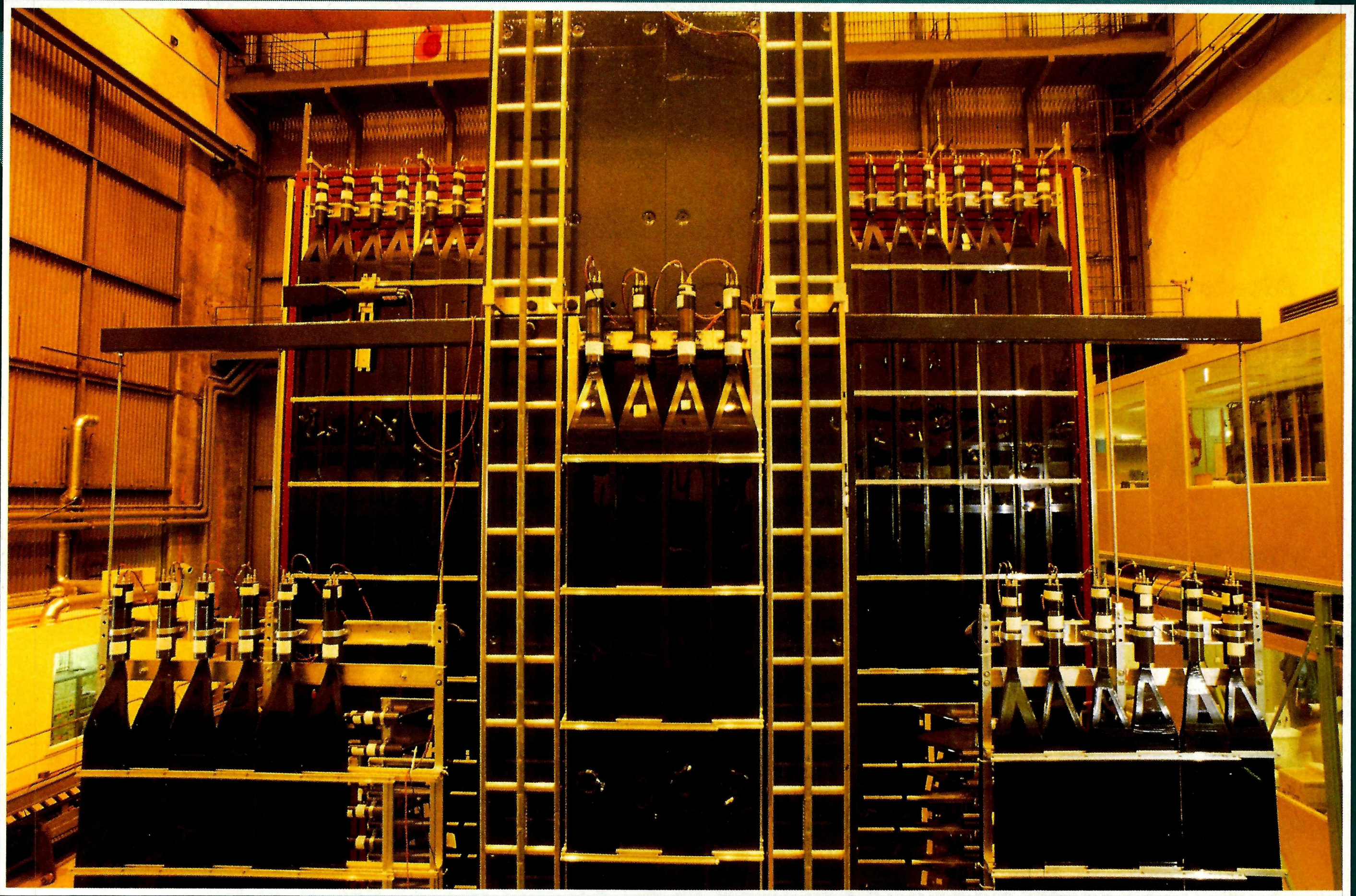
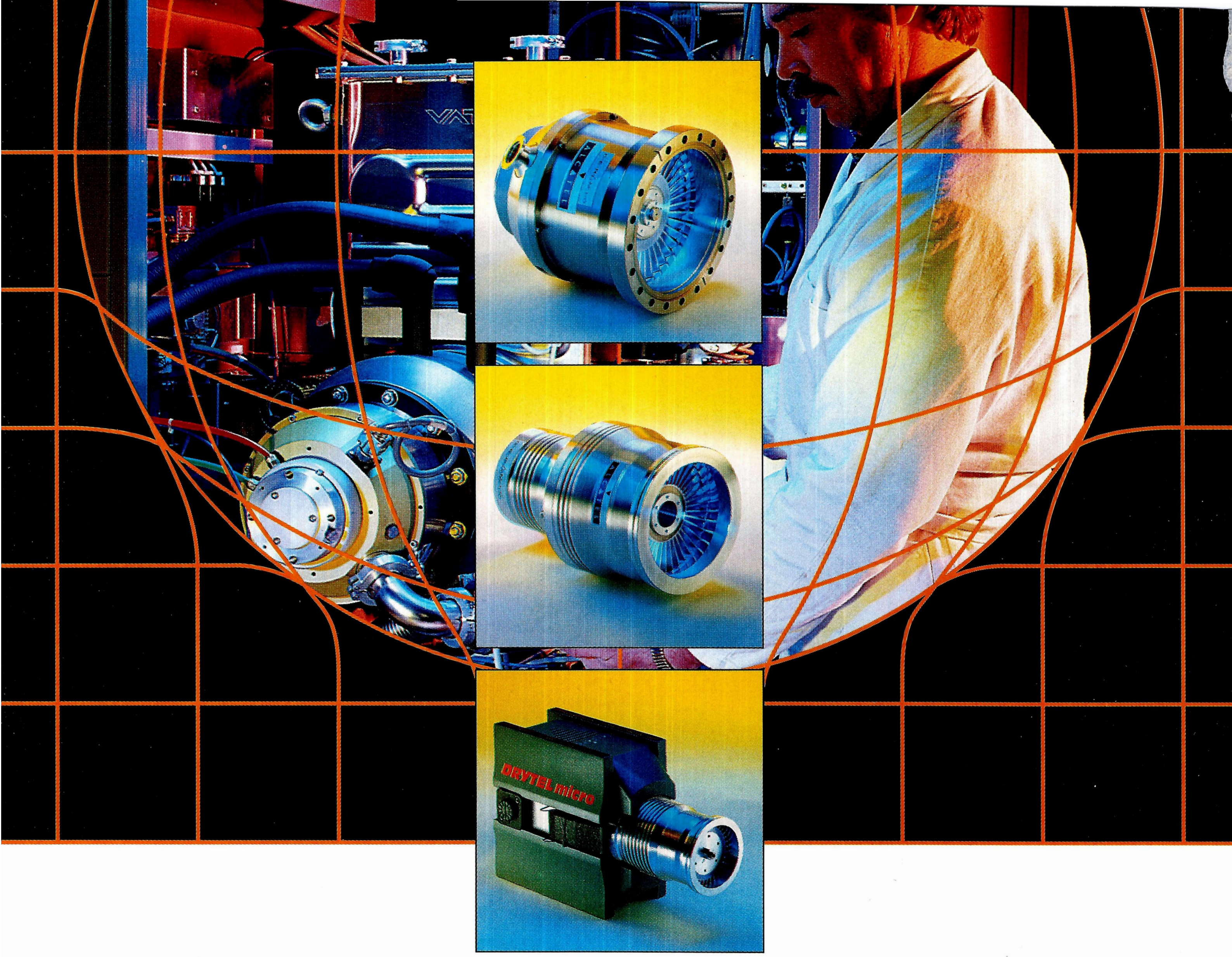
CERN COURIER

INTERNATIONAL JOURNAL OF HIGH ENERGY PHYSICS

VOLUME 34 2 MARCH 1994





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EUROCOM QUARTET Annecy - ALA319 - 01/94

Volume 34
No. 2
March 1994

Covering current developments in high energy physics and related fields worldwide

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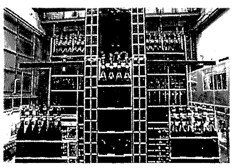

Cover photograph: Veto scintillator counters now adorn the front of the spectrometer magnet for the NOMAD experiment at CERN. Together with CHORUS, these two major neutrino beam experiments are a major feature of CERN's ongoing programme of fixed target physics for the 1990s (see page 1). (Photo CERN EX34.11.93)

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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
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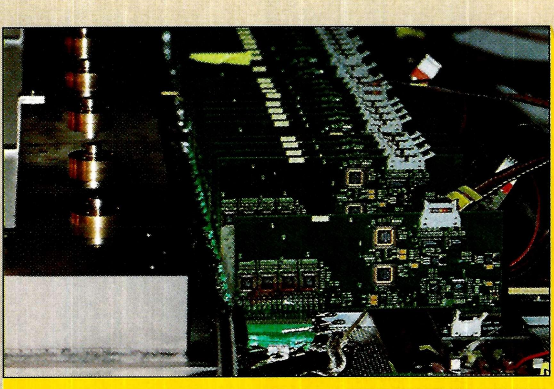
Four Reasons to Use PCOS 4



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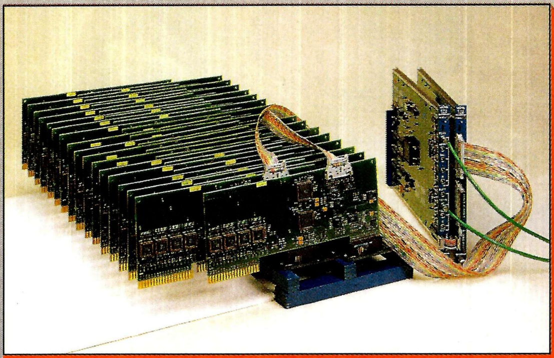

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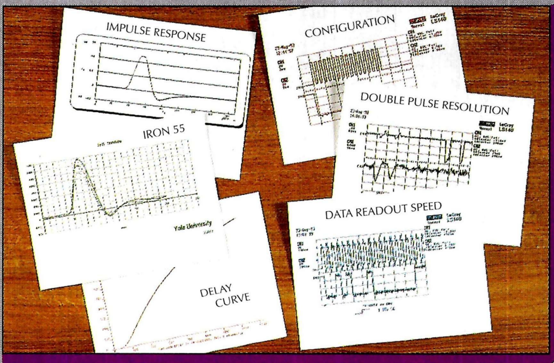

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* PCOS 4 was developed in cooperation with Yale University and Brookhaven National Lab. Photo courtesy of BNL.

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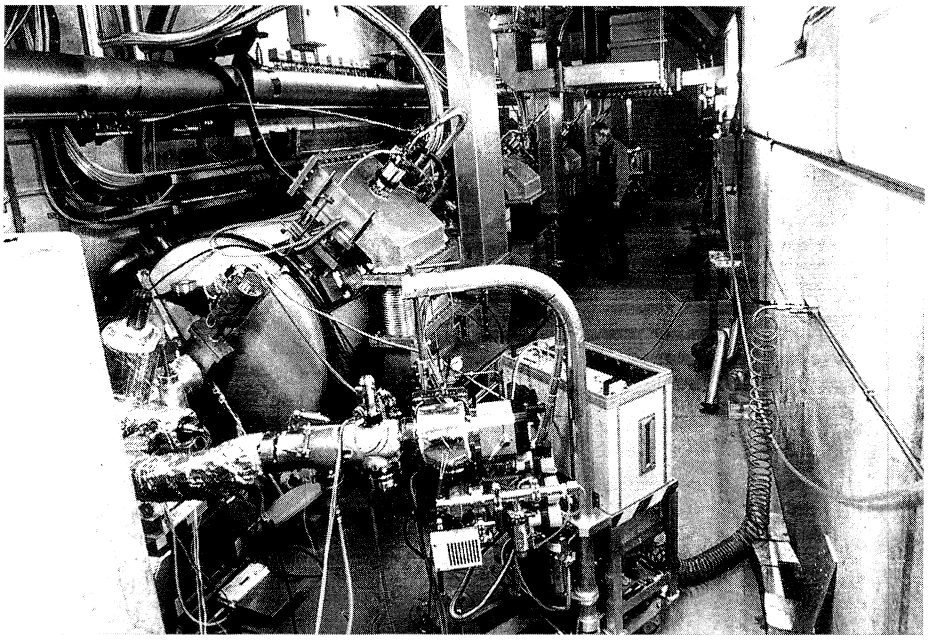
Wide ranging research

Testing a LEP superconducting accelerating cavity. Currently operated on the Z peak, LEP will have its energy doubled to explore the region above the W pair threshold and to extend further its scope for particle searches. Boosting LEP's energy was part of the original idea to construct a collider of such an ambitious design.
(CERN AC 18.12.93)



Diversity has always been a CERN trump card. Alongside the flagship experiments at the high energy frontier (yesterday at the SPS proton synchrotron, today at the LEP electron-positron collider and tomorrow at the LHC) research at lower energies has been an important factor in the success of CERN.

