number of these topics will receive extended coverage in the next specialist CAS School which is a repeat – by public demand – of the highly successful radio-frequency course held in Oxford in 1991. This school will be in Capri, Italy, with the support of the University of Naples from 29 April to 5 May. Details and application forms are now available by e-mail (CASRF@CERNVM.CERN.CH), by fax (+41 22 7824836) or from Suzanne von Wartburg, CERN Accelerator School, 1211 Geneva 23, Switzerland.

## WORKSHOP
## Stable particle motion

Particle beam stability is crucial to any accelerator or collider, particularly big ones, such as Brookhaven's RHIC heavy ion collider and the larger SSC and LHC proton collider schemes. A workshop on the Stability of Particle Motion in Storage Rings held at Brookhaven in October dealt with the important issue of determining the short- and long-term stability of single particle motion in hadron storage rings and colliders, and explored new methods for ensuring it.

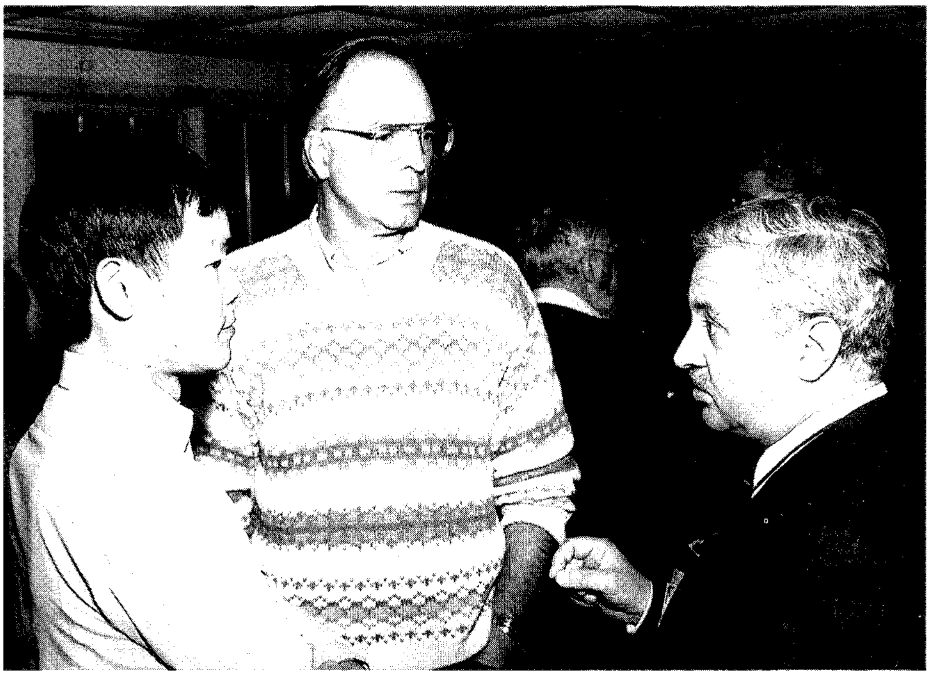
In the quest for realistic environments, the imperfections of superconducting magnets and the effects of field modulation and noise were taken into account.

The workshop was divided into three study groups: Short-Term Stability in storage rings, including chromatic and geometric effects and correction strategies; Long-Term Stability, including modulation and random noise effects and slow-varying effects; and Methods for determining the stability of particle motion. The first two were run in parallel, but the third was attended by everyone.

Each group considered analytical, computational and experimental methods, reviewing work done so far, comparing results and approaches and underlining outstanding issues. By resolving conflicts, it was possible to identify problems of common interest.

The workshop reaffirmed the validity of methods proposed several years ago. Major breakthroughs have been in the rapid improvement of computer capacity and speed, in the development of more sophisticated mathematical packages, and in the introduction of more powerful analytic approaches.

