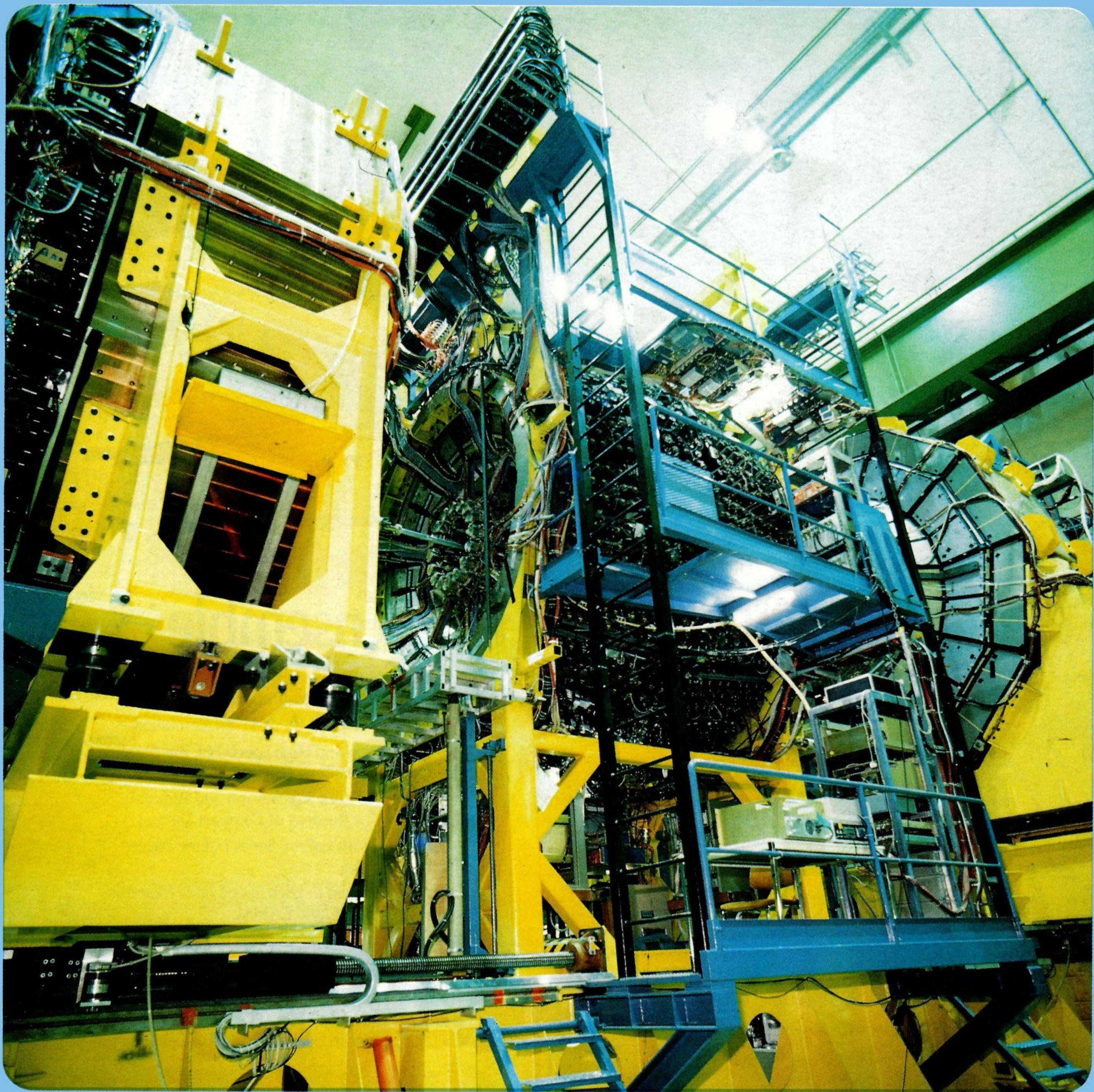
CERN COURIER

International Journal of High Energy Physics



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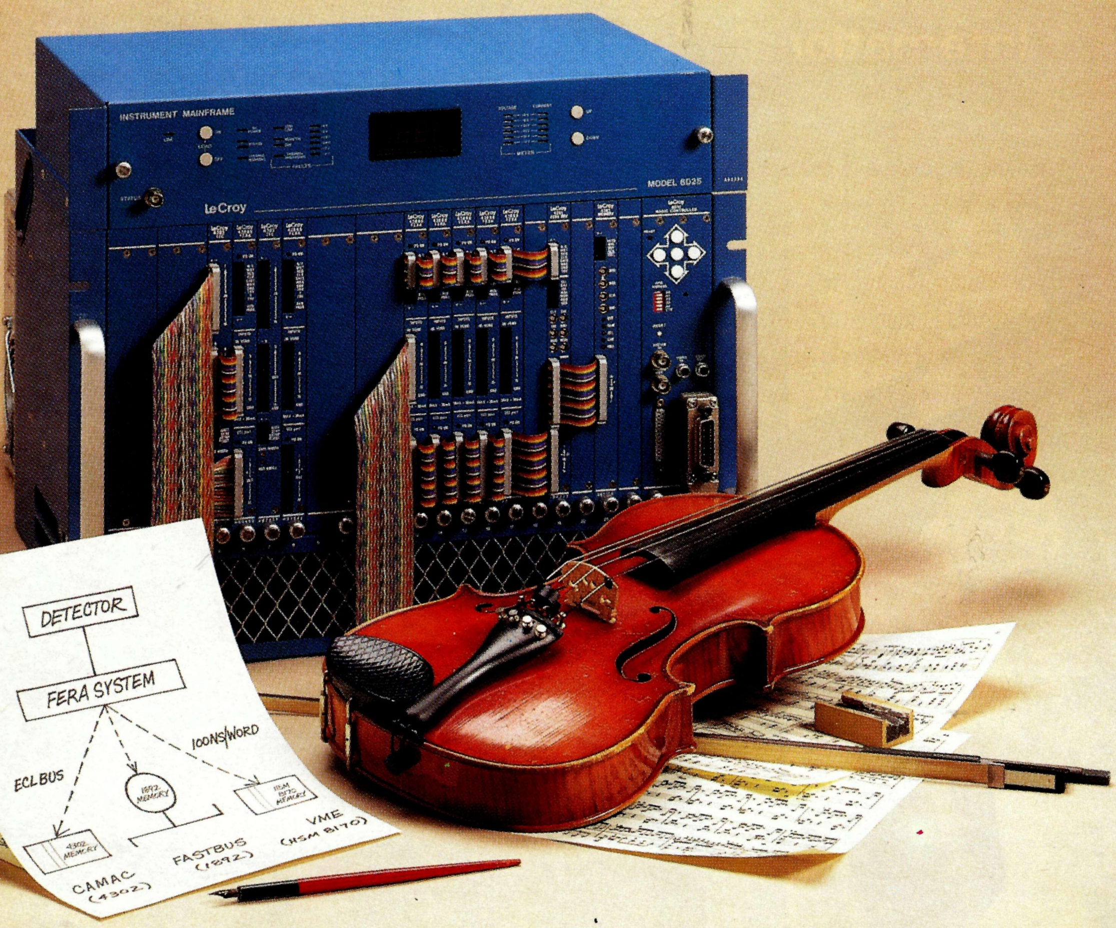