As well as cost-effective exploitation of accelerator infrastructure, this acknowledges that high energy is not always necessary for new discoveries. The current user community is split more or less evenly between LEP and the lower energy programmes, which include the ISOLDE on-line isotope separator, the LEAR low energy antiproton ring, the fixed-target SPS programme and heavy ion studies.

LEP

Currently operated on the Z peak, LEP will have its energy doubled to explore the region above the W pair threshold and to extend further its scope for particle searches (January/February, page 6). Together with the detailed study of the Z, this was an essential motivation in the decision to construct a collider of such an ambitious design. Doubling LEP energy will open up three major physics issues:

- increased scope for particle searches;
- a direct study of the WWZ coupling, of fundamental importance for understanding electroweak interactions; and
- a precision measurement of the W mass to tighten constraints on the top quark and higgs boson masses and on possible extensions of the Standard Model.

Doubling LEP's energy is a major technical enterprise, with installation of 192 superconducting cavities. With reaction rates being typically three to four orders of magnitude below those at the Z peak, luminosity as well as energy is at a premium.

Thus it has been decided to replace the present copper cavities by 32 additional superconducting cavities of lower impedance, which can therefore accept higher beam currents. The four LEP detectors are being prepared to exploit the higher energy collisions in optimum conditions (January/February, page 6). This second phase of LEP operation would last for four years.

An attractive possibility would have been high precision asymmetry measurements using longitudinally polarized beams.

However, and in spite of the remarkable results obtained at LEP after its realignment in early 1993, which resulted in transverse polarizations in excess of 50%, the success of the SLC linear collider at Stanford (SLAC) in reaching high polarizations makes this option much less competitive.

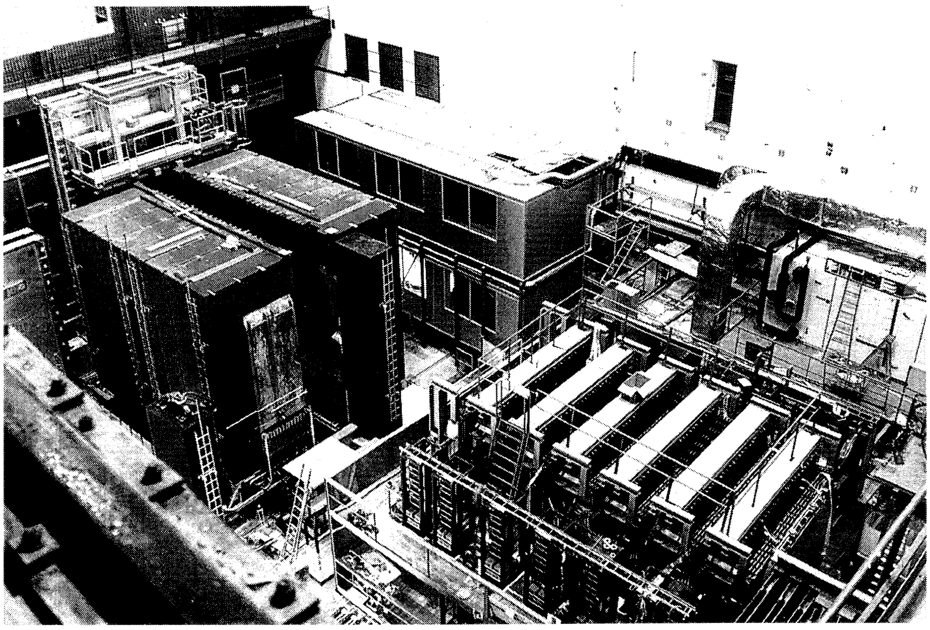
Heavy ions

After a pause of two years for the installation of a new injector (April 1992, page 8), the ion programme will resume this year with much heavier projectiles.

Ion experiments have been an important element of the CERN research programme since the mid-80s. A first phase used medium mass ion beams, oxygen and then sulphur, accelerated in the SPS to some 200 GeV per nucleon. The main motivation has been the study of a temperature-density region where quarks and gluons are no longer expected to be confined inside hadrons, a domain which played an important role in the genesis of the Universe.

The oxygen/sulphur experiments have provided evidence for high temperature-density intermediate states and have identified candidate

The new CHORUS and NOMAD neutrino experiments at CERN's SPS proton synchrotron take their first data this year. Over the next few years, these experiments aim to probe an unexplored region of neutrino masses and mixing parameters where astrophysical data suggest that oscillations may take place. On the right is the CHORUS muon spectrometer, while on the left is the big NOMAD spectrometer magnet, considerably instrumented since this photo was taken (see cover). Initial beam tests for these experiments late last year were very encouraging. (CERN EX 44.7.93)



signatures for the deconfined phase.

The programme has naturally developed into a second generation using lead projectiles to increase considerably the volume and lifetime of the quark-gluon plasma to make it more clearly visible.

For this new phase of ion physics, some experiments require only modest upgrades. Such is the case with NA44, which measures the size of the plasma when it cools down into hadrons using interferometric techniques, with NA50 which studies J/psi production and measures the mass spectrum of muon pairs, with WA97 which detects strange baryons in the Omega spectrometer, and with WA98 which focuses on photon production. Other experiments could not have survived the very high multiplicities and had to be completely redesigned.

NA49 will use large time projection chambers to disentangle the complex pattern of charged particles produced in the final state. While most experiments will have completed datataking after a few years, NA49 can be expected to run longer and eventually carry out more advanced experimental studies.

As a guideline, it is planned to stop WA97 and WA98 after the 1996 run. NA49 is expected to run for two additional years while other experiments in the North Area could also remain active. Heavy ion operation can proceed in parallel with LEP operation but not with SPS fixed-target work.

This heavy-ion programme will also pave the way for the exploitation of the LHC as an ion collider.

SPS fixed-target

After the advent of high energy colliders, the SPS fixed-target programme today focuses on a few high quality experiments using particles which cannot be stored in colliders - pions, hyperons, muons, neutrinos and neutral kaons.

A rich spectroscopy programme is currently active with the Omega spectrometer with WA89, WA91 and WA92 but should not extend beyond 1996. This will free significant resources in the West Area and make space for storage and assembly of components for the LHC.

By then, new test beams will be available in the North Hall to compensate for the loss of West Area test beams. In practice, West Area phaseout and opening new test lines in the North will be progressive, with important work distributed over the long shutdowns at the end of 1996 and 1997.

In the North Area the SMC experiment (NA47), which studies the spin structure of the nucleon by scattering polarized muons on a polarized nucleon target, could be extended through to 1996.

After encouraging beam alignment tests late last year, the new CHORUS and NOMAD neutrino experiments take their first data this year. Their aim is to probe an unexplored region of neutrino masses and mixing parameters where astrophysical data suggest that oscillations may take place. These results will be of great interest to cosmologists as well as the particle community. This physics should be complete by the end of 1997, with a complete shutdown of the West extraction in 1998 in preparation for the LHC.

For a possible future neutrino research programme, neutrinos from beams using a new LHC transfer tunnel could be pointed towards the Italian Gran Sasso Laboratory 730 kilometres away, to detect oscillations over a very long baseline.

The CP violation experiment NA48 completes the list of experiments currently scheduled in the SPS fixed-target programme. To begin in 1995, it is the successor of a long series of experiments which have studied the neutral kaon system. In five years, its task should be complete.

LEAR

The LEAR low energy antiproton ring is currently producing important results in meson spectroscopy and in CP violation in the neutral kaon system.

Three large experiments, OBELIX, Crystal Barrel and JETSET take advantage of the large gluon content of proton-antiproton annihilation to search for unconventional light mesons such as glueballs, hybrids and multi-quark states. Particularly successful are Crystal Barrel and OBELIX, which complement each other in the study of multi-pion final states where evidence for new mesons has been found. At least two more years will be necessary to complete this study.

The CPLEAR experiment studies CP violation using an approach complementary to NA48. While CPLEAR cannot compete with NA48 in evidence for direct CP violation, it brings significant improvements to several other important parameters. An extension into 1995 is very likely.

Many other LEAR experiments have an original approach to problems of atomic and nuclear physics. Experiment PS196 traps very cold antiprotons, making it possible to compare proton and antiproton masses to one part in a billion. This opens up very attractive prospects for ultra-low energy antiprotons in atomic physics, for example in the spectroscopy of antihydrogen. However such a programme would require many years to come to fruition.

The overall plan sees LEAR research terminating by the end of 1996. The important resources used by the LEAR programme (it is the sole CERN market for antiprotons) makes it an obvious source of manpower and funds for the LHC. LEAR's conversion into an ion-accumulation ring for LHC ion injection will require its availability by the end of the century.

ISOLDE

After being moved from its former home at the synchrocyclotron to the PS Booster, ISOLDE has now resumed operation successfully (May 1993, page 13). While a rich programme is currently under way on the general-purpose separator, preparations for the installation of the high-resolution separator are in progress. ISOLDE research will certainly justify continuation until the end of the century.

The ISOLDE community has expressed interest in building at CERN a unique world facility for radioactive beams, providing exotic beams of up to 6-10 MeV per nucleon for astrophysics and nuclear physics studies. Although such a development cannot be excluded, such a facility could be built elsewhere.

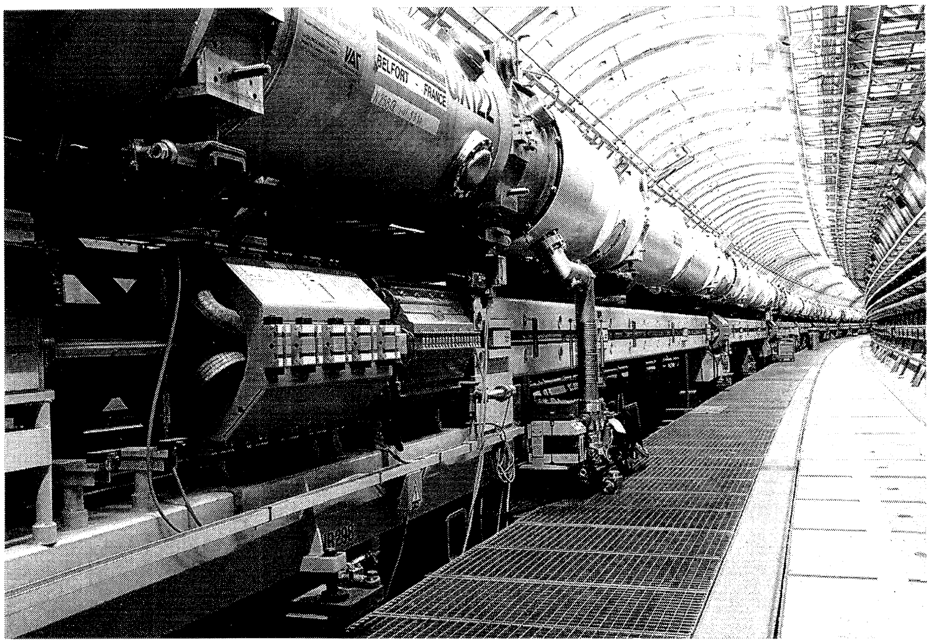
It is difficult to plan research for a decade. Flexibility will be required to accommodate new physics directions, and a modest contingency (some 10 MCHF per year) has been allowed.

A concern is the low level of productive research during the early years of the next century when most of the available resources and efforts will be concentrated on LHC completion. Part of this period will be used to analyse collected data. While all efforts will be made to avoid the early termination of productive programmes, a significant reduction of the experimental activity in the years 2000-2 will be a price to pay for the LHC.

As well as its baseline proton programme, the new machine will open up heavy-ion collisions and fixed-target experiments, while the electron-proton collision option provided by having LEP and LHC in the same tunnel provides an additional long-term prospect. Together with ISOLDE and possible new initiatives (for example with neutrinos), this programme would maintain the diversification which has always been CERN's trademark.

Around the Laboratories

Tunnel vision. DESY's HERA electron-proton 6.3 kilometre collider ring, with, above, the superconducting magnets to guide the protons, and, below, the conventional electron ring.



DESY HERA looks back, and forward

The HERA electron-proton collider at the DESY Laboratory in Hamburg has completed a successful second year of operation, with achievements and progress so far promising well for 1994.

The collider was commissioned in October 1991 and during the winter 1991-92 shutdown the two major experiments (H1 and ZEUS) were installed in the ring. HERA commissioning resumed in April 1992 and by the end of June the experiments had their first meals of electron-proton collisions. 1992 peak luminosity with nine colliding bunches in each ring was roughly 2×10^{29} $cm^{-2}s^{-1}$. By the end of that year a total integrated luminosity of 58 nb^{-1} had been delivered to each of the experiments, with 25 nb^{-1} recorded.

The 1992-93 winter shutdown was used to upgrade the HERA control system and to prepare for multibunch operation, with several feedback systems installed. The 1993 peak luminosity with 84 colliding bunches in each ring was 1.5×10^{30} compared to the design value of 1.5×10^{31}, with 210 colliding bunches in each ring. By the end of October 1993 a total integrated luminosity of 1088 nb^{-1} had been delivered to ZEUS and 998 to H1. Some 60% of this data was recorded on tape by each experiment.