In a typical storage ring, a particle may be required to circulate for about a billion revolutions. While ten years



*At the recent Brookhaven workshop on the Stability of Particle Motion in Storage Rings – left to right, Alex Chao (SSC), Alex Dragt (Maryland), and workshop chairman Alessandro Ruggiero of Brookhaven.*

# Experimental High Energy Physics

## Massachusetts Institute of Technology

The Department of Physics has a long-standing and substantial commitment to experimental high energy physics and invites applications for a junior faculty position. The current faculty are engaged in major programs at both lepton (LEP, SLC, BEPS) and hadron (Tevatron, AGS) accelerators and are preparing for the next generation facilities LHC and SSC. At this time, our preference is for candidates whose research interests overlap those of the L3 experimental program at LEP although candidates of outstanding accomplishment will be considered in other areas. The M.I.T. group has a leadership role in the L3 program and thus is positioned to participate fully in the new science opened up by the LEP upgrade to 200 GeV. The candidate is expected to initiate a research program, supervise graduate students, and participate in the department's undergraduate instructional program. For exceptional candidates, senior faculty appointment may be considered. Candidates are asked to send a *curriculum vitae* and to have three letters of reference sent directly to the chairman of the search committee, Professor Stanley Kowalski, Department of Physics 26-427, Massachusetts Institute of Technology, Cambridge, MA 02139-4307, USA. Applications from women and underrepresented minority candidates are particularly encouraged. MIT is a non-smoking environment.

**PHYSIKALISCHES INSTITUT**
**DER UNIVERSITÄT BONN**

Am Physikalischen Institut der Universität Bonn ist ab 1.4.1993 die neugeschaffene

**Leitungsstelle für den Elektro- und Elektronikbereich**

zu besetzen. Die Vergütung erfolgt bis BAT Ia. Die Probezeit beträgt 1/2 Jahr.

Das Physikalische Institut treibt mit seinen experimentellen Gruppen Forschung in der hochenergetischen und mittelenergetischen Teilchenphysik und betreibt dazu eine Elektronen-beschleunigeranlage. Weitere Aktivitäten bestehen in der Forschung mit Synchrotronlicht sowie in der Erforschung der Planetenatmosphären. Der Elektro- und Elektronikbereich (E-Bereich) unterstützt diese wissenschaftlichen Forschungsarbeiten durch Entwicklung, Fertigung und Service elektronischer Komponenten und Geräte. Das Institut möchte die Infrastruktur seines E-Bereichs im Rahmen der verfügbaren Ressourcen verbessern und neue Richtungen in der Entwicklung elektronischer Komponenten und Bauelemente für die Experimente aufnehmen.

Für diese Aufgaben wird ein Leiter (eine Leiterin) des E-Bereichs gesucht mit Hochschulabschluss in einem einschlägigen Ingenieursstudium oder in Physik, der hohe Anforderungen an Organisationstalent und Führungsqualitäten erfüllt. Neben den selbstverständlich vorausgesetzten fundierten Kenntnissen in analoger und digitaler Elektronik für physikalische Experimente, bevorzugt der Teilchenphysik, und das Interesse an neuen Entwicklungen in der VLSI-Elektronik sowie an der Zusammenarbeit mit Diplomanden und Doktoranden erwünscht.

Bei gleicher Eignung werden Schwerbehinderte bevorzugt berücksichtigt.

Auskunft über die Stelle geben gerne Prof. B. Schoch (0228 732344) und Prof. N. Wermes (0228 733533). Bewerbungen werden bis 28.02.93 erbeten an den Geschäftsführenden Direktor des Physikalischen Instituts, Nussallee 12, D-W-5300 Bonn 1, Fax 0228 737 869, oder an die Personalabteilung 3.1 der Universität Bonn, Postfach 2220, D-W-5300 Bonn 1.