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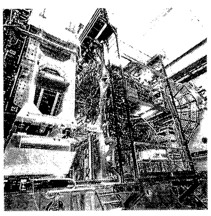
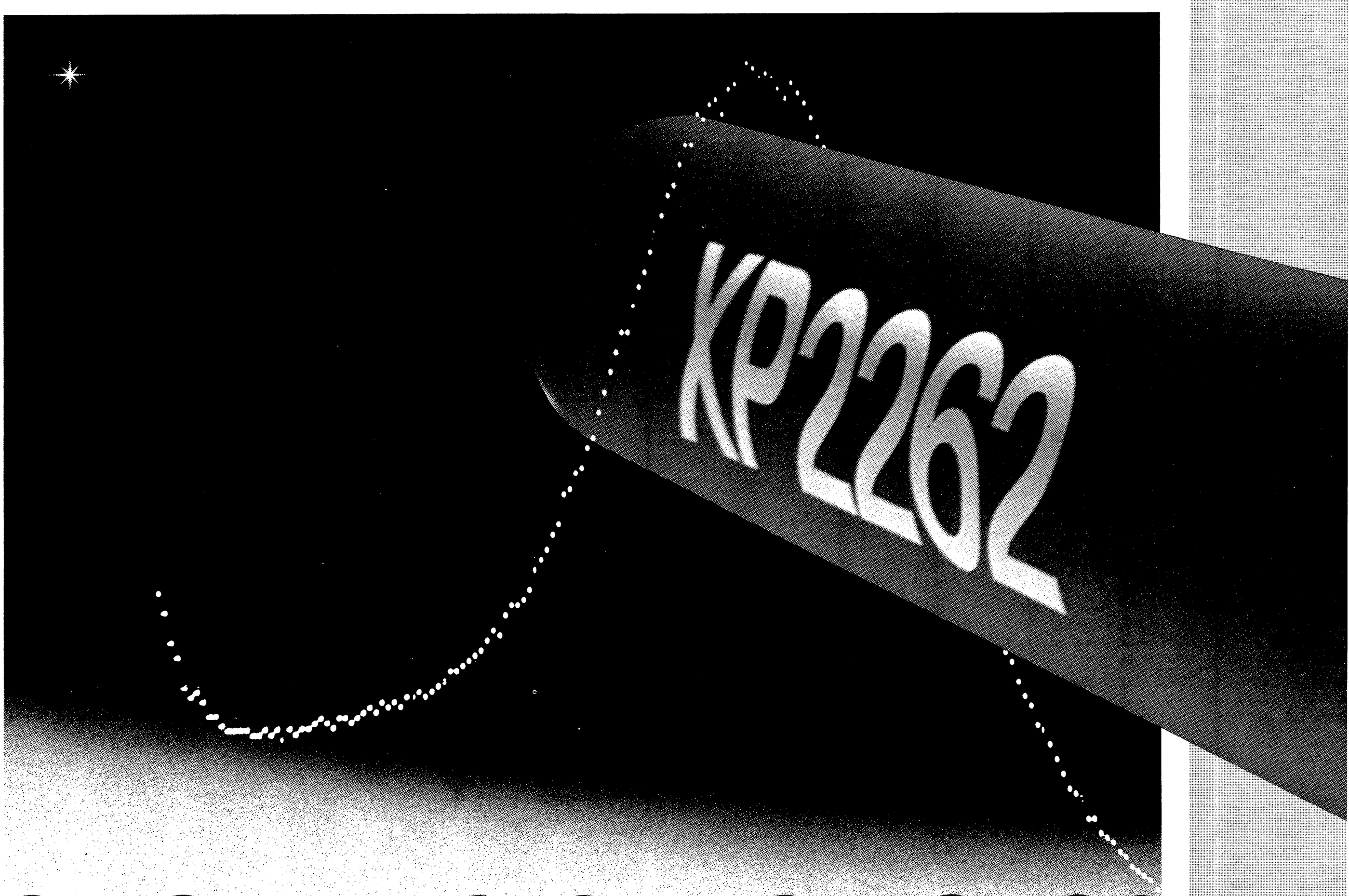


Cover photograph:
The UA2 experiment at CERN's proton-antiproton collider came to the end of its research programme in December. This big detector has made important contributions to physics as well as pioneering the application of new detector techniques. Its final physics results are eagerly awaited (Photo CERN EX134.1.91).



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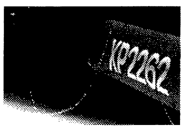

STILL SETTING THE STANDARD

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Around the Laboratories

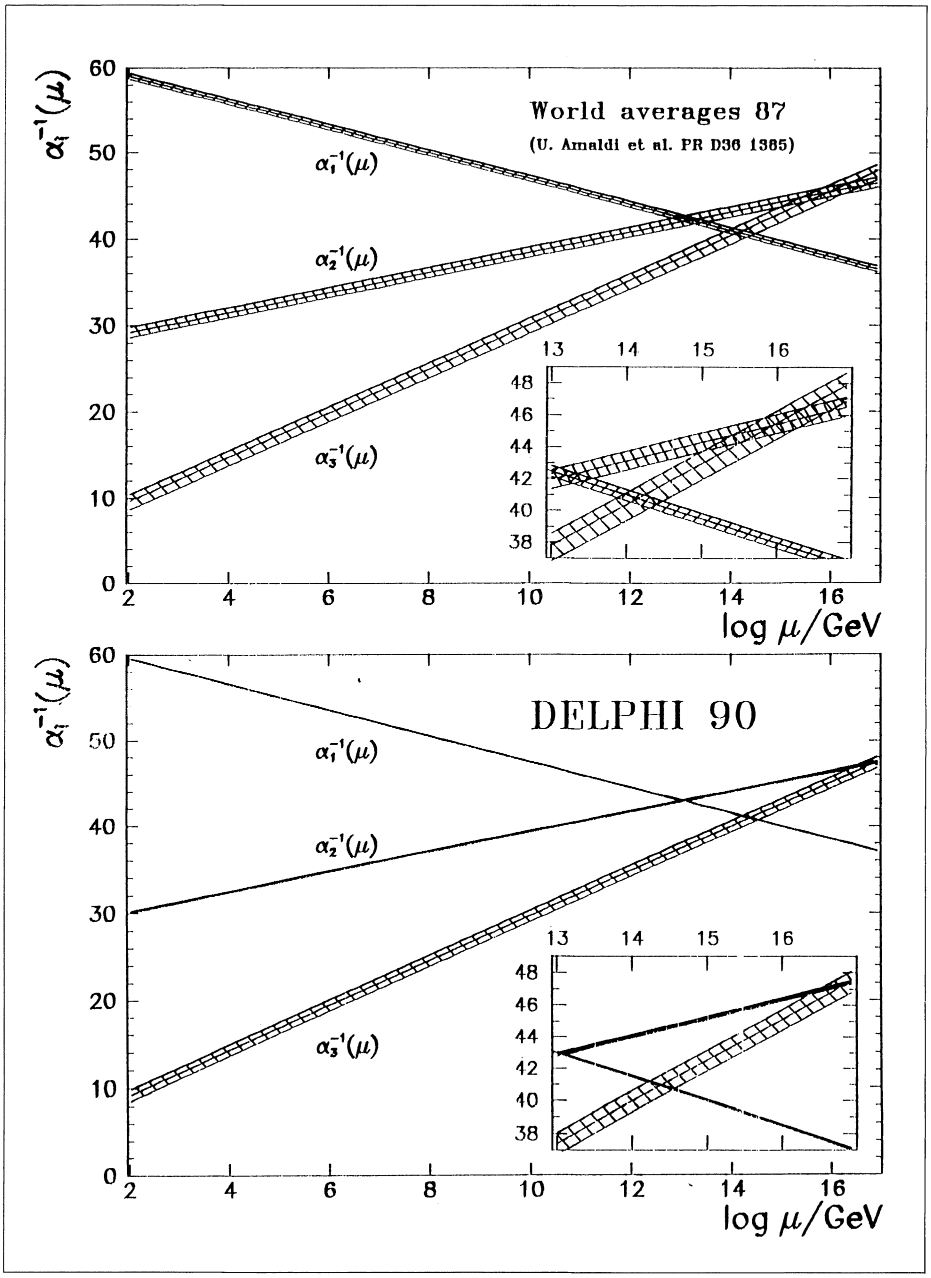
CERN
Making the most of LEP

Amid the effort to prepare for the LHC proton collider for CERN's 27-kilometre LEP tunnel (December 1990, page 3), the LEP electron-positron collider remains the main research thrust of European high energy physics. With well over half a million Z particles collected last year alone (to complement the 100,000 from 1989 operations) the four big experiments – Aleph, Delphi, L3 and Opal – are off to a flying start.