In 1992 the maximum electron current which could be stored with lifetimes of the order of a few hours at 27 GeV was strongly limited. All observations suggested that this was caused by macroscopic particles trapped in the strong field of the circulating beam. By replacing two vacuum chambers the current could be raised from 3 to 20 mA. It has now been concluded that these macroscopic particles might be emitted by the distributed ion getter pumps in the dipole and quadrupole magnets. By lowering the voltage on these pumps a current of 33 mA with an acceptable lifetime of several hours has been stored at 26.7 GeV. This can be compared to the design current of 58 mA. So far the maximum achieved current has been limited by the vacuum of the radiofrequency cavities.

HERA's transverse electron beam polarization is determined by measuring the up-down asymmetry of backscattered polarized laser light using a tungsten-scintillator sandwich counter. The observed polarization of more than 60% is built up in 31 minutes (March 1993 issue, page 6). This healthy polarization was furthermore shown to be both robust and reproducible and can coexist with luminosity operation. This cleared the way for further planning of experiments.

A pair of 60m spin rotator magnet chains designed to turn the transversely polarized electron beam in the arcs into states of well defined helicity at the collision point and to restore the transverse polarization before the electron enters the downstream arc is now being installed in straight section East. It will be used by the recently approved third HERA experiment, HERMES, to study collisions with polarized atomic beams. Two sets of spin rotators for the H1 and ZEUS experiments are on order and will be installed in the 1995-96 shutdown.

The cryogenic system and the superconducting magnets are the most challenging components of the HERA proton ring. Both systems have been very reliable and none of the superconducting magnets has had to be removed in three years of operation.

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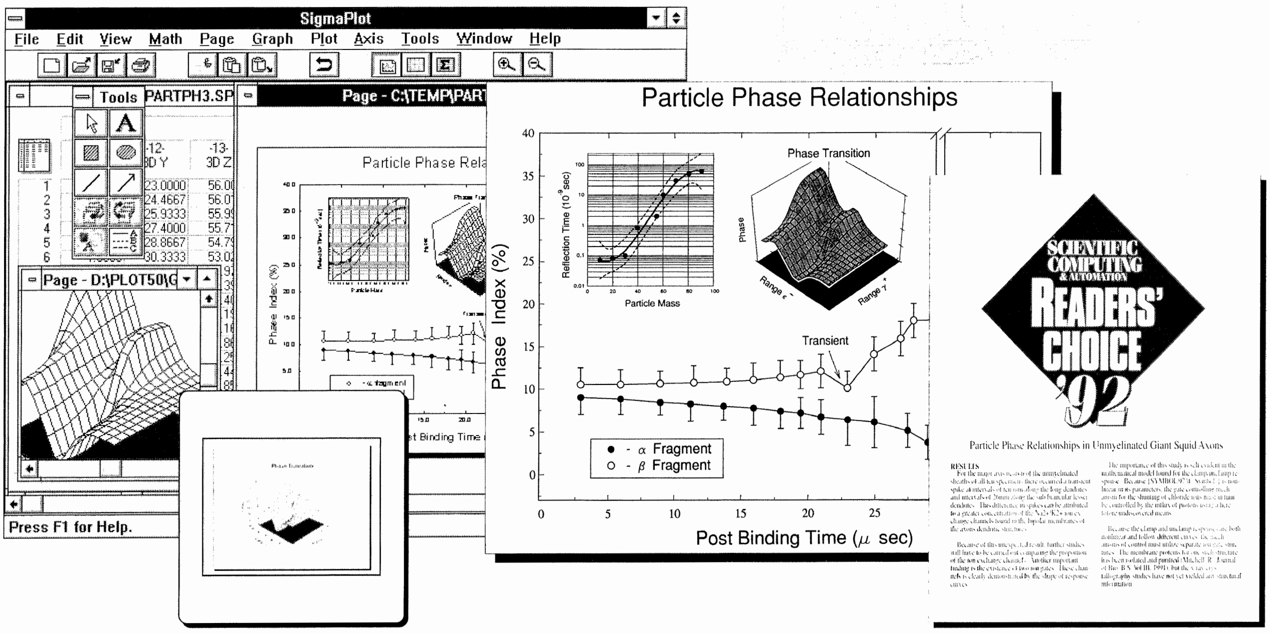

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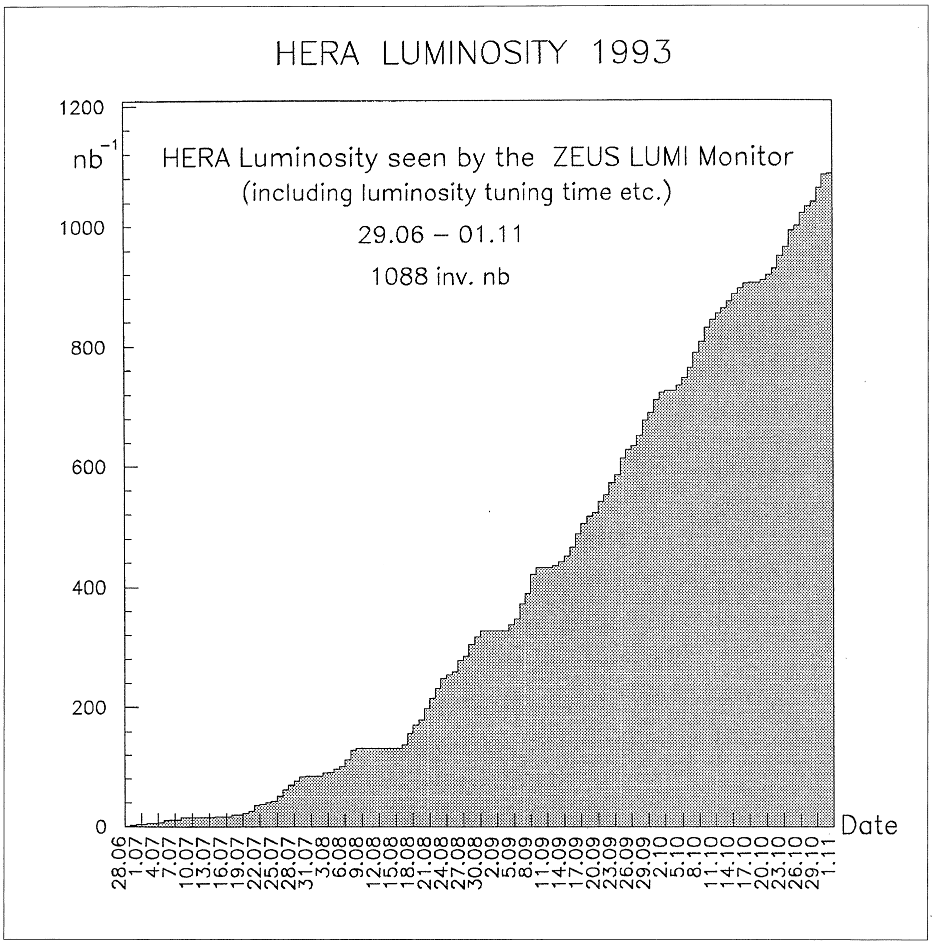
Steady growth of 1993 luminosity at DESY's HERA electron-proton collider.



magnets, using information from two reference magnets running in series with the ring magnets, the proton beam lifetime at injection is of the order of 10 hours, while the complete filling procedure takes just a few hours.

The single bunch current was limited to some 4×10^{10} protons per bunch compared to the design value of 10^{11}. This limit occurs in the 7.5 GeV proton preinjection in PETRA II, at HERA during injection at 40 GeV, and in the first part of the energy ramp. Feedback systems to cure these instabilities are now being installed. A total of 33 mA has been stored at 820 GeV in 84 bunches compared to the design value of 158 mA in 210 bunches. The measured normalized emittance was between 10 and 15 p mm mrad in both planes, compared to the design value of 20.

During the 1992 run and initial 1993 operations, protons were accelerated and stored using only the 52 MHz r.f. system yielding a bunch length of roughly 20 cm. Turning on the 208 MHz system reduced the bunch length to an average 14 cm (.46 ns), with a best value of 10 cm (.33ns).

While the number of electron bunches has been limited by the maximum electron current which can be stored, the number of proton bunches is chosen to match the number of electron bunches. At the end of 1993 a test with 180 proton bunches and 33 mA current was successful.

Proton beam lifetime is in general longer than 100 hrs, compared to a typical 6 to 20 hrs lifetime of the electron beam. Thus in general protons are filled once every 24 hours while electrons are dumped and reinjected every 4-5 hours.

The specific luminosity, defined as the luminosity per unit current of both beams, is a measure of the correct beam overlap and of the transverse beam dimensions. Whereas the luminosity drops by a factor of 3 during an 8 hour store, the specific luminosity remains constant. The specific luminosity is now nearly a factor of two above its design value.

Operations ceased in November 1993 for the usual winter shutdown and will resume in May 1994. Primary goal will be operation with 180 bunches per beam. In retrospect 1993 HERA operation was very successful. The progress achieved promises that the original design parameters will soon be reached, and perhaps even improved in some cases.

INTERNATIONAL COLLABORATION US panel members named

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

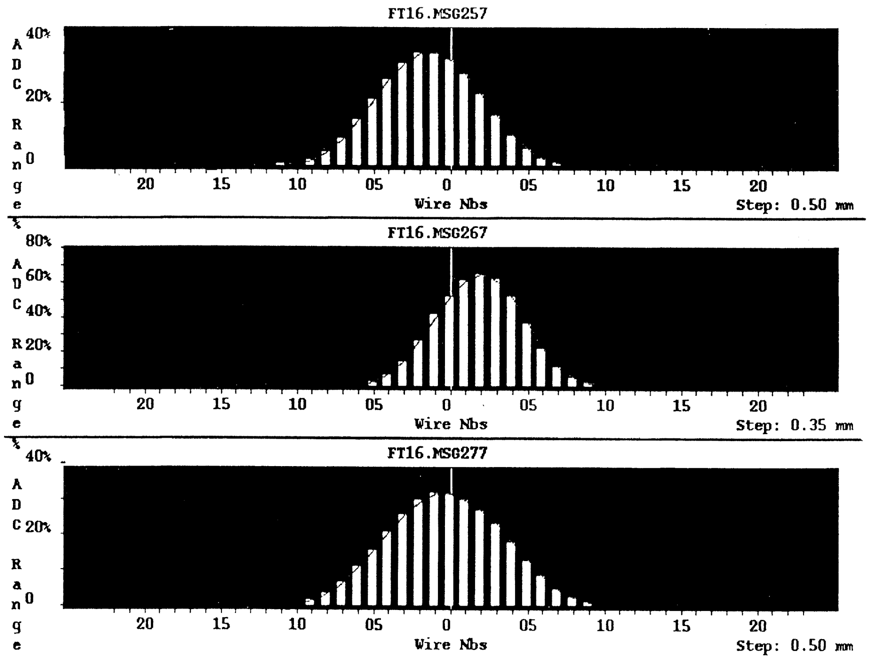
To provide input for this plan, the High Energy Physics Advisory Panel (HEPAP), the 'voice' of the US particle physics community, has formed a new subpanel, chaired by Sid Drell, to study international collaboration possibilities.

The first meeting of the subpanel took place on 10 January. Its members are: Sidney D. Drell, Chairman Stanford Linear Accelerator Center; Jonathan A. Bagger, Johns Hopkins; Patricia R. Burchat, University of California at Santa Cruz; David L. Burke, Stanford Linear Accelerator Center; Joel N. Butler, Fermilab; Helen T. Edwards, Fermilab; Kevin Einsweiler, Lawrence Berkeley Laboratory; Val L. Fitch, Princeton; Lorenzo Foa, CERN; John Huth, Harvard; Dan Kleppner, Massachusetts Institute of Technology; Akihiro Maki, Japan Society for the Promotion of Science; William J. Marciano, Brookhaven; Jack L. Ritchie, University of Texas at Austin; Bernard Sadoulet, University of California at Berkeley; and Maury Tigner, Cornell. Ex-Officio members are Roberto D. Peccei, UCLA; Stanley G. Wojcicki, Stanford and Michael E. Zeller Yale.

CERN
PS for LHC

CERN's veteran 28 GeV PS Proton Synchrotron, which first came into action in 1959 and has since become the kingpin of CERN's unique interconnected particle beam factory, is preparing for a new role as pre-injector for the LHC proton collider to be built in the 27-kilometre LEP tunnel. When LHC comes into operation early in the next decade, the PS will then be more than 40 years old!

Horizontal profiles of the LHC-type beam extracted from the PS at 26 GeV/c on three consecutive Secondary Emission Monitors in the beam line towards the SPS. This beam, equivalent to about 10 out of the 2835 LHC bunches, is sufficiently dense to potentially fill the LHC up to the beam-beam limit.



LHC's proton beam will have a brilliance (intensity/width ratio) twice that of current PS beams. In principle such a beam is attainable with the higher intensities available from Linac 2 equipped with a radio-frequency quadrupole (RFQ), with acceleration of one bunch (instead of five) in each of the four PS Booster rings, with the Booster kinetic energy increased from 1 to 1.4 GeV, and with using two Booster pulses to fill the PS.