# Accelerator Physicist
# Electromagnetic Physicist/Engineer

TEXAS ACCELERATOR CENTER (TAC) invites applications for staff scientist positions in programs of accelerator development and related technologies. TAC is a research center within the Houston Advanced Research Center (HARC). Current research projects include 13 Tesla dual dipole for hadron colliders, 4 Tesla whole-body MRI for medical imaging, compact special-purpose MR imagers, 19 Tesla MR spectroscopy for structural biology, ion source and rf quadrupole for ion beams, compact proton synchrotron for tumor therapy, and superconducting magnetic energy storage.

Interested candidates for the Accelerator Physicist position should have a Ph.D. or equivalent in Physics and experience in theoretical or experimental accelerator physics. Activities may include superconducting magnet development, beam dynamics calculations, and proton accelerator systems.

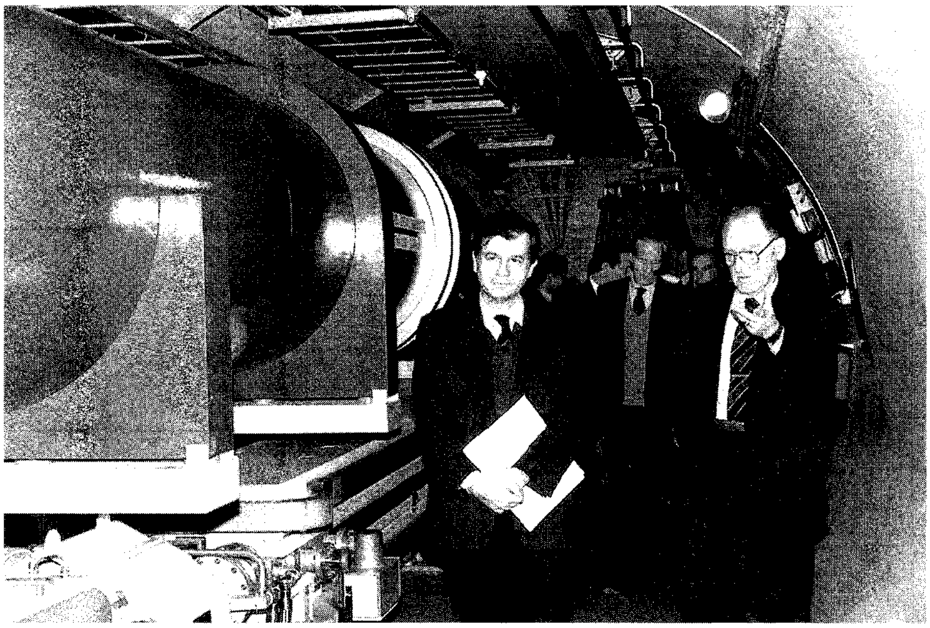
Electromagnetic Physicist/Engineer candidates should have a Ph.D. or equivalent in Physics or Electrical Engineering, programming experience in Fortran and other high level languages, experience in finite-element codes and integral methods for precise calculation of electromagnetic fields, magnetostatic calculations, rf and eddy current design computations. The successful candidate is expected to perform design calculations and develop new design methods for superconducting magnets and rf devices.

Applicants should send a resume, publication list, and names of three professional references to:
Dr. Peter McIntyre
Director, Texas Accelerator Center
HARC (T-200)
4800 Research Forest Drive
The Woodlands, Texas 77381, USA

HARC is an Equal Opportunity Employer

# People and things

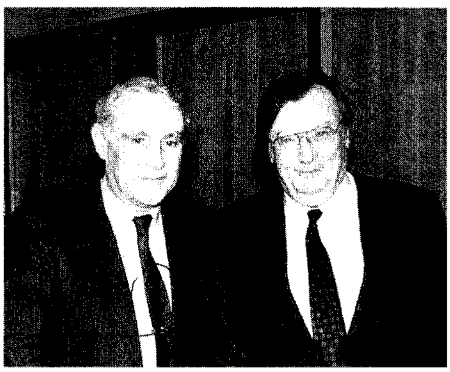
Italian Under Secretary of State Valdo Spini (left), visiting CERN on 2 December, is shown a full-scale model of the LHC/LEP tunnel by Giorgio Brianti.



ago it was only possible to predict accurately stability over about a thousand revolutions, it is now possible to predict over as many as one million turns. If this trend continues, in ten years it could become feasible to predict particle stability over the entire storage period. About ninety participants from the USA and Europe attended the meeting.