After the completion of LEP 1990 operations on 30 August, a group of LEP researchers gathered under the chairmanship of Jacques Haissinski (also Chairman of the LEP Experiments Committee) at the alpine resort of Cogne to look to the LEP future. Last year a push got underway to boost LEP beam energies from the current 50 GeV level used for probing the Z towards the 80 GeV threshold needed to create pairs of W particles (the electrically charged counterparts of the neutral Zs – September/October 1990, page 24).

At Cogne, the importance of this energy upgrade was strongly endorsed. In the meantime running at the Z would continue with the aim of accumulating some five million Zs per experiment. The W-pair production threshold was only seen as such, and not a limit – the energy should go 'significantly above' this level.

To extend the search for the Higgs particle (the source of symmetry breaking at the heart of the electroweak theory) up to the Z mass, LEP's collision energy needs to be pushed to 190 GeV, well



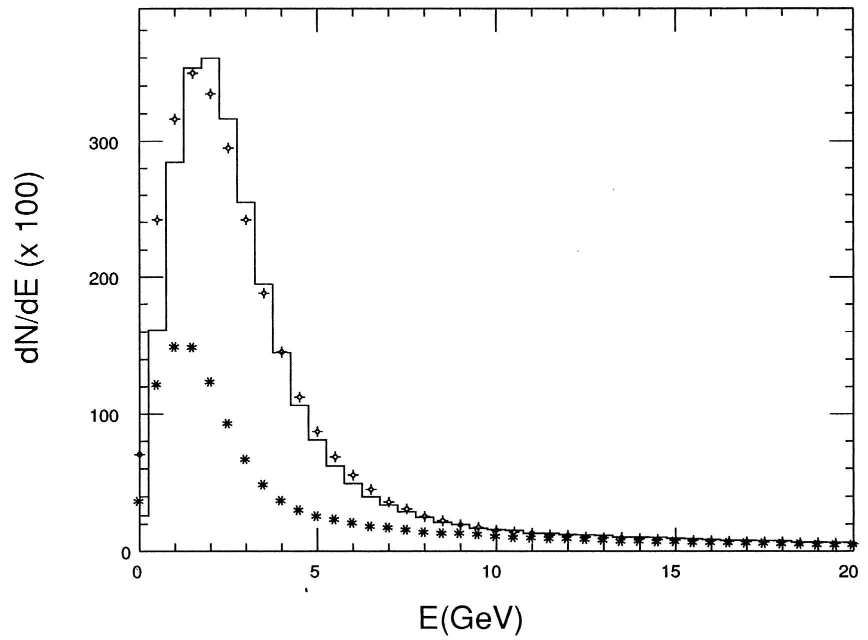
Showing this diagram at recent conferences, Ugo Amaldi, spokesman of the Delphi experiment at CERN's LEP electron-positron collider, has been pointing out interesting implications for possible 'Grand Unified Theories' synthesizing electroweak and strong nuclear forces.
In such a theory, the strengths of electroweak and strong effects should become equal at some remote energy. Already several years ago (top figure) extrapolations of existing results did not meet at a point on the logarithmic plot, suggesting that a Grand Unified Theory needed additional physics input.
With the electroweak strengths (top two lines in lower figure) now more accurately known and with measurements at the Z peak giving a lever arm on the strong coupling (bottom line), it looks even less likely that extrapolations from today's high energy results will converge at a point. Somewhere, those lines will have to take account of new physics.
For a suggestion, see next month's issue.

above the Z pair threshold.

The recent observation of polarization in LEP (November 1990, page 3) has opened new physics possibilities for precision measurements to probe the Standard Model.

Increasing the number of colliding bunches in LEP will pay collision dividends, and eight-bunch per beam operation will be facilitated by taking over electrostatic beam separators previously used in CERN's SPS proton-antiproton collider.

Moves to increase the number of experiments were viewed with caution, with implications of reduced machine performance. Thus the existing four major detectors will benefit from the planned improvements in LEP performance to provide a 'rich and largely unique research programme for the next decade'.



Thermal photons scattered from a 46 GeV positron beam in CERN's 27-kilometre LEP ring, shown up to 20 GeV (histogram), as measured by the LEP-5 (Rome) experiment. The stars show the expected level of beam-gas bremsstrahlung, while the crosses show the expected level of scattered thermal photons.

LEP takes its temperature

Any body, as long as it is not at absolute zero, emits thermal electromagnetic radiation ('black body radiation') with the characteristic Planck spectrum. The 27-kilometre beam pipe of CERN's LEP electron-positron collider is no exception, which at ambient temperatures is filled with photons with a mean energy of 0.07 electronvolt.

At LEP's working vacuum level of 10^{-10} torr, there are more of these photons in the beam pipe than residual gas molecules, and they contribute to the scattering of the circulating electrons and positrons.

This effect was recently observed and measured for the first time by two groups working at LEP looking at photons emerging from the beam pipe. This signal is dominated by the bremsstrahlung radiation seen whenever electrons are accelerated, but at low energies a shift in the photon spectrum is seen which is due to scattering off thermal photons.

One of the measurements was a quick study using a lead-glass block and a photomultiplier, while the other came as a by-product of the LEP-5 Rome experiment using a bremsstrahlung monitor to measure LEP luminosity.

The observed effect agrees with expectations and is fortunately too small to significantly degrade LEP performance by reducing the lifetime of the stored beams.

New front end for LEP's front end

To improve the reliability and ease the maintenance of the LEP Pre-Injector (LPI), a new front end for the LEP Injector Linac (LIL) has been designed and installed during the recent shutdown of CERN's LEP electron-positron collider.

Beam tests demonstrated excellent performance with a primary 200 MeV electron beam on the electron to positron converter target of up to 5 x 10^{11} electrons and an electron to positron yield of 0.45 per cent. (In LIL, particles are taken to 500 MeV for storage in the EPA accumulator prior to injection into the PS, the next link in the LEP injection chain.)

The LIL front end consists of a thermionic electron gun, a bunching system and a beamline matching the LIL accelerating sections. The electron gun has been equipped with a completely redesigned modulator able to provide a beam of 15A for 50 nsec.

A prebuncher and a buncher cavity resonating at 3 GHz with a simpler mechanical design than the previous bunching system provide a train of 15-picosecond microbunches at 4 MeV. The space made available is used for improved instrumentation and for the beam matching section mainly responsible for the improved performance.

Listening with intent – a presentation of a Letter of Intent for an experiment at the planned US SSC Superconducting Supercollider.

SUPERCOLLIDER Defining the first round of experiments

In January (January/February, page 22) the Superconducting Supercollider (SSC) Laboratory in Ellis County, Texas, took an important step toward determining its initial scientific programme.

Following last summer's intensive studies of the first expressions of interest in experiments at the SSC, it had been decided to focus attention on the largest experiments, which must be decided early because of the very long gestation times involved in designing and building the detectors.

Letters of intent to propose such large detectors were invited, with the understanding that only two could be built due to funding limitations. Three such letters were received, two from existing collaborations (SDC and L*) and one representing a merger of two previous collaborations (EMPACT and TEXAS). The SDC – Solenoidal Detector Collaboration – led by George Trilling proposed a general purpose detector featuring good central tracking, hermetic calorimetry, lepton energy measurement and identification, and high resolution vertex detection.