This approach was tested during a marathon 12-day machine development session last December. The hardware had been prepared as prototypes and ingenious ad-hoc modifications at little cost, using only one Booster ring and a slow cycle repetition rate. This test was a full success: in Booster ring 3, one bunch containing a few 10^{12} protons was accelerated on a new radio-frequency harmonic to the new peak energy of 1.4 GeV (in a machine initially built for 0.8 GeV and now running at 1 GeV) without a hiccup.

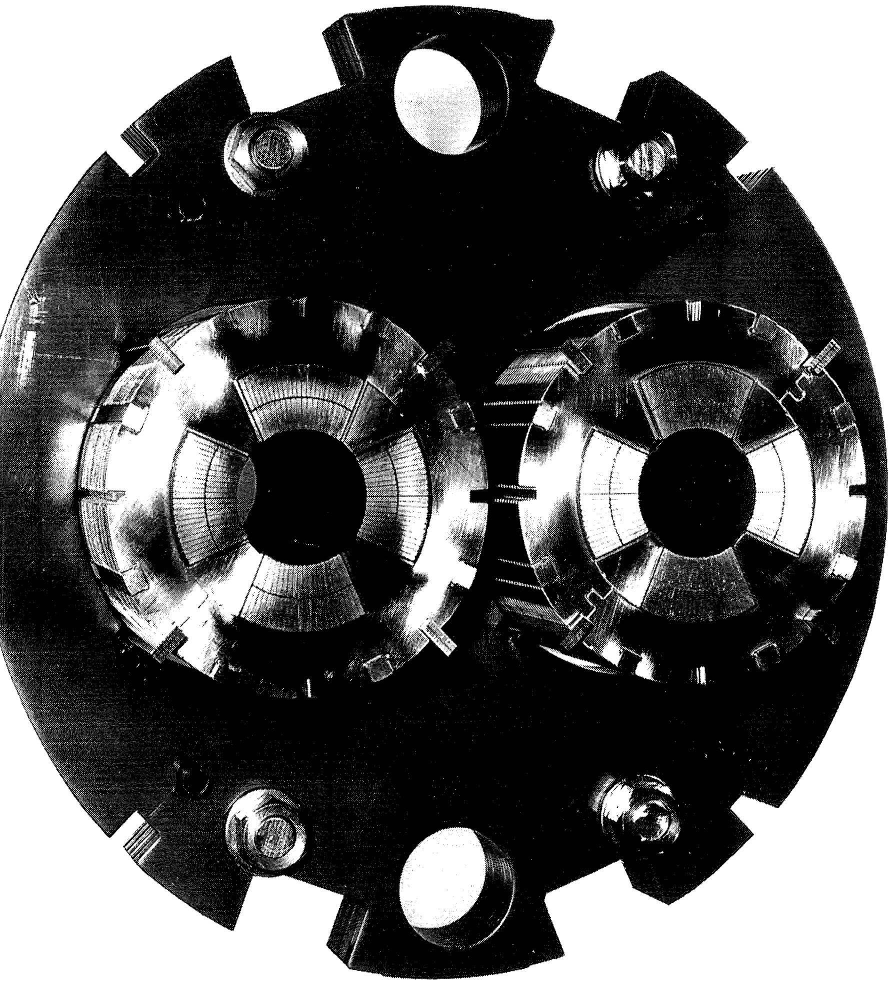
Two such beam pulses were injected into the PS on a 1.2 second magnetic 'front porch', accelerated on new r.f. harmonics to 25 GeV, and finally extracted into the line leading to the SPS.

Comprehensive sets of beam intensity and profile measurements confirm that the PS complex is capable of supplying the required high-brilliance proton beam, and can eventually assume its new role as LHC pre-injector.

SACLAY
Test of second LHC quadrupole

The second "two-in-one" quadrupole prototype for CERN's LHC proton collider has been successfully tested at Saclay. After transitions at 12353, 14890 and 14842 A, the latest

Model of the magnetic mass of the prototype LHC quadrupole



Principal characteristics

Nominal gradient 252T/m
Coil gap 56mm
Field quality in 30mm diameter 10^{-4}
Magnetic length 3m
Nominal current (88% of critical intensity) 15060A
Mean coil current 530A/mm^2
Maximum field 7.76T
Operating temperature 1.8K
Stored energy 890KJ

magnet reached and exceeded the nominal intensity of 15060 A, corresponding to a gradient of 252 T/m. This is all the more outstanding because this new result was obtained only two months after the successful tests of the first quadrupole (December 1993, page 10).

The remarkable efficiency of the operating teams in dismantling the first quadrupole, mounting the second one, cooling it down to superfluid helium temperature, and testing it, is due to the experience gained with the first prototype.

The latest quadrupole was designed as part of the contract of collaboration between CERN and the French Atomic Energy Authority (DSM/DAPNIA/STCM) at Saclay. It is identical to the quadrupole successfully tested in October 1993 and delivered to CERN in December.

These results confirm the soundness of the magnet design, the nominal characteristics of which are already 17% higher than required by the new LHC machine parameters. Prior to being delivered to CERN it will be intensively tested on Saclay's 1.8 K test bench to study the operation of the active protection system and the behaviour of the magnet during a transition.

BAKSAN
Underground and on the ground

In November a new air shower array to measure cosmic rays came into operation at the Baksan Valley, North Caucasus. Called 'Andyrchi' after the mountain it is located on, the array is a substantial addition to the Baksan Neutrino Observatory facilities built by the Russian Academy of Sciences' Institute for Nuclear Research.

The new array is constructed on the mountain slope 350m above the Baksan Underground Scintillation Telescope (BUST). It has 37 plastic scintillation detectors on a 40-m square grid covering 5 x 10^4 sq m. The array can operate independently for ultra high energy gamma-ray astronomy. On an incline (about 30° to the horizon) it can also study cosmic ray Extensive Air Showers (EAS). But its prime objective is to provide the energy scale of events, mainly high energy muon bundles, recorded by BUST.

This major underground detector started operating as long ago as 1979. Constructed by a team led by

A. Chudakov, BUST is a four-storey underground building with floors and walls (eight planes in total) covered with 3150 scintillation detectors - about 300 tons of liquid scintillator. Using time-of-flight measurements in this multi-purpose instrument, upward neutrino-induced muons are separated from the usual (and 10^7 times more intense) flux of atmospheric muons.

Among the most important BUST results so far is an upper limit for the superheavy magnetic monopole flux. A new possibility for the veteran underground cosmic ray muon detector is the analysis of muon bundles whose multiplicities reflect the nuclear composition of the primary cosmic rays.

In the energy range from hundreds of MeV to tens of GeV per nucleon, the nuclear and even isotopic composition of cosmic ray primaries is directly measured by space- and balloon-borne detectors. The range 10^{14}-10^{16} eV studied by BUST is particularly important because it is the region of the well-known 'knee' - where the cosmic ray energy dependence changes sharply (see page 17). The analysis so far suggests unchanged primary composition compared with lower energies, with a variety of nuclei - 40% primary protons, 20% helium and 10% iron nuclei at a given energy per nucleus (for a given energy per nucleon these contributions are 94, 5 and 3×10^{-4}% respectively).

For all theories of the origin, acceleration and propagation of cosmic rays, their composition with energy is of fundamental importance. However the measured value is an effective atomic number of nuclei in a wide energy range. The constant composition hypothesis is based on the suggestion that different groups of nuclei have similar energy spectra. There are serious doubts about the validity of this hypothesis, especially in the 'knee' region. If so, the muon bundles should be more detailed and an estimation of the energy of each event highly desirable. The Andyrchi array will do this by measuring the size of each extensive air shower accompanying the muon bundle seen by BUST.

This idea is not new. The Italian Gran Sasso underground Laboratory has the MACRO large underground muon detector and the EAS-TOP extensive air show array above it. MACRO is four times deeper and is sensitive to much higher primary cosmic ray energies. Thus the Gran Sasso and Baksan data will complement each other.

The third large Baksan facility is 'Kovyor' (Carpet), one kilometre away, but which eventually will be incorporated with the other detectors. With its large sensitive area (200 sq m), it will soon be upgraded with a 700 sq m muon detector. Then it will be able to measure the muon content of extensive air showers at large distances, with the core region being monitored by the Andyrchi-BUST tandem scheme.

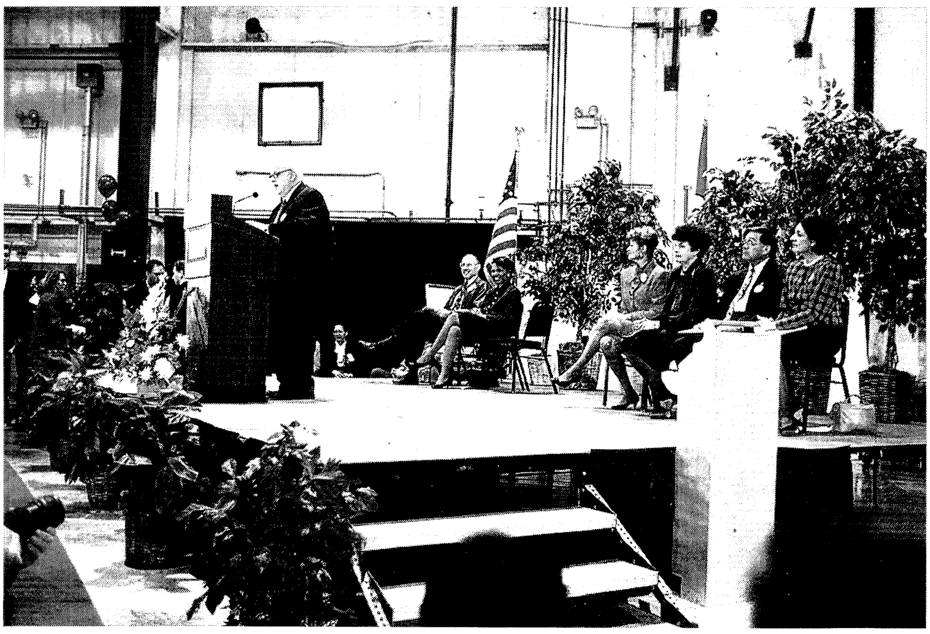
STANFORD (SLAC) B factory construction begins

At a ceremony marking the start of construction, members of the US Congress and Secretary of Energy Hazel O'Leary hailed the new Asymmetric B Factory as the key to continued vitality of the Stanford Linear Accelerator Center (SLAC).

Being built in collaboration with the Lawrence Berkeley Laboratory and the Lawrence Livermore National Laboratory, the B factory is a $177 million upgrade of the existing PEP electron-positron collider.

Scheduled for completion in 1998, the B factory will generate many millions of B mesons, allowing,

Below, Stanford Linear Accelerator Centre Director Burton Richter opens the inaugural ceremony for the SLAC/Lawrence Berkeley Laboratory/Lawrence Livermore Laboratory B factory, now under construction on the SLAC site. Seated behind him are (left to right) Project Director Jonathan Dorfan, Stanford Provost Condoleezza Rice, Secretary of Energy Hazel O'Leary, Senator Dianne Feinstein, and Representatives Norman Mineta and Anna Eshoo.
(Photo Joe Faust)



ISA
Institute for Synchrotron Radiation Aarhus University

Position in Experimental Accelerator Physics
at
the Aarhus Dual Purpose Storage Ring

The **Institute for Synchrotron Radiation Aarhus (ISA)**, which is responsible for running the storage ring – ASTRID – and beamlines, invites applications for a position in **experimental** accelerator physics. ASTRID operates half-time for storage of positive/negative ions and molecules and half-time as a synchrotron radiation (SR) source (580 MeV electrons). Concerning ion storage, the research programs focus on laser cooling, electron recombination/cooling, and lifetime measurements of metastable ions and molecules. In SR three beamlines with monochromators are operational at present. New multipole undulator beamlines are under construction. ISA is also involved in design studies of the 5MW European Spallation Source.

Candidates having experience at an electron/ion storage ring are highly desirable. The successful candidate shall take part in operation and development of the storage ring facility and will also be encouraged to take part in the research programs. Activities may include RF-systems and beam dynamics calculations. ISA is located in the same building as the Institute of Physics and Astronomy, together with the newly funded Aarhus Center for Advanced Physics – ACAP – with major activities centered around the storage ring facility.

Applications including Curriculum Vitae and list of publications together with the names and addresses of three professional references should reach the Director of ISA,

Professor E. Uggerhøj
University of Aarhus, DK-8000 Aarhus C, Denmark.
e-mail: **ISA@dfi.aau.dk**

by **May 1, 1994**. Further information (newsletters, etc.) can be obtained from ISA on request.

B Factory Director Jonathan Dorfan briefs US Energy Secretary Hazel O'Leary on some details of the project. (Photo Stanford Daily)

among other physics, an intensive search for the phenomenon of CP violation in the decays of these particles.

The novel feature of this collider is the fact that electron and positron beams will circulate at different energies - 9.0 GeV for the electrons and 3.1 GeV for the positrons. For this, a second, positron ring is being added to the existing PEP storage ring, which will be refurbished to handle the much higher beam currents that will be used in the B factory, typically 1-2 amperes. The design luminosity of this collider is 3×10^{33} $cm^{-2}s^{-1}$.