*From Alessandro G. Ruggiero*

Director General Carlo Rubbia (right) welcomes Swiss Federal Councillor Flavio Cotti to CERN on 4 December.



## On people

*Bikash Sinha, Director of the Variable Energy Cyclotron Centre, Calcutta, also becomes Director of Calcutta's Saha Institute of Nuclear Physics.*

*Alexander Feschenko of the Institute for Nuclear Research of the Russian Academy of Sciences has recently received the Faraday Cup Award for his paper: Bunch Shape Measuring Technique and its Application for an Ion Linac Tuning. The award is given for an outstanding contribution to the development of an innovative beam diagnostics instrument of proven workability.*

*The Faraday Cup Award was refereed and presented by the committee members of the 1992 Accelerator Instrumentation workshop that was held at Lawrence Berkeley Laboratories on October 27-30. The prize was donated by Julien Bergoz of Bergoz Inc.*

## UK awards

*This year the UK Institute of Physics Guthrie award, for a physicist of international reputation, goes to Ian Butterworth, while the Institute's Maxwell award, for contributions to theory, goes to Thomas Kibble. Both are at London's Imperial College.*

*Butterworth, CERN Research Director from 1983-6, moved from a pivotal role in UK bubble chamber research to become Head of Department at Imperial before coming to CERN. In 1986 he became Principal of London's Queen Mary College. After a formal retirement he has moved back to research at Imperial.*

*Kibble is honoured for his numerous contributions to theoretical physics, particularly in gauge theories. Many of these contributions hinge on the subtle but pervasive symmetry breaking effect which has subsequently become known as the Higgs mechanism. He was Head of Department at Imperial from 1983-91.*

Xiaodong Zhang (left) of Stony Brook receives the first Gertrude S. Goldhaber Physics Prize at Brookhaven. The prize honours Gertrude Scharff-Goldhaber (second from right) noted nuclear physicist and long-time promoter of opportunities for women in science, seen here with her husband, former Brookhaven Director Maurice Goldhaber (right). The prize was presented by their son Alfred, also of Stony Brook.

Karen Avetovich Ter-Martirosyan – 70th birthday

## Ter-Martirosyan at 70

On 5 October a special seminar at Moscow's Institute of Theoretical and Experimental Physics marked the 70th birthday of theorist Karen Avetovich Ter-Martirosyan. A student of Yakov Frenkel and Lev Landau, his initial contributions came in the Coulomb excitation of nuclei. After pioneer work on the three nucleon system he went on to Regge theory and multiple hadron production. His students have also gone on to make their mark.

## Yakov Abramovitch Smorodinsky 1917-1992

Prominent theorist Yakov Smorodinsky died in Dubna on 16 October. Working at Moscow's Kurchatov Institute and the Joint Institute of Nuclear Research, Dubna, his interests ranged widely, but his main contributions came from the application of ideas from algebra and geometry to nuclear and particle physics. His main passion was books, where he collected an extraordinary library and edited many Russian editions of Western physics works.

## US Particle Accelerator Conference

The fifteenth biennial US Particle Accelerator Conference will convene at the Omni Shoreham Hotel in Washington, DC, May 17-20. Under a new arrangement, the conference is jointly sponsored by the Institute of Electrical and Electronics Engineers (IEEE) Nuclear and Plasma Sciences Society (NPSS) and the American Physical Society (APS) Division of Physics of Beams (DPB). The conference serves as the annual meeting of APS/DPB. Conference chair is Christoph W. Leemann of CEBAF, program chair is Joseph J. Bisognano of CEBAF, program deputy chair is Helen Edwards of Fermilab, and local arrangements chair is I.E. Campisi of CEBAF. A tour to CEBAF, about 200 km south of Washington, near Williamsburg, Virginia, is being organized for May 21 for those interested. For further information contact Avril Quarrie, PAC93 Program Coordinator: CEBAF MS 12-A1, 12000 Jefferson Avenue, Newport News, Virginia 23606-1909, USA, telephone/fax (804) 249-6377/5024; e-mail quarriea@cebaf.gov .