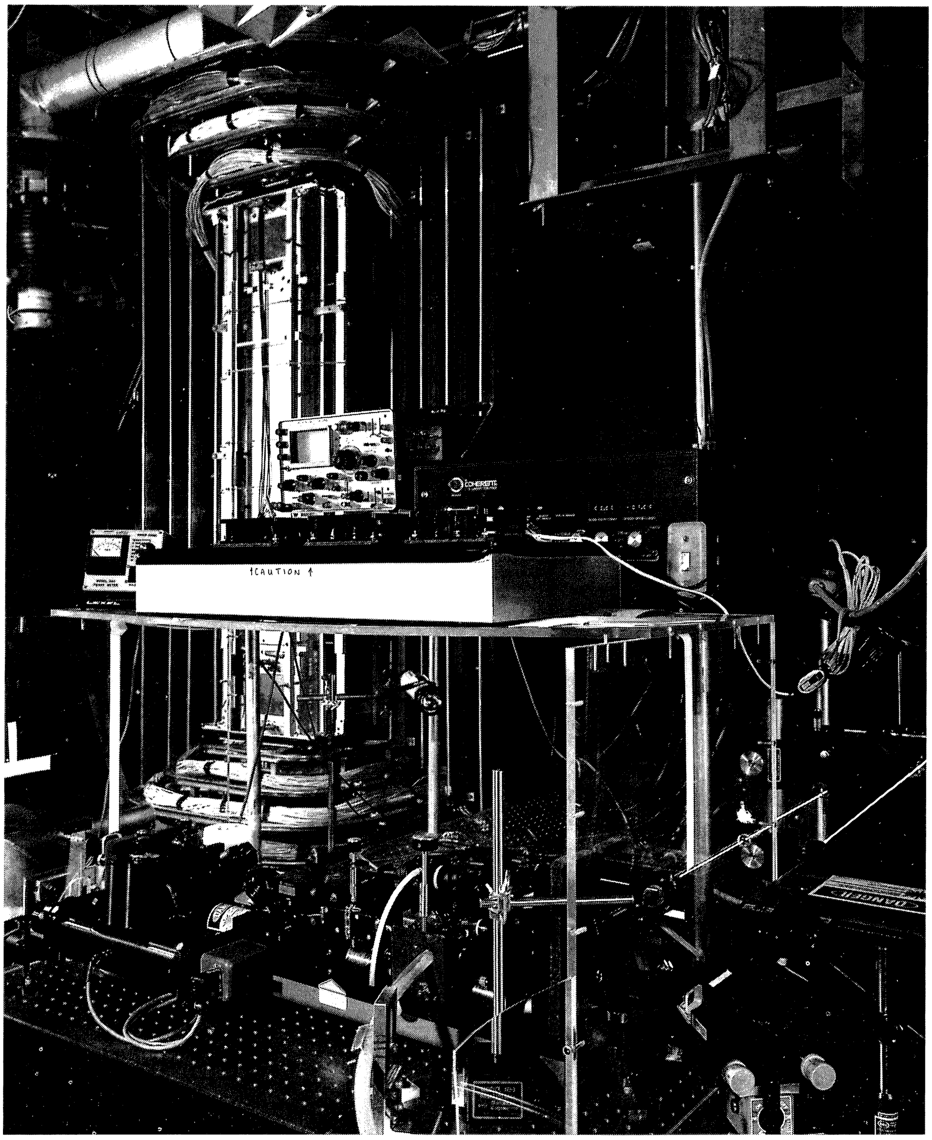
L*, led by Samuel Ting, offered a large solenoidal magnetic field, vertexing/tracking, excellent electron, photon and muon energy measurement, and hadronic calorimetry. EMPACT/TEXAS, led by Michael Marx, included a combined transition radiation detector and tracker, a preradiator plus hadron and electromagnetic calorimetry and a muon system featuring an air core toroidal magnet.

Following a December meeting of the Program Advisory Committee (PAC), the SSC Laboratory has reaffirmed its intention to mount two big experiments, and made some important decisions toward that end. The SDC collaboration will be supported to proceed with development of a full technical proposal.

The Laboratory will carry out a detailed cost review of the proposed L* detector, and will also work with the spokesman to address PAC concerns about personnel and governance. L* will be reviewed again within a few months. The EMPACT/TEXAS collaboration was not approved for support to develop a technical proposal. The SSC Laboratory will make every effort to encourage and facilitate participation by these physicists in the SSC scientific programme.

The deadline for technical proposals for major SSC experiments has been set for 1 April 1992, somewhat later than the previous 'late 1991' guideline. The additional time is intended to help the collaborations incorporate results from current detector R&D into their detector designs. Final decisions on the technical proposals are expected by the end of September 1992, so that detector construction can begin early in fiscal year 1993, which begins late in 1991. Further PAC review and much spadework on management, cost estimates and formal agreements between the Laboratory and participating institutions will be needed for the final go-ahead to build detectors.

At Lawrence Berkeley Laboratory, an atomic beam magnetic resonance apparatus with separated oscillatory fields is used to look for an electric dipole moment of the electron. Heated thallium atoms defined by narrow slits are collected on a magnetic substate by optical pumping with 378 nm (UV) light linearly polarized along the direction of a weak applied magnetic field.



The Laboratory has also confirmed its intention to reserve about $75M for smaller experiments. A schedule for selecting these will be announced later this year, after further PAC discussions in the summer. The current view is to set a relatively late date for the proposals, to benefit from advances in high energy physics and detector technology that may occur between now and SSC startup, planned for 1999.

BERKELEY
Looking for the electron's electric dipole moment

An elementary particle can act as an electric dipole only if the invariances of left/right reflection (parity – P) and time reversal (T) are violated. So far no such electric dipole moment (EDM) has been found.

This is not too surprising since the Standard Model plus the six-quark (Kobayashi-Maskawa) description of quark flavour coupling predicts no electron EDM larger than 10^{-37} e-cm. However other models can accommodate much larger electron EDMs, and finding a value much larger than 10^{-37} e-cm would be clear evidence for new physics.

Over the past 25 years the experimental upper limit to the electron EDM has improved five orders of magnitude. The most recent improvement, a factor of seven over previous measurements, comes from the Lawrence Berkeley Laboratory, where Kamal Abdullah, Conny Carlberg, Eugene Commins, Harvey Gould, and Stephen Ross have set a new experimental limit of 10^{-26} e-cm (published in Physical Review Letters,**65**, 2347, 1990).

The Berkeley experiment (which uses no accelerator) searches for the EDM by measuring its energy in an electric field. While this is impractical for a free electron, it is feasible using a valence electron in a heavy atom.

An atomic beam magnetic resonance apparatus with separated oscillatory fields is used to make the measurements. Heated thallium atoms defined by narrow slits are collected in a magnetic substate by optical pumping with 378 nm (UV) light linearly polarized along the direction of a weak applied magnetic field.

Atomic transitions are induced by a pair of radiofrequency loops 1.2 m apart around a set of electrodes producing an electric field of 10^5 V/cm. An EDM shows up as a difference in the transition frequency when the electric field is reversed.

While the shift in frequency due to electron EDM is no larger than

*Also at Oxford, see next month.

10^{-6} Hz/kV/cm, the shift due to the electron magnetic dipole moment is much larger, about 10^{6} Hz/G. To prevent a magnetic dipole moment mimicking an EDM, magnetic field changes synchronous with the electric field are kept to below 10^{-10} G.

One source of a synchronous magnetic field is that due to the atoms moving in the electric field if the latter is not exactly parallel to the weak static magnetic field (defining the polarization axis). This effect is minimized by using two counter-propagating thallium beams whose average velocity is close to zero.

Despite their low beam energy and primitive cooling techniques, the experimenters are optimistic that they can improve their limit by the next order of magnitude in much less than the average five years! Further improvements may come with thallium beams of even lower energy.

Massive neutrino?

Evidence for a neutrino with a mass of 17 kiloelectronvolts – far heavier than any predicted by theory - has been seen by scientists at Berkeley.*

This new evidence, reported by Eric Norman and coworkers, supports a claim made over five years ago by John Simpson of Guelph, Canada, for a 17 keV neutrino from the beta decay spectrum of tritium (July/August 1985, page 241).

This claim did not convince most of the scientific community and the noise subsequently died down. However interest revived in 1989 when Simpson reported additional results from new experiments using tritium and sulphur 35.

Norman's team set out to confirm or disprove the latest Guelph observations, and their data now support Simpson's observations. Norman is planning a follow-up experiment to clinch the result one way or the other.