The combination of higher luminosity and the asymmetric nature of the electron-positron collisions will permit a much more detailed study of CP violation than is possible at any existing collider.

The B Factory project emerged relatively unscathed from last summer's US legislative hiatus which voted down the SSC Superconducting Collider (December 1993, page 2). The B Factory project is now underway, with the first $14 million being spent.

A collaboration of over 300 physicists from a dozen countries is now developing a detailed conceptual design of a new B factory detector, estimated to cost about $60 million. Further details of both the collider and detector in forthcoming issues.

ORSAY
Helium polarized electrons

At the beginning of the 1980s a group of atomic physicists from Rice University built a device producing polarized electrons for atomic physics. For preliminary studies for a possible European accelerator, Orsay's Institute for Nuclear Physics (INP) decided at the end of 1989 to take advantage of this work.

This new source is now operational. Very pure gaseous helium passes through a microwave cavity which excites and partially ionizes it. A very efficient Roots blower pumps this gas at high speed (some 100 m/sec). After the electrons and ions have been trapped on the walls, all that are left are metastable helium atoms (2^3S_1 state) mixed with helium atoms in the ground state. It is then possible, by optical pumping by circularly and linearly polarized light, to populate these metastable atoms in a spin state $+1(\uparrow\uparrow)$ or $-1(\downarrow\downarrow)$ passing through an intermediate level (2^3P_0). This light comes from a laser with a wavelength of 1.08 mm and a power of 5W built at INP.

In the subsequent stage a Penning reaction on the metastables releases polarized electrons:

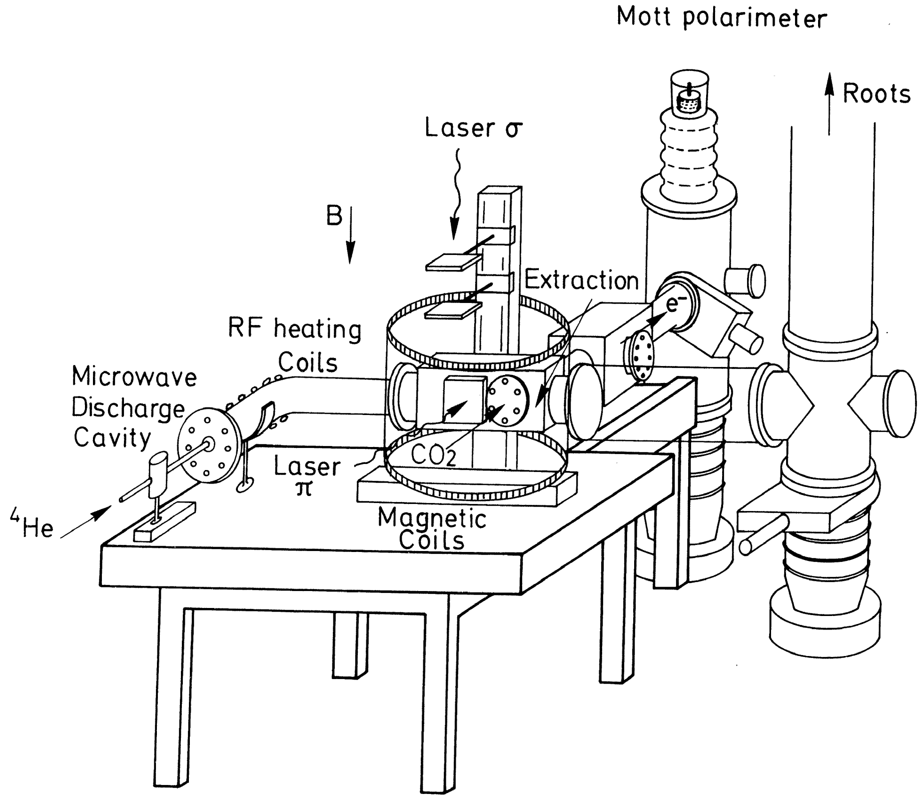
$He(2^3S_1)\uparrow\uparrow + CO_2 \rightarrow He(1S_0)\uparrow\downarrow + CO^+_2\uparrow + e^-\uparrow$

This reaction, which conserves angular momentum, uses gaseous CO_2 because of its high chemical ionization rate.

As soon as they are emitted, the electrons are collected and formed into a beam by an electrostatic optical system and their polarization measured using a Mott polarimeter.

The Rice group had taken the transition through the 2^3P_1 level, very close to the 2^3P_2 level, which can be attained owing to the Doppler width and its depolarizing effect. Orsay's choice of the 2^3P_0 level, far from the 2^3P_2 level, makes it possible to employ a cheap and easy-to-use multimode laser.

INP has also built a small single-mode laser to measure the number of magnetic substates and hence the polarization of the metastable atoms. The polarization rate of the metastables is better than 90% and that of the electrons is about 85% for cur-



Schematic of a new source for producing polarized electrons for atomic physics at Orsay's Institute for Nuclear Physics (INP).

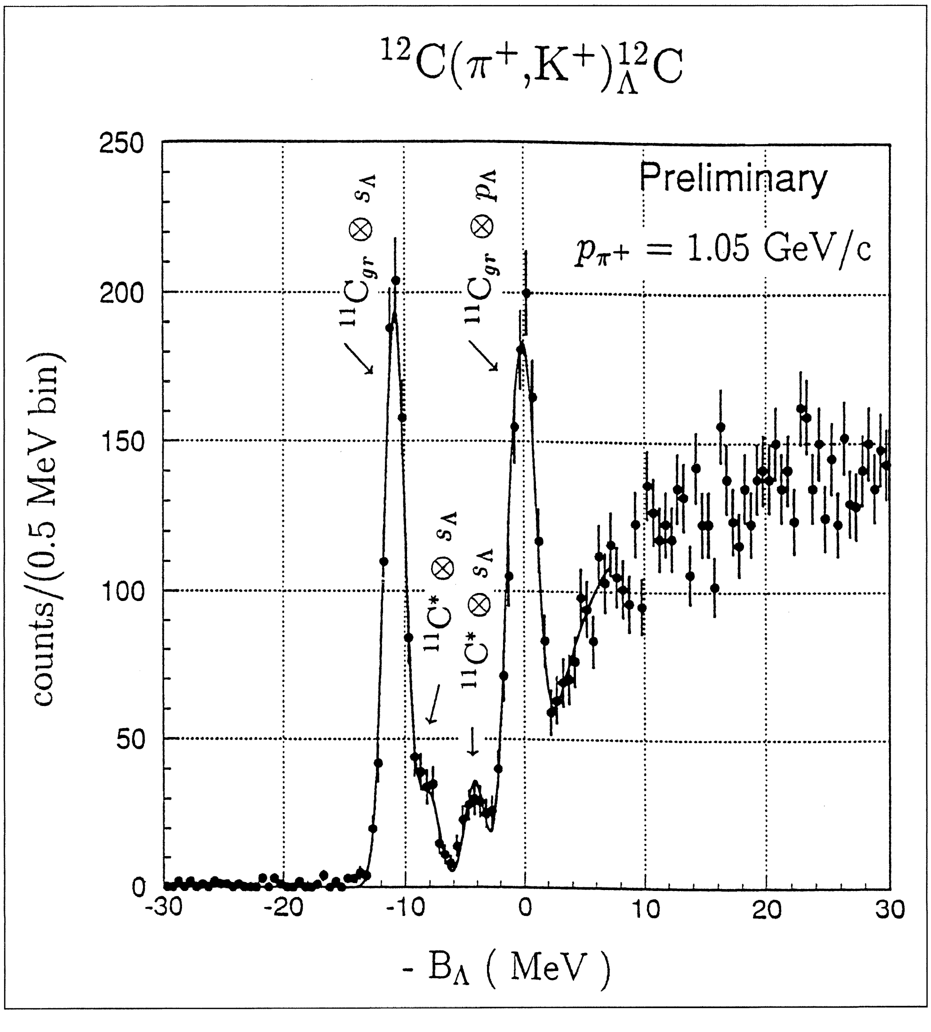
rents below 3mA. This rate drops to 75% at higher currents and is close to 60% at 50mA. These figures appear to correspond to the intrinsic limits of this kind of source, at least with the present configuration.

Most electron accelerators are currently fitted with gallium arsenide photocathode sources with a theoretical polarization rate of only 50%, amounting in practice to 40-45%. Recently, however, specially prepared photocathodes have been supplying electron polarizations as high as 90% (January/February, page 9).

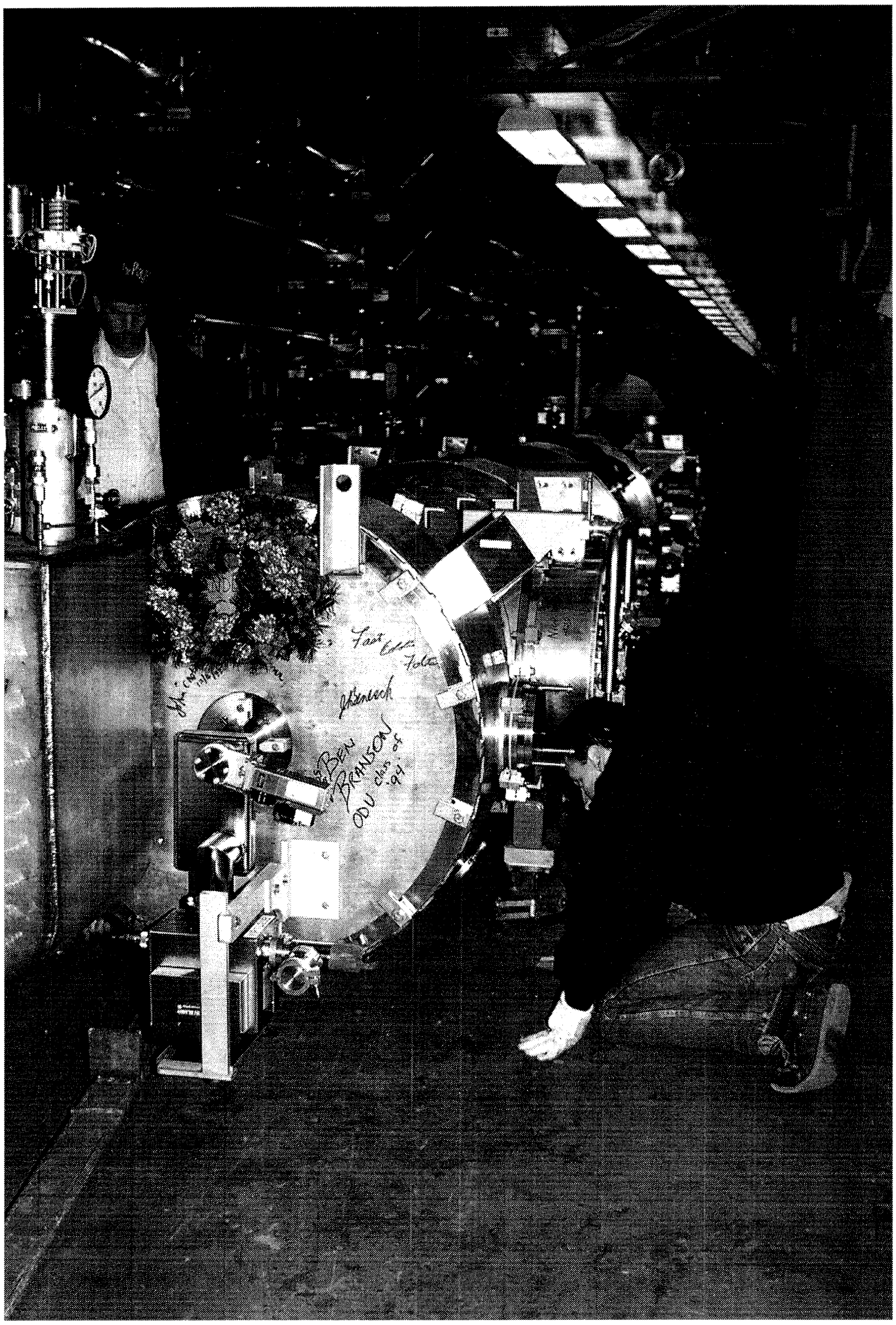
KEK Superconducting spectrometer

The large-aperture superconducting spectrometer built for fixed target experiments at the 12 GeV Proton Synchrotron at the Japanese KEK Laboratory is now fully operational, with interesting first physics results emerging.

The spectrometer was designed to achieve good momentum resolution over a large aperture (100 msr), mostly for nuclear spectroscopy with pions or kaons in the 1 GeV range. The fan-shaped superconducting dipole magnet produces a field of 3 tesla across a 50 cm gap and can be rotated around a target pivot so that angular coverage extends to 55°. It has demonstrated 0.1% momentum resolution with beam and



Hypernuclear spectrum measured with a new large-aperture superconducting magnet at the Japanese KEK Laboratory's 12 GeV Proton Synchrotron, showing two new states sandwiched between the well known sharp peaks.



achieved 2 MeV energy resolution with secondary particles.