Yakov Abramovitch Smorodinsky 1917-1992

### *Bubble Chamber Conference*

*A conference at CERN from 14-16 July will mark the fortieth anniversary of the bubble chamber. Speakers will cover both the development of the technique and its numerous contributions to physics. Further information from Susannah Tracy at CERN, e-mail bubbles@cernvm.cern.ch Early application is advised as attendance will be limited to 300.*

### *1993 European School of High-Energy Physics*

*The 1993 European School of of High-Energy Physics (formerly CERN-JINR School of Physics) will take place from 12-25 September near Zakopane, Poland. Topics covered will include Field Theory, Radiative Corrections, QCD, the Standard Model and Beyond, CP Violation, and Experimental Techniques; with additional lectures on HERA and LEP results. Further information from: Miss S.M. Tracy, CERN School of Physics, CERN – DG-A, 1211 Geneva 23, Switzerland. E-mail tracy@cernvm.cern.ch Telex: 419000 cer ch Telephone: + 41 22 767 27 24 Telefax: + 41 22 782 30 11 Closing date for applications is 31 March.*

### *Meetings*

*Instrumentation specialists LeCroy are sponsoring their Third Annual Conference on Electronics for Future Colliders, to be held at their Chestnut Ridge, New York, headquarters on 4-5 May. Further information from George Blanar, LeCroy Corp, 700 Chestnut Ridge Rd, Chestnut Ridge, NY 10977-6499, tel (914) 578 6012, fax (914) 578 5984.*

### *CERN Council*

*At the December meeting of CERN Council, the Organization's governing body, Chairman Sir William Mitchell, after opening his report by congratulating Georges Charpak on his 1992 Nobel Prize, explained adjustments for the future contributions of Germany to the Laboratory's budget.*

*A letter from the German delegation, earlier considered by the Committee of Council, had asked CERN Member States to take account of German's special reunification burden through a temporary reduction of the German contribution to CERN's budget.*

*A rebate of some 10% of Germany's contribution to CERN's budget*

*European Physical Society President Maurice Jacob (right) with S. Krupicka, Director of the Czechoslovak Academy of Sciences, at the recent EPS "Large Facilities" meeting at the newly amalgamated Institut Laue-Langevin (neutron beams) and European Synchrotron Radiation Facility complex at Grenoble.*