Neutrinos (of the electron type) from beta decay cannot be observed directly – they can only be inferred from their effects on the beta electron spectrum (it was the missing momentum in beta decay which led Pauli more than 50 years ago to postulate the existence of the neutrino).

Neutrinos were long thought to be massless, but there is enough room for a small vestigial mass, and there is a big effort underway to try to measure this mass directly. However a mass as substantial as 17 keV, a few per cent of that of the electron, is a surprise.

Massless neutrinos would give a continuous beta spectrum extending from zero up to the full decay energy. However if some of the neutrinos have a mass, less energy is available to the electrons, giving a 'kink' in the spectrum.

Simpson measured the beta spectrum in a sample of tritium implanted inside a detector – a crystal of silicon – to reduce noise and permit detection of very small effects. However implanting the tritium in the crystal by bombardment may have damaged it.

Norman chose another sample/detector combination, using carbon 14 as the beta emitter and germanium as the detector crystal.

Beta decay measurements with the carbon/germanium crystal got underway early last year and continued for four months. This was followed by two months of measurements with a plain germanium crystal, closely matched to the original in size and other characteristics, to measure background.

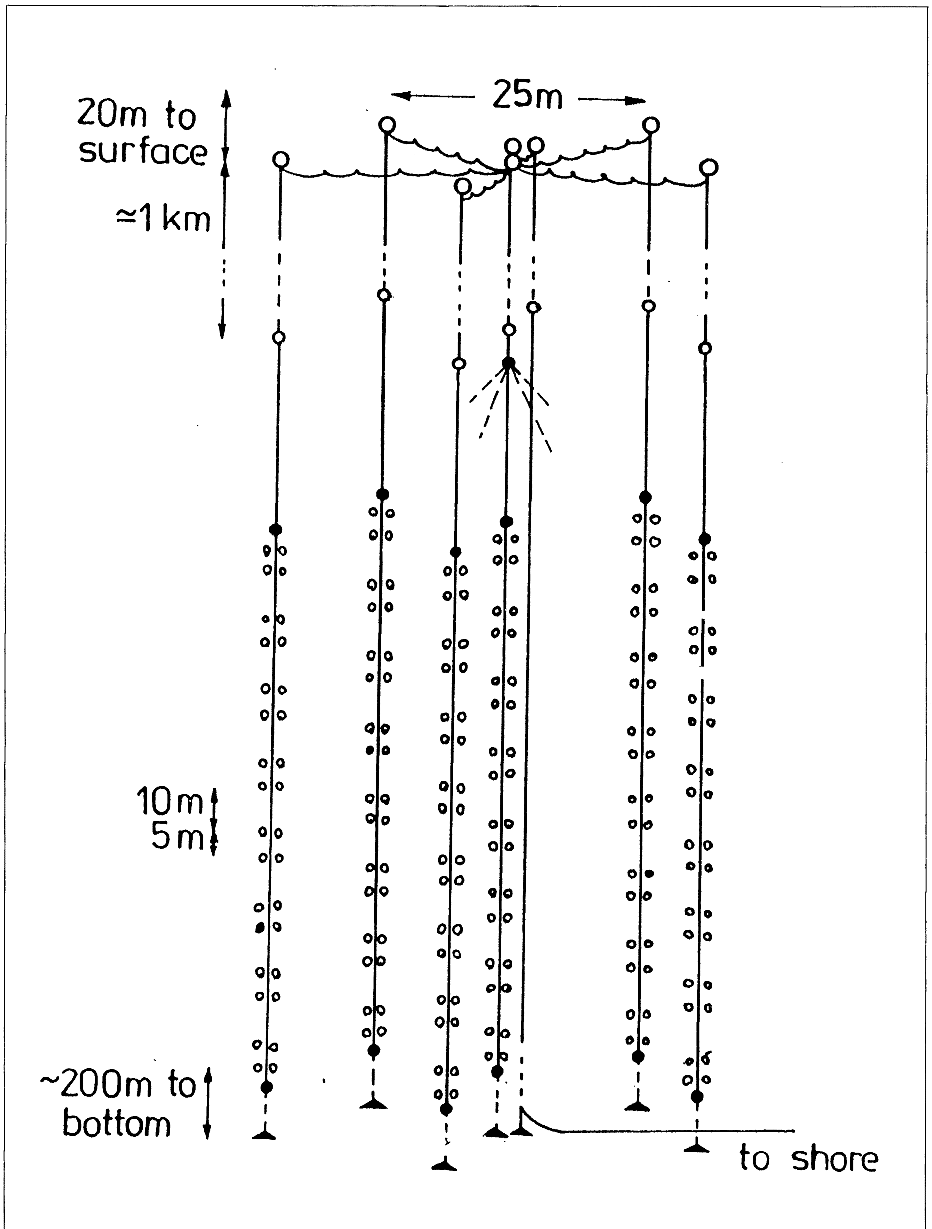
The kink in the beta spectrum at 17 keV is extremely small, though statistically significant to 99 percent. Norman reported the results at the 14th Europhysics Conference on Nuclear Physics, held in Bratislava, Czechoslovakia, in October. He plans to repeat the experiment with a new carbon 14/germanium crystal that will yield 10 times as many carbon decays, thus greatly improving the reliability of the results.

LAKE BAIKAL
Underwater neutrino detector

A new underwater detector soon to be deployed in Lake Baikal in Siberia, the world's deepest lake with depths down to 1.7 kilometres, could help probe the deepest mysteries of physics.

One of the big unsolved problems of astrophysics is the origin of very energetic cosmic rays. However there are many ideas on how particles could be accelerated by exotic concentrations of matter and provide the majority of the Galaxy's high energy particles. Clarification would come from new detectors picking up the energetic photons and neutrinos from these sources.

So far, neutrino observations have relied on underground detectors to make initial measurements of particles from the sun and from the 1987 supernova. However these detectors might not be sensitive enough to probe the feeble fluxes from more distant sources. An alternative and less expensive approach towards large detector arrays is to go underwater.



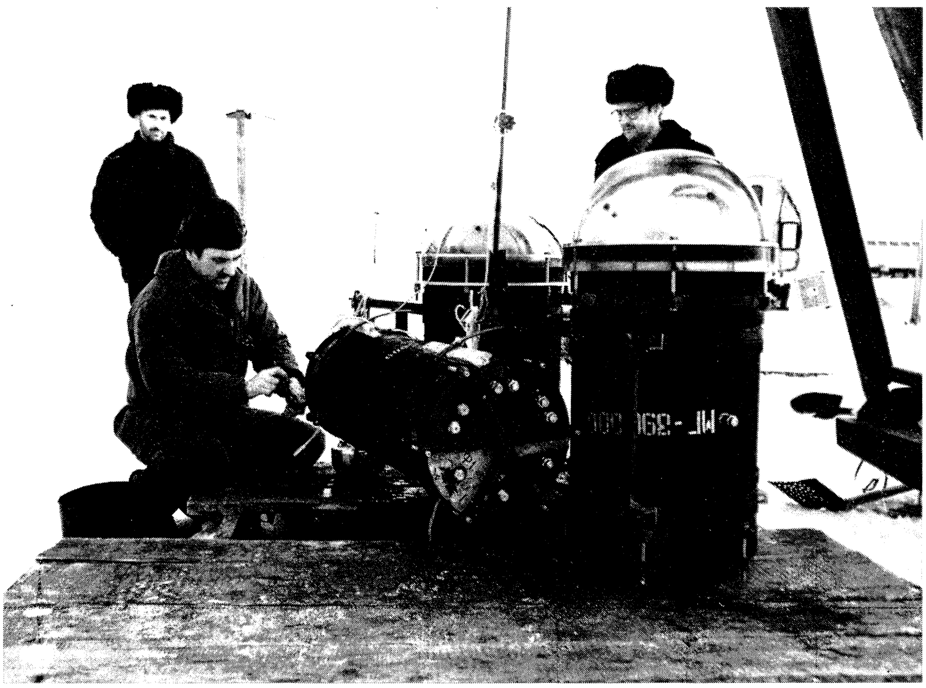
Schematic of the six strings of photomultiplier arrays soon to be deployed for the underwater neutrino telescope project in Lake Baikal, USSR.