Two experiments using the spectrometer in a single-arm configuration completed data-taking last summer. E269 (Kyoto with other centres) measured pion-carbon elastic and inelastic scattering in the incident momentum range 0.6-1.0 GeV. Then E140A (Tokyo INS with other centres) carried out a systematic study of hypernuclei looking at kaon production from a pion beam. Here the detection of a positive kaon signals the production of a lambda hyperon from a pion interacting with an intranuclear neutron. In this case there is a good chance that the resulting hyperon stays in the target nucleus, where it replaces a neutron.

Two large peaks in the kaon spectrum correspond to a lambda hyperon orbiting the nuclear core of a ground-state carbon-11 nucleus. In between, the spectrometer has picked up two small peaks, interpreted as a hyperon coupled to excited states. The relative size of the signals could go on to provide valuable new information on the lambda-nucleon interaction and the structure of hypernuclear states.

Data using heavier targets will look at a wide range of hypernuclei, while subsequent experiments will study the weak decay of a lambda in a nucleus. In both cases, the spectrometer helps to identify individual hypernuclear states and lambda decay products. E278 (Osaka with other centres) started taking data last fall, while E307 (Seoul with other centres) will begin later this year.

On 23 December the final cryomodule, containing eight accelerating cavities, was installed for the superconducting Continuous Electron Beam Accelerating Facility (CEBAF) machine at Newport News, Virginia. Commissioning begins this spring.

CEBAF
Final accelerator module

With the 23 December installation of its final cryomodule containing eight accelerating cavities, the superconducting Continuous Electron Beam Accelerating Facility (CEBAF) machine at Newport News, Virginia, is all but complete.

Each of the two linacs in the recirculating machine now has its full 20-cryomodule complement. CEBAF uses two antiparallel linacs linked by semicircular arcs. Beam will be recirculated five times, attaining energies up to about 6 GeV.

The 45 MeV injector, where accelerator tunnel installation of superconducting components began back in August 1990, has $2^{1}/_{4}$ additional cryomodules. Both the injector and a partial configuration of the north linac have undergone pre-operations testing in parallel with ongoing construction. Single-pass commissioning (nominal 800 MeV) is set to begin this spring.

Physics monitor

Looking for high neutron fluxes

The neutron is a powerful and versatile probe of both the structure and dynamics of condensed matter. However unlike other techniques such as X-ray, electron or light scattering, its interaction with matter is rather weak. Historically neutron scattering has always been intensity limited and scientists are always looking for more intense sources.

These come in two kinds - fission reactors and spallation sources (in which neutrons are released from a target bombardment by beams). Unfortunately the power density of high flux reactors is approaching a technical limit and it will be difficult to achieve a large increase of neutron fluxes above typical present values as represented for example by the high flux reactor at ILL, Grenoble.

Recent years have seen a steady development of accelerator-driven spallation sources, particularly the pulsed variety, for example at Argonne (IPNS), Los Alamos (LANSCE), KEK Japan and the UK Rutherford Appleton Laboratory (RAL - ISIS), and their benefits have been clearly recognized. Pulsed spallation sources are still at an early stage of development and there seems no major difficulty in principle in building a source many times more powerful than the most powerful existing source -ISIS.

At the initiative of KFA (Kernforschungsanlage) Jülich in Germany and RAL in the UK, study work has begun for a high power pulsed European Spallation Source (ESS). At present seven European countries are participating in a two year, site-independent study, supported by the European Community.

This study should result in a technical proposal with possible options. It should give in addition a realistic cost estimate, identify R&D requirements and assess safety and availability aspects.

As a compromise between many and sometimes conflicting arguments the design parameters are :

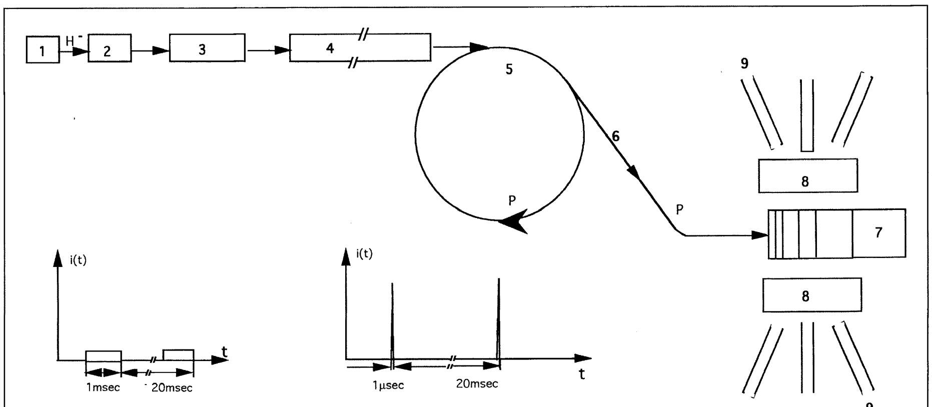
- 5 MW average beam power at the target, corresponding to the average power of the high flux reactor at ILL, Grenoble and about 30 times the ISIS beam power;
- About 1 microsecond pulse length;
- Two target stations, one operating at 50 Hz, 5 MW and a second at 10 Hz, 1 MW.

Using present technology these requirements cannot be fulfilled by a linear accelerator (linac) alone and a combination of a linac and a ring accelerator must be used. The linac current is accumulated over many turns in the ring, which subsequently is emptied during a single turn giving a short proton pulse with high peak intensity. An energy range for the proton pulses at the target of 0.8 to 3 GeV is considered and its exact value has still to be fixed. Average linac currents would be 6.3 to 1.7 mA.

For the design of high intensity linacs the average and the peak (pulse) current are dominating parameters. Peak currents at low energy up to 200 mA have been achieved but with a duty cycle well below 10^{-3}. An example is the Linac 2 at the CERN PS. The most powerful existing high energy proton linac (LAMPF at Los Alamos) operates at 0.8 GeV with an average current up to about 1 mA and a duty cycle of some 10 %. The average current and beam power are about a factor five below those foreseen for the ESS.

An additional constraint for the ESS linac is the need for injection into the accumulator or accelerator ring with low beam losses to avoid an intolerable activation of ring components. The proposed solution is to accelerate negative hydrogen ions in the linac. These ions are stripped to protons at injection. This promises much lower losses than the usual proton injection and has already been successfully exploited at other pulsed spallation sources.

Present limitations of negative hydrogen ion sources and space charge limitations at low energies



Top - schematic of a pulsed neutron source: 1 - negative hydrogen ion source; 2- radiofrequency quadrupole; 3 - drift tube linac; 4 - high energy linac; 5 - accumulator ring; 6,7,8 - output beam, target and moderators. Below - time structure of pulsed beams in linear accelerator and target.

make it advisable to double the low energy end of the linac. For the high energy section of the linac normal conducting or superconducting acceleration cavities could be considered. The latter could increase the acceleration efficiency and thereby lower operation costs, an essential argument for high power accelerators.

At linac energies up to about 1.6 GeV an accumulator ring without accelerating cavities could be used for pulse compression. At higher energies the ring would have to participate in acceleration and increase energies to the desired value. This could be done, for example, by a high intensity rapid cycling synchrotron of the type already in use at ISIS . The circumference of the ring would probably be of the order of 200 m, resulting in a proton pulse length of 0.7 microsec.

Beam losses at injection and beam instabilities will limit the number of circulating protons to about 2.5 x 10^{14}. At an energy of 1.3 GeV and a repetition rate of 50 Hz this corresponds to a beam power of 2.5 MW. Therefore the use of two rings in parallel is considered. Beam instabilities will probably also limit the injection time to about 1 msec (or some 1500 turns) resulting in a similar pulse length for the linac. The use of a fast kicker for ejection requires a time gap of a few hundred nanosec in the circulating beam which is produced by suitably "chopping" the linac pulse.

The energy content of each proton pulse will be 100 kJ, more than 30 times that of ISIS. The high energy beam transport between ring and target will be determined largely by the requirements of the high power targets. It should provide a possibility for shaping the proton beam at the target and its entry window to the desired beam dimension and profile. At present horizontal or vertical injection into the target are being considered.

The design of a 5 MW target for 1 microsec proton pulses at 50 Hz repetition rate will be a major challenge. The average power and the energy density exceeds by more than a factor five the level foreseen at the most powerful existing continuous-wave spallation source (SINQ at PSI, Switzerland). As the power will be deposited in the target in very short pulses, the material will be submitted to shock waves and temperature increases whose effects have to be studied carefully. In addition radiation damage to the entry window and the target material may further shorten component lifetime. Radiation safety and remote handling will be other critical issues and will strongly influence the detailed layout of the block. For all these reasons the choice of an optimum proton energy will need further and more detailed study. It is probable that a beam power of 5 MW could no longer be handled by a stationary target of solid heavy metal, and two alternatives - a rotating target wheel with many heavy metal targets, and a stationary liquid metal target - are being examined.

For wider operational flexibility and an increased number of neutron channels, two separate target configurations with widely different moderator and neutron guide layout are proposed - 50 Hz/5 MW and 10 Hz/1 MW, both with a pulse length of about a microsecond. A third target could be fed directly by the linac. In the design of the linac additional pulses with a length of a few millisec and a few MW power could be foreseen.

It is now recognized that the increase in source power and brightness will significantly improve the quality of information on condensed matter. Experiments can be done for smaller samples, more complex structures or in more dilute systems, while time-dependent phenomena can be investigated more effectively. Time-of-flight methods will not only increase brightness but will allow also higher sensitivity and a better signal-to-noise ratio.

From Herbert Lengeler, ESS Project Leader, CERN and KFA Jülich

AUSTRON

Another high flux pulsed neutron spallation source being proposed is the AUSTRON project to provide a new research centre in Central Europe, covering experiments in materials science, physics, chemistry, and biology. Accelerating light ions as well as protons, the source will also support work in cancer therapy and research. Being supported initially by Austria, it would also need additional partners. It would be of more conventional design than the European Spallation Source and would be faster to design and build. Planning and construction could span seven years. To be attractive the Austron would need to equal or even surpass ISIS performance.

COSMIC RAYS
From knee to ankle

Despite the advent of TeV machines providing energies of 10^{12} electronvolts, the highest particle energies by far are still provided by cosmic rays, where a sprinkling of particles from outer space go beyond 10^{17} electronvolts, a hundred thousand times up on the highest laboratory levels.

New results from the 'Fly's Eye' cosmic ray detector in Utah provide new hints on the energy spectrum of these particles. Included in the sample is an event at 3×10^{20} eV, the highest energy interaction ever recorded.

The ultra-high energy cosmic ray primaries arriving from outer space soon crash into atmospheric nuclei, giving extensive secondary air showers. It is these showers which provide the clues to the high energy cosmic ray component.

The 'Fly's Eye' detector, which came into operation in 1981, consists of 67 1.5-metre diameter spherical mirrors each viewed by photomultipliers at the focus and together covering the entire night sky. In 1986 this configuration was complemented by 'Fly's Eye II', 3.4 kilometres way, with 36 mirrors covering half the sky. This can either operate as a stand-alone device or in conjunction with the main detector to provide stereoscopic views.

The higher energy cosmic particles are rarer, and this falloff can be written as a power law. This first happens at the well-known 'knee', around 5×10^{15} eV. The Fly's Eye sees this exponential falloff increase further at about $10^{17.6}$eV, but it suddenly flattens at $10^{18.5}$eV. This second kink (seen before by other experiments) has earned the name 'ankle'.

The shower elongation gives a handle on the chemical composition of the primary particles. The energy spectrum suggests that the composition of cosmic rays is getting lighter with increasing energy.

As they travel through space, cosmic ray tracks get tangled in magnetic fields and tend to arrive from all over. However particles originating inside the galactic disc should retain some directionality. With the Fly's Eye ultra-high energy events fully isotropic, they look to come from outside the galaxy.

Physics in Vietnam

Vietnam is a country in rapid evolution, opening up communications with the rest of world and encouraging foreign investors. Although there is more ground to make up, the heady mixture of communism and free market they are aiming for is along the same lines as China.

Jean Tran Thanh Van , who left Vietnam about forty years ago, judged that it was the right time to bring together Western and Vietnamese physicists. He promoted and organized the "Rencontres du Vietnam" on high energy physics and cosmology, which from December 13-18 brought together about one hundred physicists, half from Vietnam and half from abroad, in Hanoi for an intense programme to review the status of particle physics and its deep implications for cosmology.

The physicists were received by the President of the Republic, and for the physicists Jack Steinberger expressed their appreciation for the President's warm interest in this

From 13-18 December, the "Rencontres du Vietnam" on high energy physics and cosmology brought together in Hanoi about one hundred physicists, half from Vietnam and half from abroad. The physicists were received by the President of the Republic, and for the physicists distinguished scientist Jack Steinberger (front row, light suit, standing on the President's right) expressed their appreciation for the President's warm interest in this special scientific event. Jean Tran Thanh Van, who promoted and organized the event, is on Steinberger's right.

special scientific event. The following evening this encounter was screened on national TV.