## Laboratory correspondents

Argonne National Laboratory, (USA)
**M. Derrick**

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, (USSR)
**B. Starchenko**

KEK National Laboratory, (Japan)
**S. Iwata**

Lawrence Berkeley Laboratory, (USA)
**B. Feinberg**

Los Alamos National Laboratory, (USA)
**C. Hoffman**

Novosibirsk, Institute, (USSR)
**V. Balakin**

Orsay Laboratory, (France)
**Anne-Marie Lutz**

PSI Laboratory, (Switzerland)
**R. Frosch**

Rutherford Appleton Laboratory, (UK)
**Jacky Hutchinson**

Saclay Laboratory, (France)
**Elisabeth Locci**

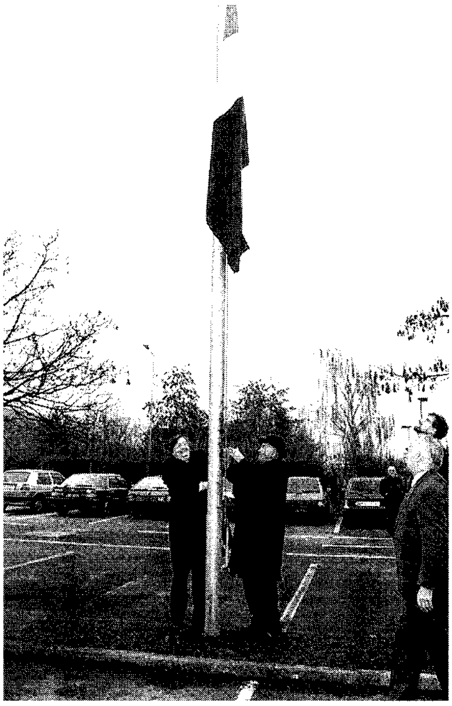
IHEP, Serpukhov, (USSR)
**Yu. Ryabov**

Stanford Linear Accelerator Center, (USA)
**M. Riordan**

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

TRIUMF Laboratory, (Canada)
**M. K. Craddock**

On 18 December, during the end-year meeting of CERN Council, Hungary's flag was hoisted at CERN by CERN Director-General Carlo Rubbia (left) and Erno Pungor, Minister President of the Hungarian National Council for Technological Development, watched by CERN Council President Sir William Mitchell (right). The country had become the Organization's 18th Member State on 1 July.



will be granted for the three years 1994-6, and the situation will be reassessed in 1995 with a view to possibly continuing the arrangement for another two years (1997-8) at the most. This limited duration arrangement calls for no formal modification of the ground rules in CERN's Convention.

At the Council meeting, Christopher Llewellyn Smith of Oxford was appointed as CERN's next Director General, to succeed Carlo Rubbia. He will take office on 1 January 1994.

Günter Wolf of DESY was elected Chairman of CERN's Scientific Policy Committee (SPC) for a period of one year. New SPC members are M. Danilov of ITEP Moscow, Felicitas Pauss of ETH Zurich, Jean-Paul Repellin of IN2P3 Paris, David Saxon of Glasgow, and Gustav-Adolf Voss of DESY. Günter Flügge of Aachen has become Chairman of ECFA, the European Committee for Future Accelerators.

At CERN, John Ferguson becomes Leader of Administrative Support (AS) Division and Jean-Pierre Gourber Leader of Accelerator Technology (AT) Division from 1 January 1993.

## CERN Accelerator School Proceedings

The following CERN Accelerator School Proceedings can be obtained free-of-charge from: CERN Accelerator School, SL Division, 1211 Geneva 23, Switzerland. Fax: +44 22 782 4836.

"Antiprotons for colliding beam facilities", CERN 84–15 (December 1984).
"The generation of high fields for particle acceleration to very high energies", ECFA 85/91, CERN 85–07, (June 1985).
"General accelerator physics", CERN 85–19 (2 vols.) (November 1985).

"Advanced accelerator physics", CERN 87–03 (2 vols.) (April 1987).
"Applied geodesy for particle accelerators", CERN 87–01 (February 1987).
"Second general accelerator physics course", CERN 87–10 (July 1987).
"New developments in particle acceleration techniques", CERN 87–11, ECFA 87/110, (2 vols.) (October 1987).
"Second advanced accelerator physics course", CERN 89–01 (February 1989).
"Superconductivity in particle accelerators", CERN 89–04 (March 1989).
"Third general accelerator physics course, CERN 89–05 (April 1989).
"Synchrotron radiation and free electron lasers", CERN 90–03 (April 1990).
"Third advanced accelerator physics course", CERN 90–04 (April 1990).
"Power converters for particle accelerators", CERN 90–07 (July 1990).
"Fourth general accelerator physics course", CERN 91–04 (May 1991).
"RF engineering for particle accelerators", CERN 92-03 (2 vols.) (June 92).
"Fourth advanced accelerator physics course", CERN 92-01 (April 1992)
"Magnetic measurement and alignment", CERN 92-05 (September 1992)
"Fifth general accelerator physics course 1992", to be published.
"Fifth advanced accelerator physics course 1993", to be published.

## Robert Marshak 1916-1992

Robert E. Marshak died in December. A tribute will appear in our next edition.