Neutrinos hitting water nuclei produce muons (by charged current interactions), which in turn give tiny pulses of Cherenkov radiation which can be monitored by large arrays of photomultipliers. Since the high energy muons tend to maintain the direction of the primary neutrino, such an array would work as a neutrino telescope with an angular resolution of one or two degrees.

Two deep underwater neutrino projects are taking shape – DUMAND, in the Pacific Ocean near Hawaii (June 1988, page 29) and in Lake Baikal, where the final goal is to construct a full-scale muon detection array covering 100,000 square metres. Such an ambitious project involves many logistic problems and needs to be attacked stepwise.

In the ten years since the idea was first put forward, the project has adopted a technique of using the lake's ice cover, up to a metre thick in late winter, as a platform to deploy detector strings at depths down to 1350 metres. These strings do not have to be hauled up when the ice melts. Since 1984, four tests have been mounted using an initial detector design with a flat photocathode 15cm in diameter, transmitting data to the shore station 4.5 km away.

As well as showing the feasibility of the approach, these tests gave important new limits on magnetic monopole fluxes and for dark matter searches. In addition to the physics, this work also contributed to advances in marine and ice technology, detector design and data transmission (using an armoured



Two of the second-generation photomultipliers developed for the Lake Baikal neutrino telescope. The complete detector will use 200 similar such devices.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In 1987, the group was ready to embark on a second stage detector using an improved photomultiplier with a 35-cm diameter hemispherical head developed initially by Philips and subsequently at the Novosibirsk Laboratory. This detector, christened NT-200 (a neutrino telescope with 200 photomultipliers), is now under construction.

At depths of up to 1.1 km, this 3,000 sq m array will use six strings each containing 16 optical modules with twin pressure-housed photomultipliers. Measurements with prototype equipment showed that muons can be detected up to 10 metres in the clear Baikal water. This determined the string spacing (about 25 metres) and the module array on each string (about 7 m apart).

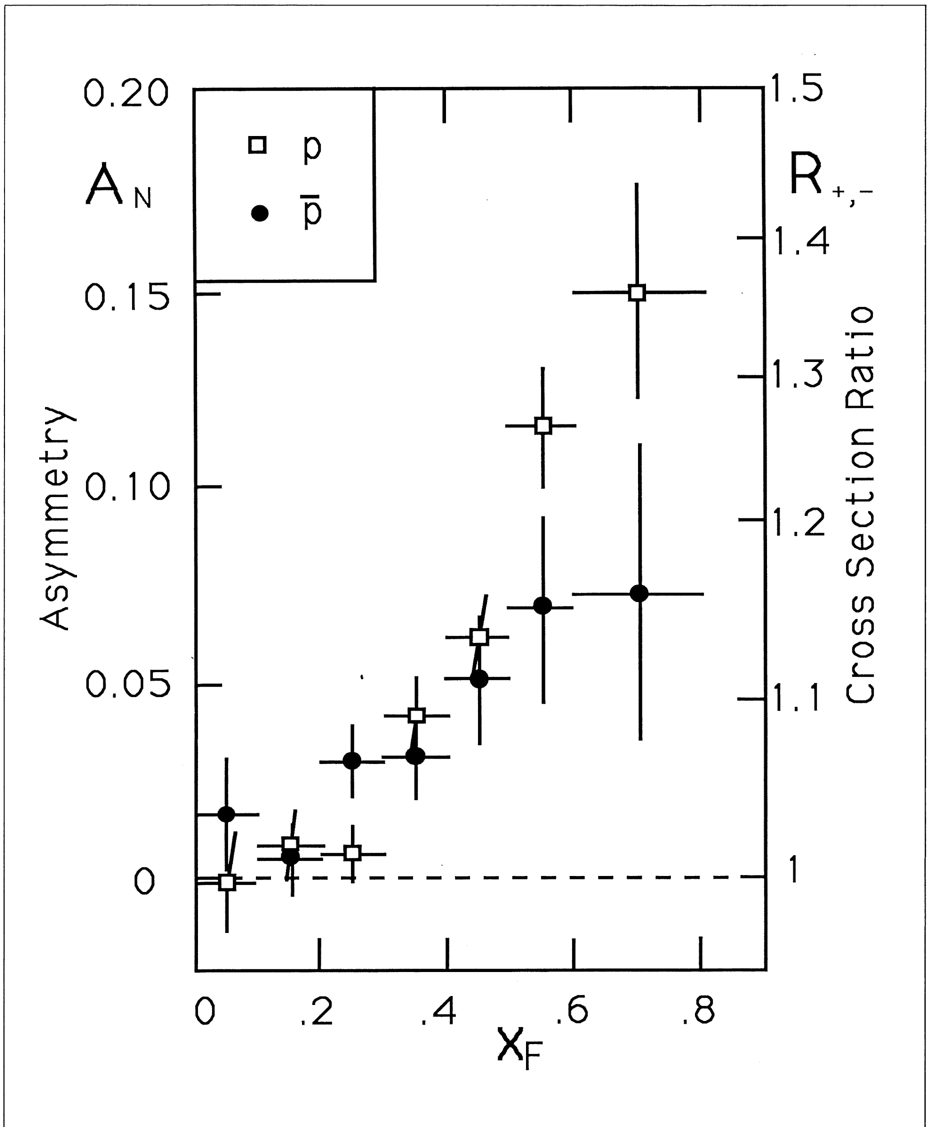
NT-200's main goal will be to measure upward-travelling muons from neutrino interactions to within 1.5 degrees against a substantial background of downward muons. Some hundred events per year are expected from atmospheric neutrinos, hopefully augmented by a few signals from distant neutrino sources such as binary stars, young supernovae or the galactic centre.

Additional goals are the investigations of cosmic ray muons and the continuing search for dark matter, as well as biological studies and hydrography.

The Baikal collaboration includes several Soviet institutes (notably the Moscow Institute of Nuclear Research and the University of Irkutsk), the High Energy Physics Institute of Zeuthen/Berlin and KFKI Budapest.

While the basic technical problems of the detector are solved, the deployment of the six-string array in 1993 is still a challenge.

Comparison of spin effects (measured by left-right asymmetry – left-hand axis) in the production of neutral pions by polarized protons and antiprotons at Fermilab for different fractional momenta (integrated over a range of transverse momentum). The right-hand axis is the ratio of reaction rates for opposite beam particle spins.