The atmosphere at the meeting was friendly and productive. For our Vietnamese colleagues it was a unique opportunity to make contact with world science after many years of isolation and of work in extremely difficult conditions. For us it meant getting to know a country which is emerging with energy and optimism after three decades of war.

Vietnam is poor and the resources for science are extremely limited. But there is a long tradition of scientific culture, as shown by the many researchers of Vietnamese origin who are active abroad, especially in France. At present the country has an obvious predominance of theoretical physicists with a rather formal orientation.

This meeting offered a good opportunity to create contacts with Western institutions which should hopefully lead to promising Vietnamese students being able to spend some time abroad. In turn this will help satisfy Vietnam's urgent need for qualified scientists to help and accelerate the country's technological development for a new era of prosperity.

From Monica Pepe Altarelli

UNIX at high energy physics Laboratories

With more and more high energy physics Laboratories "downsizing" from large central proprietary mainframe computers towards distributed networks, usually involving UNIX operating systems, the need was expressed at the 1991 Computers in HEP (CHEP) Conference to create a group to consider the implications of this trend and perhaps work towards some common solutions to ease the transition for HEP users worldwide.

UNIX was developed originally at the AT&T Bell Labs in the late 60s and from its early beginnings as an interesting tool in research labs, it has been developed into a general-purpose operating system for a wide range of computers from desktops to mainframes and offered by a wide range of suppliers, especially workstation manufacturers.

HEPiX was created at CHEP91 to group UNIX users and system administrators working in high energy physics Laboratories and cooperating academic institutes. After CHEP92, the group was structured along regional lines with a European and North American (USA plus Canada) chapters, with each chapter meeting approximately every six months. All meetings are open and anyone from any part of the HEP world is welcome to attend any meeting.

The most recent meeting of the European group was in October 1993 in Pisa and the minutes were published in the HEPiX newsgroup (see below) in December. The main theme which emerged was a general downsizing trend in many of the larger sites and its effect on HEP user groups and on the future directions of computing support for HEP.

A month later, the North American chapter met in SLAC (Stanford), and a report was published in January. Major topics at this meeting concentrated on a new file system (AFS) which is starting to become popular at a number of sites, and the subject of "farming" - using clusters of UNIX workstations to provide high quality batch processing.

The next events scheduled will include a meeting of worldwide HEPiX to follow the CHEP94 Conference in San Francisco in April and a meeting of the European chapter in Paris some time in October.

Between meetings, the group is active through electronic mail and Internet news. Other activities include a subgroup developing scripts to define a standard UNIX environment for use at HEP sites and another which produced a report comparing the different UNIX batch processing schemes used by HEP.

The results of these and other activities are published in the news group (HEPNET.HEPIX) and stored on an archive server. An index of information published by HEPiX is available via the World Wide Web and much of this can be viewed or accessed via the Web directly. (An article on the World Wide Web will feature in a forthcoming issue.)

There is no formal procedure to join HEPiX and all activities are publicized via the electronic mail list and the Usenet news group. Normally automatic procedures ensure the same information appears in both channels, so users may decide which channel they prefer.

To subscribe to the mail list, send a message to hepix-request@hepnet.hep.net (Internet) or hepnet::hepix-request (ES-DECnet) or hepix-request@hepnet (BITNET) where the first line of your message should be SUBSCRIBE. If you prefer to participate in the HEPIX discussion via netnews, subscribe to the newsgroup hepnet.hepix.

For further information, contact Alan Silverman at CERN (e-mail Alan.Silverman@cern.ch) or Judy Nicholls at Fermilab (NICHOLLS@FNALV.FNAL.GOV).

From Alan Silverman, HEPiX European Coordinator

CES PRESENTS:

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The FDL 8050 (copper or fibre) is specially targeted for the demanding Real-Time Nuclear and High Energy Physics as well as for industrial applications. The Fast Link is designed to push data transfer speed, time latency and robustness of Real-Time systems to their higher limits.

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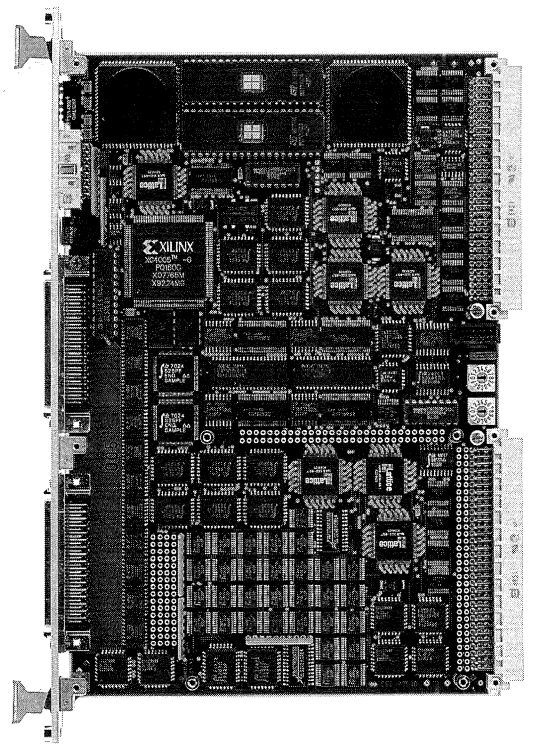

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Industry and spinoff

Applications of massive parallel processing for complex computing tasks provide another good illustration of how frontier science and emerging technology can benefit each other.

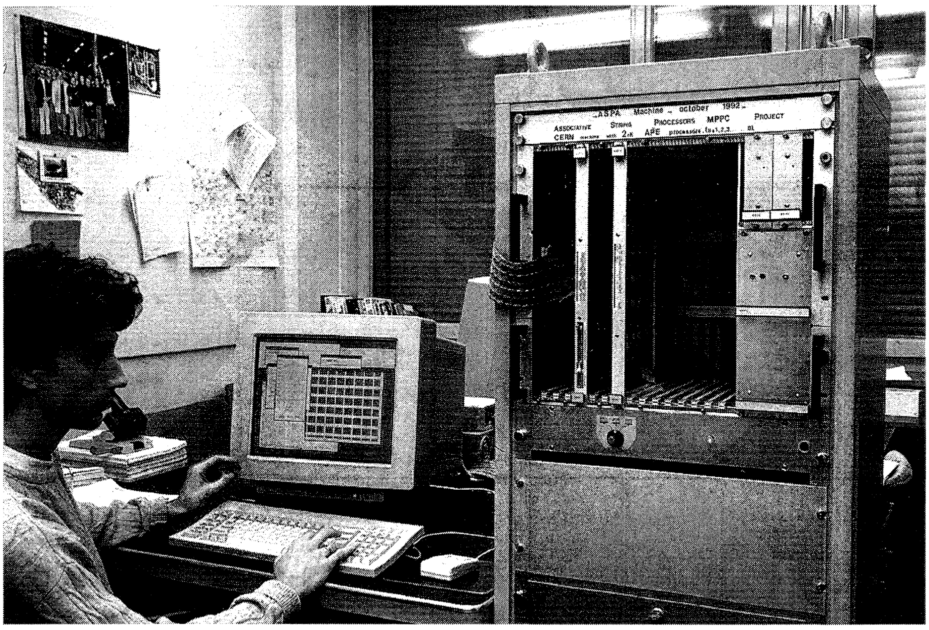
CERN Ad ASTRA

In 1988, when detailed plans began for experiments at CERN's proposed LHC proton-proton collider, sophisticated real time 'triggering' systems were quickly identified as a challenge. As more and more physics is understood and becomes routine, interesting new events become correspondingly rarer.

With the impossibility of storing all data and subsequent processing off-line, stringent on-line filtering is called for. To extract these signals in real time from a mass of background, trigger systems must filter through megabytes of raw information flooding in at high speed (40MHz) through many millions of detector channels.

Three triggering levels are foreseen for this filtering process. The first and fastest level would use hard wiring to push candidate information into temporary buffer memory at the rate of one event every 10-50 microseconds, reducing the raw data rate by a factor of several thousand.

The next trigger level would carry out a rough analysis of the event and its kinematics. This programmable stage would achieve an additional enrichment factor of about 100. Finally a 'farm' of several thousand high speed microprocessors would make a detailed analysis of the selection emerging from the second level and store the filtered events at the rate of a few per second.



Working on the ASTRA - ASP System Testbed for Research and Application - at CERN. The Associative String Processor (ASP) provides a way of getting out of high speed data processing bottlenecks.

For high data rates, parallel processing is an obvious route to follow. In parallel processing, computing modules carry out their allotted tasks at the same time, rather than sequentially as in more traditional computing solutions.

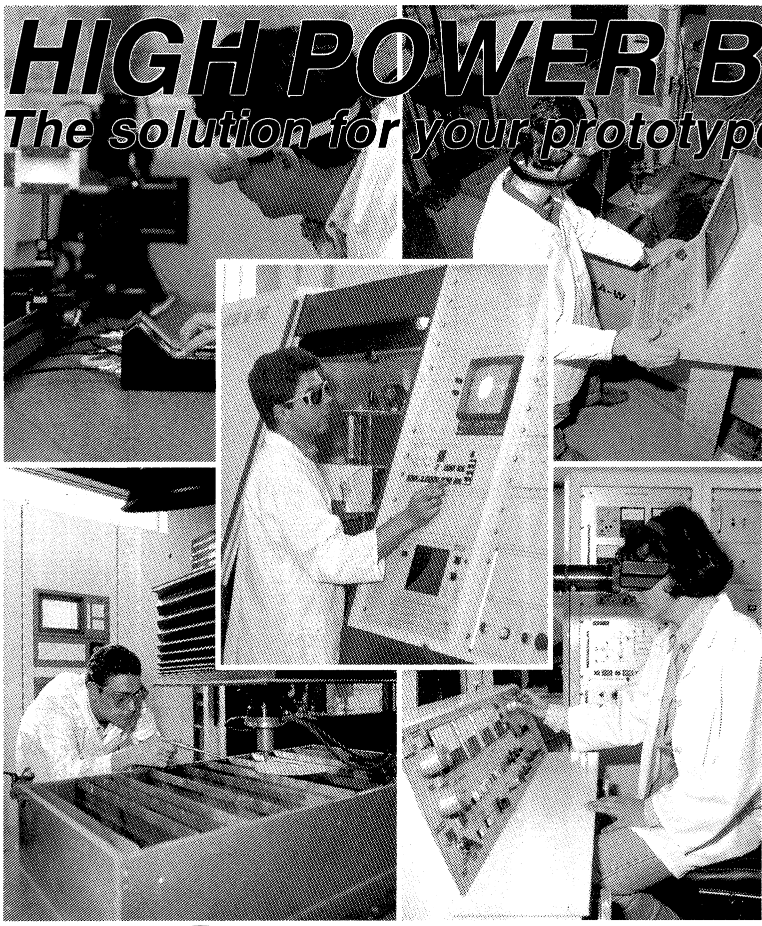
Back in 1988, the second level selection process looked problematic. However in 1989 a new Single-Instruction Multiple Data (SIMD) architecture device - the Associative String Processor (ASP) from ASPEX Microsystems in the UK - was identified as a possible way out of this bottleneck.

In 1990 a Massively Parallel Processing Collaboration (MPPC) was built up, linking CERN, ASPEX and two major French research centres, Orsay and Saclay. As the project evolved, other partners in France, Switzerland, the UK and Hungary joined the project.

With its role in the LHC context, the MPPC project was also a part of CERN's effort supervised by the Detector Research and Development Committee. In 1992, this project led to the development of a prototype ASP machine integrating many thousands of associative processing elements.

This initial ASP implementation was called ASTRA - ASP System Testbed for Research and Application - now operational at CERN, Orsay and Saclay as well as in the parent company.

In ASP, one instruction is simultaneously applied to a large number of identical processing elements, each storing one item of data. Each element has its own local memory, can make an association between its own stored data and present a key in parallel to all elements, can communicate with any other element of the string, and can perform elementary instructions. This associative parallel strategy is the basis of ASP architecture, with conventional sequential



CERN

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Comment visiter le CERN

Organized visits take place only on Saturdays, at 9.30 a.m., and/or 2.30 p.m. The visits last about three hours and are free. The minimum age limit is 16 years.

Les visites commentées ont lieu seulement le samedi, à 9 h. 30 et/ou à 14 h. 30. Elles durent environ trois heures et sont gratuites. La limite d'âge minimum imposée est de seize ans.

Please write or call:
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addressing replaced by an associative global data access (content addressing).

The basic chip (VASP-64) uses a string of 64 processing elements with a programmable intercommunications network. These chips can be cascaded to make a multichip string of any required length.

Each board, built by Saclay under an extended VME standard, contains 32 chips making a string of 2048 processing elements.