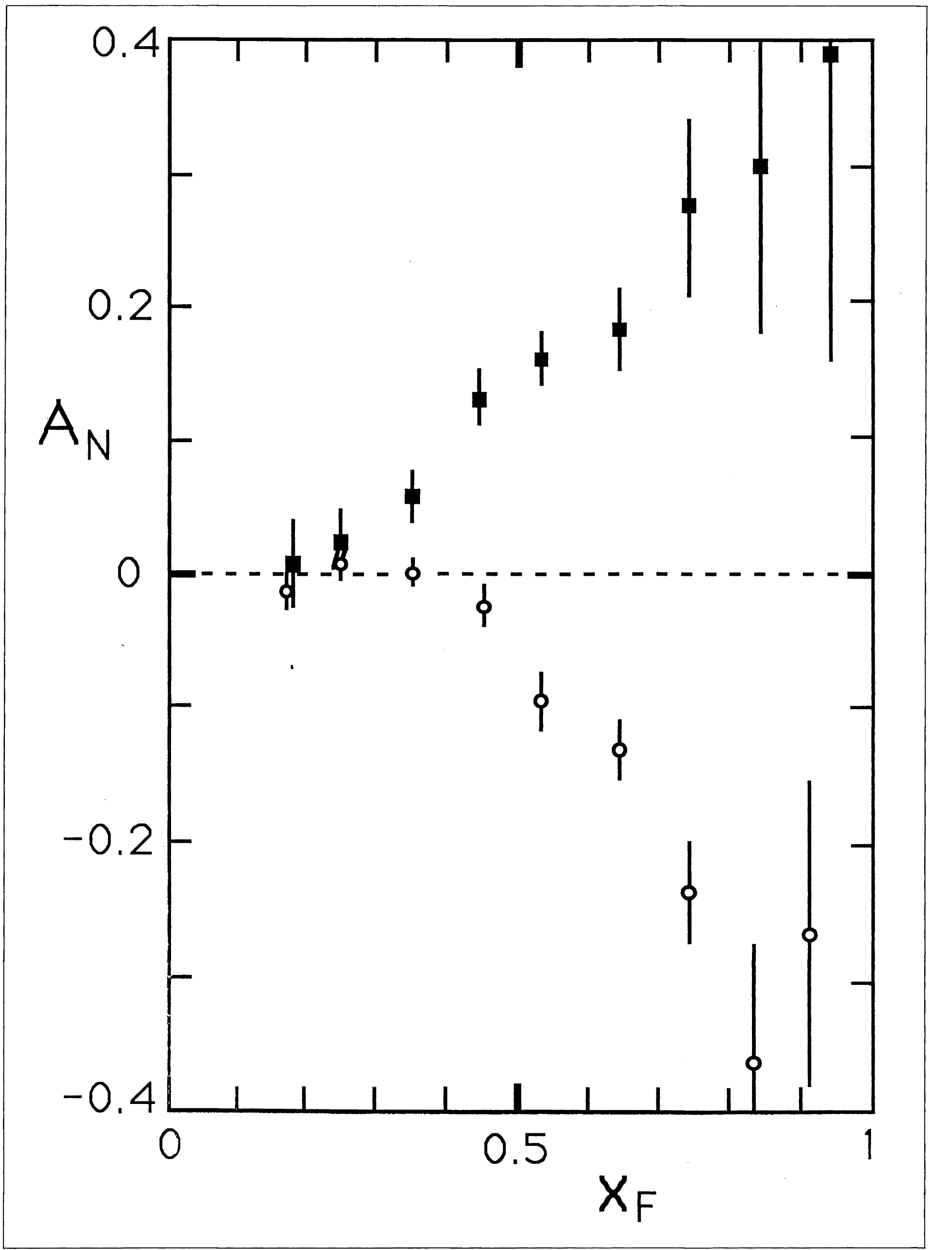
FERMILAB High energy spin effects

While many physicists would agree that it is important to study interactions of different isospin states (for example comparing proton and neutron data), many of them also accept as normal data averaged or integrated over ordinary spin.

However an ongoing programme at Brookhaven studying elastic scattering (where the incoming particles 'bounce' off each other) produced marked spin effects which are not well understood (September/October 1990, page 34). Our understanding of particle interactions should not be influenced by which observables are easy to measure and which aren't, and until a clear understanding of spin effects emerges, it is important to continue and extend these studies.

Insights at higher energies and

More high energy spin effects. Left-right asymmetry parameter for the production of positively-charged pions (squares) and negatively-charged pions (open circles) at 200 GeV for different fractional momentum, x_F, integrated over a range of transverse momentum.



for inelastic reactions (where new particles are formed) come from a beamline at Fermilab commissioned in 1987-88 for experiments with polarized proton and antiproton beams of 200 GeV. These spin-oriented particles come from the direction-sensitive beta decay of secondary lambda (and antilambda) hyperons (October 1988, page 25). Motivation for this polarized beam facility came from earlier Fermilab measurements of hyperon magnetic moments (June 1988, page 25).

The first results from the 1990 run of the Fermilab experiment E704 in this beam come from neutral pion production by transversely polarized protons incident on a liquid hydrogen target.

The first measurement has established that, as the pions' longitudinal momentum approaches that of the beam, the production rates for opposite spin states (measured by the difference between pions coming out on the left and on the right) diverge, the asymmetry eventually reaching a factor of about 1.3. This spin effect seems to involve the transfer of a leading up ('u') quark from a beam proton to the produced neutral pion.

Other kinematical conditions are probed by looking at the transverse momentum dependence of the left-right asymmetry when only a small fraction of the proton momentum is imparted to the target quark. Here the asymmetry changes with transverse momentum, moving from around zero through negative values to eventually acquire a substantial positive value, underlining pion production effects found at Brookhaven, CERN and Serpukhov.

Together, the data from energies ranging from 13 to 200 GeV suggest a mechanism depending neither on the energy nor on the transverse momentum, but only a transverse scaling variable – the fraction of the maximum kinematically-allowed transverse momentum. At the highest values, reached at Fermilab's 200 GeV energies, the spin effect is large – beam protons with their spins pointing up produce more than twice as many neutral pions to the left as to the right.

This suggests that spin continues to play an important role at higher energies.

Meanwhile Fermilab's study of hyperon production continues to add to knowledge of hyperon magnetic moments.

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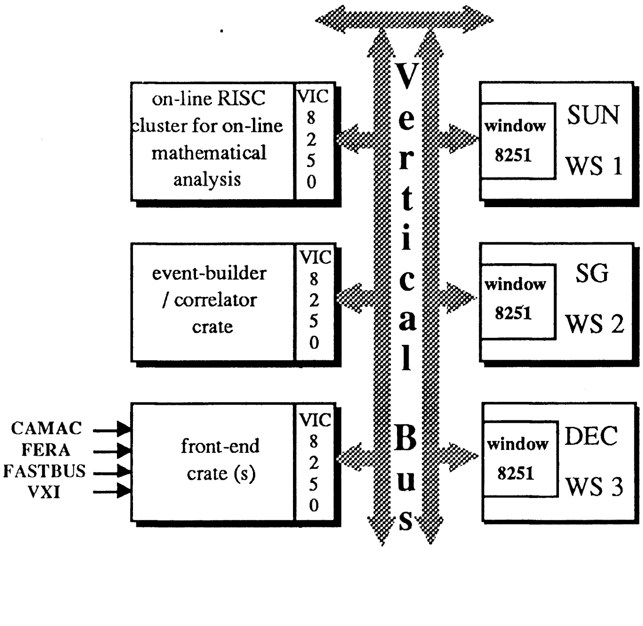
These processors are equipped with similar facilities (VME / VSB interfaces, communication FIFOs, dual-port memories) as the acquisition processors, using RISC or CISC based architecture and large global memories. They conform to the IEEE POSIX Full Use interface definition (1003.1) and will conform to the POSIX real-time extensions (P1003.4). They are compatible with the two leading flavours of UNIX: AT&T System V and Berkeley 4.3 BSD.



Bi-processor VME 68040 CPU:
The FIC 8234, developed by CES, is based on 2 MC68040 for real-time applications.
When they execute program internally on their on-chip 4K data and 4K instruction caches, they operate at full speed in parallel. The System Memory provides 8 Mbytes up to 128 Mbytes of DRAM. The burst mode operates at 80 Mbytes/sec in write mode, and at 57 Mbytes/sec in read mode (@25 Mhz). As a standard CPU on the market the FIC 8234 incorporate Ethernet, RS232, SCSI VME (D64) / VSB Master / Slave, Timers, RTC, Memory back-up,...
Thanks to the cache-coherency of the 68040 and special logic, the FIC 8234 can share different areas of data also with other VME / VSB CPUs.