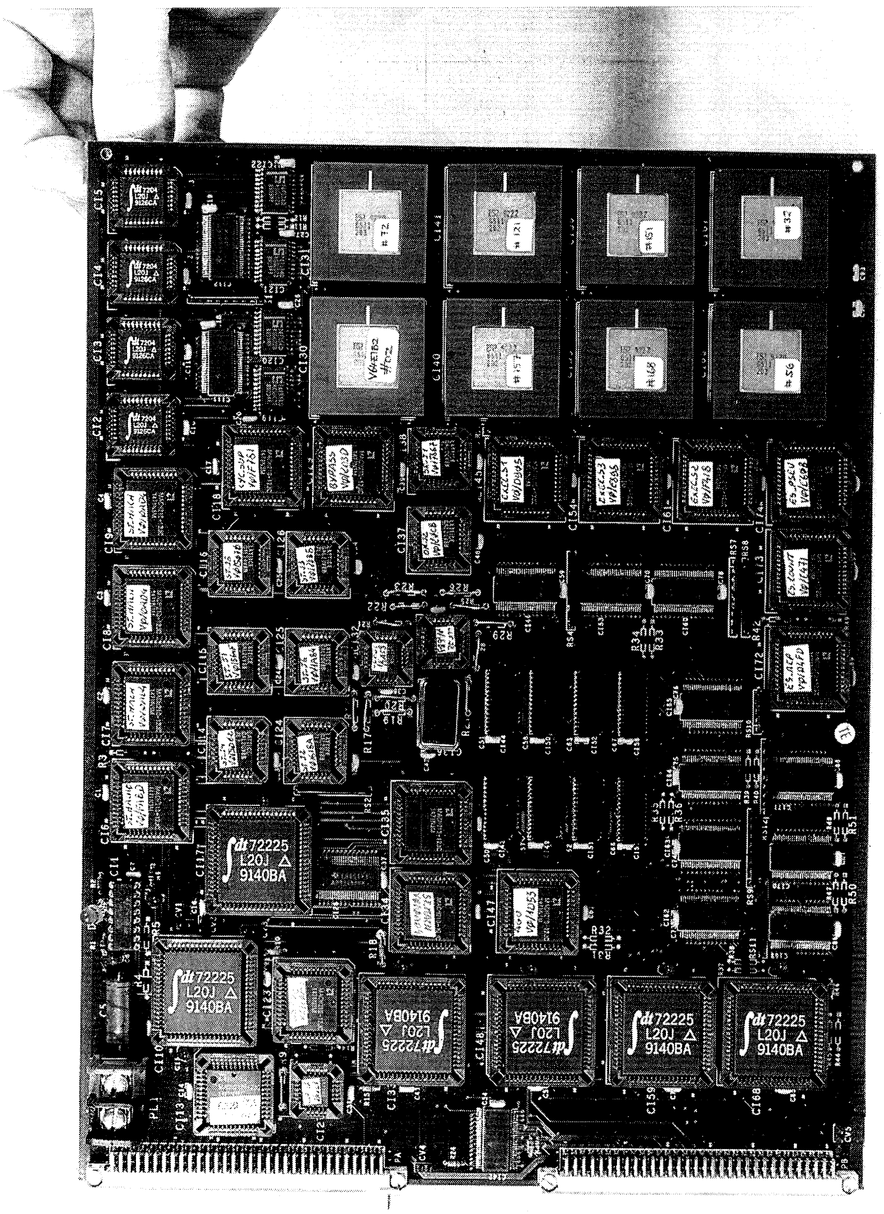
The first VASP-64 came in 1990 by European Silicon Structures, a French firm, using electron-beam implementation of a CMOS (complementary MOS) technology. Subsequent high performance developments elsewhere have used alternative technologies (SOS).

Applications undertaken by MPPC partners have included trigger designs for proposed hadron collider detectors and fixed target experiments and for online data processing at physics Laboratories. A dedicated real-time ASP machine - ASPEN - was designed, built and used by and at Saclay for the evaluation of a very fast trigger in a physics experiment (NA48).

High speed image processing is another potentially interesting applications area. The Signal Processing Laboratory at EPF Lausanne, Switzerland, studied ASP image coding algorithms to compress visual data at video rate, while Saclay has looked at ASP processing for the EROS star survey (December 1993, page 4).

The ability of CCD cameras (with CCDs from Thomson-TMS) to generate large amounts of data at high speed was seen as a good way of putting ASP processing power to the test, and an interface to the ASTRA machine was built at CERN for this purpose.

With the initial MPPC project complete, an ASTRA user group has been formed at CERN to provide the physics community with a new tool for studying on-line parallel algorithms, while collaboration members ASPEX and Saclay are developing new dedicated ASP machines and custom-built chips.



Closeup of the ASP interface circuitry, showing the eight special (VASP-64) parallel processing chips, top right.

Bookshelf

"An Introduction to Quantum field theory" by G. Sterman, Cambridge University Press (ISBN 0 521 31132 2)

This book contains a systematic presentation of quantum field theory. Canonical quantization, path integrals, non-abelian gauge theories, renormalization and axial anomalies are discussed to a satisfactory level, so that the book can be easily used for an introductory course in field theory.

The most interesting aspect of the book is contained in Part IV, with a full treatment of soft and collinear singularities, together with a discussion of the meaning of perturbative cross-sections when soft and infrared divergences are present. This subject is too often neglected in textbooks, in spite of the fact that a large amount of current research in high energy physics (and much of the motivation for QCD as a theory for strong interactions) is based on it. The author is certainly a great expert in this field, to which he has brought many important contributions. The core of Part IV is a demonstration of the infrared finiteness of jet cross-sections in electron-positron annihilation. Following this, the more complex topic of hadron-initiated reactions involving hadrons in the initial state is dealt with. The physics of scaling violation in both the parton model and in terms of the operator product expansion is discussed. The computation of first order corrections to deep inelastic scattering and to the Drell-Yan pair production process, which marks the beginning of the application of perturbative QCD to hadronic collisions, is given in detail, illustrating the factorization of the hadronic cross-section into a short distance cross-section and a universal parton density.

One apparent limitation of the book is its lack of explicit contact with phenomenology. Comparison of theoretical calculations with experimental results are never mentioned (the only graphs one finds in the book are Feynman graphs). The book is therefore mainly aimed at theoretical physicists. However field theory courses are generally paralleled or followed by a course in particle physics phenomenology, and Sterman's book can certainly facilitate the understanding of high energy strong interaction phenomenology .

In conclusion, the book should be useful for an introductory course in quantum field theory to graduate students. Furthermore it provides a good introduction to the theory of perturbative QCD for research scientists who are interested to work in this field.

Paolo Nason

CERN Courier contributions

The Editor welcomes contributions. As far as possible, text should be sent via electronic mail.

The address is courier@cernvm.cern.ch

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

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

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People and things

At the 25th anniversary at Vienna's Institute of Theoretical Physics of the 'Triangle Seminars', J. Pisut (left) receives a toast by his wife A. Pisutova (centre) and H. Pietschmann (right).

Hans-Joachim Stuckenberg

The architect of some of the most sophisticated electronic data handling systems used in DESY experiments, Hans-Joachim Stuckenberg, died last October. He had retired in March 1992 but was still active teaching and advising his students and former collaborators as long as his health allowed.

During his 33 years at DESY, Stuckenberg not only designed and built new trigger systems for several detectors (DASP, TASSO, CELLO) and digital controls for accelerators (like the one for DESY III), but was also the driving force behind many different ideas in and outside DESY. He started the Departments of Informatics at the University of Hamburg and at the Technical College of Wedel; in both he lectured and organized practical work. The international coordination of electronic standards was one of his specialities and many ESONE, CAMAC and NIM experts will remember his contributions. Stuckenberg was an active member of many committees and for several years chairman of DESY's Scientific Committee (Wissenschaftlicher Ausschuss).

Earthquakes and dark matter

After the fatal earthquake that shook Los Angeles on January 17, a symposium - 'Critique of the Sources of Dark Matter in the Universe' - scheduled to be held in a Santa Monica, Los Angeles, hotel on 16-18 February, had to find an alternative venue .

At first the damage to the original site for the meeting, the BayView Plaza Holiday Inn, Santa Monica, was believed to be cosmetic but further evaluation revealed damage to the support structure and the hotel has been closed for some six weeks while repairs are made.

At short notice, the symposium was rescheduled for the Radisson Bel-Air Summit Hotel on Sunset Boulevard, just two miles from the UCLA campus. With dark matter developments continually accumulating, we hope to have a report of this meeting in a forthcoming issue.

Triangle Seminar

Last November saw the 25th anniversary at Vienna's Institute of Theoretical Physics of the 'Triangle Seminars', founded in 1968 by H. Pietschmann of Vienna to stimulate contacts between Bratislava, Budapest and Vienna, following earlier Vienna-Bratislava joint seminars arranged by W. Thirring and his colleagues in Bratislava. Over the past quarter-century, the meeting has grown to involve many Central European universities - Bratislava, Budapest, Prague, Trieste, Zagreb, Krakow and Vienna - together with invited speakers from CERN.

Meetings

An international symposium '50 years from the discovery of the principle of phase stability by V. Veksler and E. McMillan' will be held in Dubna, near Moscow, from 12-15 July. Special emphasis will be put on its significance for physics progress, acceleration techniques and modern technology. Further information from: e-mail baldin@lhe20.jinr.dubna.su fax (095) 975 23 81 telex 911621 Dubna su.

Foundation for Fundamental Research on Matter

The Foundation FOM advances and coordinates physics research. It is being funded mainly by the Netherlands organization for scientific research NWO. In addition FOM receives funding from EURATOM, the EU and several commercial companies. FOM employs about 1100 people, most of them academics, including PhD-students and postdocs, and technicians.
They work at seven institutes within FOM and about 150 working groups at Dutch universities.
FOM was founded in 1946 and is a recognized NWO-foundation.

FOM

Experimental high energy physicist (post-doc) m/f

The Department of Experimental High Energy Physics of the University of Nijmegen has an opening for a two year post-doc position.

Nijmegen is partner in NIKHEF and is involved in the L3 experiment and in preparations for ATLAS (RD5, μ-chamber electronics and simulations).

Requirements
The applicant is required to have a Ph.D. in High Energy Physics and is expected to reinforce one of these activities.

Information
Information can be obtained from the chairman of the department, prof.dr. E.W. Kittel (tel. +31-80653343, e-mail: Kittel at cernvm.cern.ch).

Applications
Applications, including curriculum vitae, list of publications and names of three references are to be sent within three weeks after publication of this advertisement to the personnel department, Toernooiveld 1, 6525 ED Nijmegen, the Netherlands, quoting reference number 21-94.

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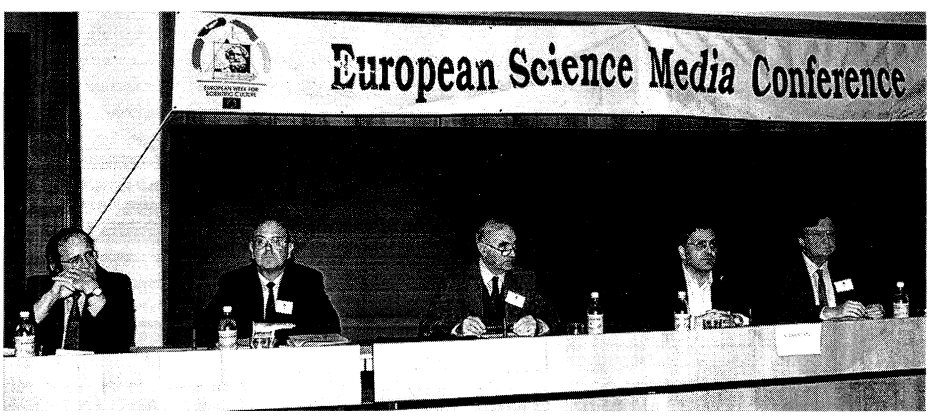
Inquiries for the rest of the world: **please see page III.**

Nuclear Science and Medical Imaging

Abstracts for the 1994 IEEE Nuclear Science Symposium and Medical Imaging Conference to be held in Norfolk, Virginia, October 30-November 5 are due April 15. For the first time abstracts and summaries may be sent electronically. For more detailed information on submission, send electronic mail to Rene Donaldson, Conference Coordinator, at rened@slac. stanford.edu.

Above: Quantum mechanics pioneer Eugene Wigner blows out 90 candles at his recent birthday party at Princeton. (Photo J.A. Lechner)

Below: The European Science Media Conference at CERN on 1-2 December, organized by Neil Calder of CERN's Media Service, brought together 220 journalists, scientists and science communicators from 24 countries to discuss the presentation of science in the media. The final session featured a panel discussion on 'How to interest young people in science,' featuring, left to right, Head of BBC Science programmes David Filkin, Christian Petermann of the German Ministry of Research and Technology, CERN Council President Hubert Curien, Journal de Genève Science Editor Suren Erkman, and then CERN Director General Carlo Rubbia. (Photo CERN MI7.12.93)



World-Wide Web

The First International World-Wide Web Conference will bring together people who have contributed to the conception, implementation, spread and success of the World-Wide Web networked information system invented at CERN. It will be held from 25-27 May at CERN, Geneva. Information: on the Web: http://www.cern.ch/WWW94/Welcome.html or telnet www94.cern.ch or e-mail www94@www1.cern.ch (secretariat: WWW94 c/o Anne Perrelle CERN CH-1211 Geneve 23 tel. +41-22-767-2406, fax +41-22-767-8730)