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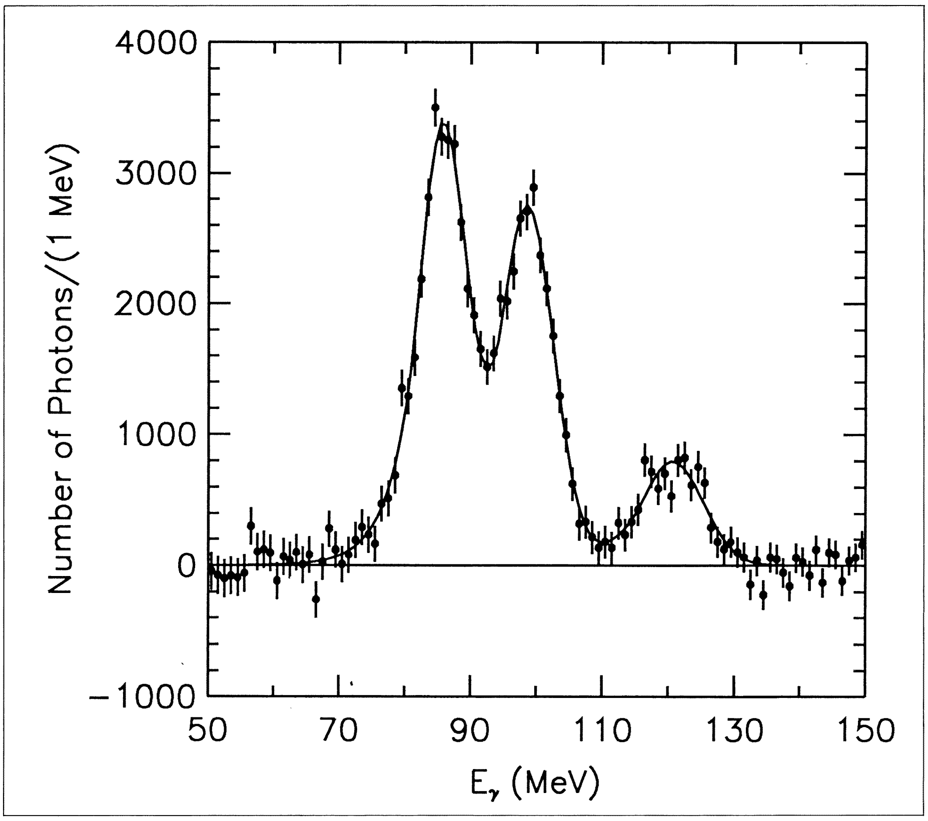
DESY
HERA progress

On 15 December, the last of the 646 superconducting magnets of the proton ring of the HERA electron-proton collider now being commissioned at DESY, Hamburg, reached liquid helium temperature. During the end-year shutdown the ring was left 'floating', reaching 85K after 15 days. Magnet testing got underway again end-January.

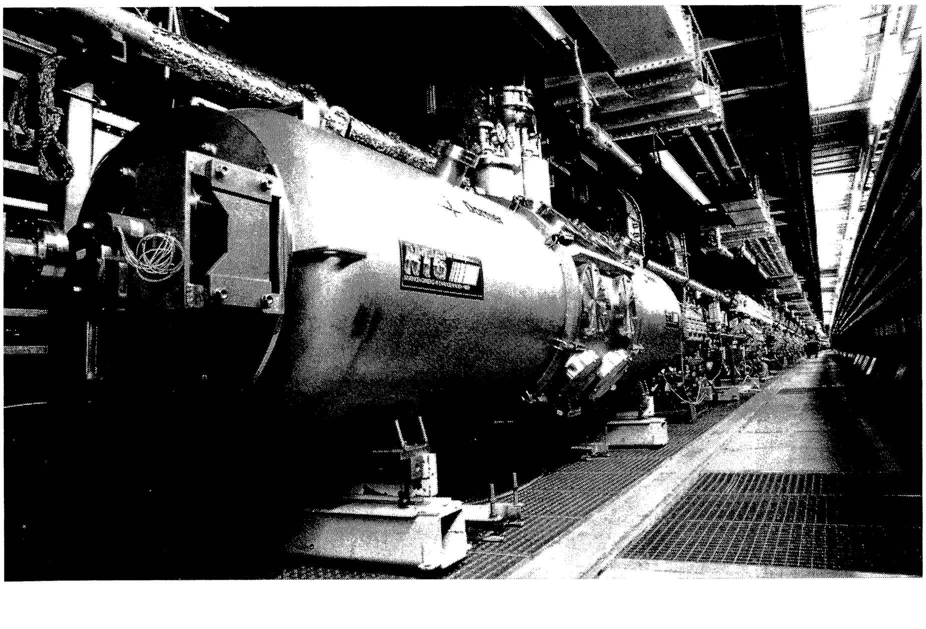
Meanwhile the two experiments – H1 and Zeus – continue to make good progress en route to intercepting HERA's first beams.



▲ *First physics from the CLEO II detector at Cornell's CESR electron-positron collider. The photon spectrum from transitions between the upsilon 3S (angular momentum zero) and chi-b (unit angular momentum) states reflects the detector's performance.*

▼ *While the superconducting magnets for the proton ring of the HERA electron-proton collider at the DESY Laboratory in Hamburg are put through their paces, final touches are also being put to the electron ring (which accelerated its first particles in the summer of 1988). A total of eight superconducting cavities will eventually take the electron energies to over 30 GeV.*

(Photo P. Waloschek)



CORNELL
CESR's progress

Cornell's CESR electron-positron collider passed three significant milestones last year:

- the CUSB group completed its experimental programme after eleven years, and the experiment was removed;
- the CLEO collaboration brought the new CLEO II version into action and reported first results;
- with a single interaction region, CESR established new luminosity (related to collision rate) records.

The CLEO group will continue to exploit these favourable collision conditions, running at the broad upsilon 4s resonance to accumulate a large sample of B mesons (containing the fifth ('beauty') quark).

The final CUSB run concluded a very productive programme. This collaboration made many vital contributions to B physics, including the sighting of the B* meson and the low-lying chi-b states, where the beauty quark and antiquark together carry one unit of angular momentum (the upsilon states have zero). After the discovery of the upsilon at Fermilab in 1977 and its subsequent elaboration at DESY, CUSB and CLEO together extended the upsilon ladder to higher energies.

In addition, CUSB contributed to many searches for axions, Higgs and other exotic particles. In 1986 the original detector was upgraded with 360 BGO crystals, achieving excellent photon energy resolution – 2% at 100 MeV and 1% at 5 GeV for low multiplicity events.

For CLEO II, the most important upgrade feature is the 7800-element cesium iodide calorimeter (October 1989, page 14), where photon energy resolution (4.1% at 100 MeV and 1.4% at 5.2 GeV low multiplicity events) exceeds design specifications. Preliminary upsilon results and calorimeter performance were presented at last year's conferences.

Although the resolution of the CUSB and CLEO II detectors is not significantly different, the latter's much finer segmentation pays dividends. Neutral pion detection power has been exploited in looking at tau lepton decays.

The removal of CUSB and operation with a single interaction region and consequently decreased beam-beam interaction opened the door to increased CESR luminosity. However increased flexibility in choosing the operating conditions has resulted in larger gains. The net result has been a new record luminosity of 1.7 x 10^{32} per sq cm per s, half as big again as the previous record level, also set by CESR, and with 7.1 inverse picobarns in a single day.

Performance is limited chiefly by radiofrequency cavity reliability. To improve this, new cavities will be installed later this year. Meanwhile achieving a vertical tune shift near 0.03 with appropriate beam dimensions has encouraging implications for proposed B factories, where similar conditions will be encountered.

COMPUTERS
Teraflops for Europe

In little more than a decade, simulation on high performance computers has become an essential tool for theoretical physics, capable of solving a vast range of crucial problems inaccessible to conventional analytic mathematics.

In many ways, computer simulation has become the calculus for interacting many-body systems, a key to the study of transitions from isolated to collective behaviour.

Computer simulation of lattice gauge theories has blazed a trail for many other physics applications. In lattice gauge theory it has now become clear that only a major progression to much larger computers will bring us to the next level of theoretical understanding.

Similar conclusions have been reached also in condensed matter physics, quantum chemistry and fluid flow studies. This demand of theorists from Europe, the US and Japan has led to planning and construction of ever faster parallel computers. For the next generation of such supercomputers, collaboration with industry and exchange of ideas and expertise could well be extremely useful to both sides.

At the beginning of October a collaboration of 16 leading American universities and research laboratories, together with the Thinking Machines Corporation as industrial partner, therefore submitted to the US Department of Energy a proposal to construct a Quantum Chromodynamics (QCD) Teraflop Supercomputer – the first computer capable of providing a sustained performance of 10^{12} floating point operations per second.

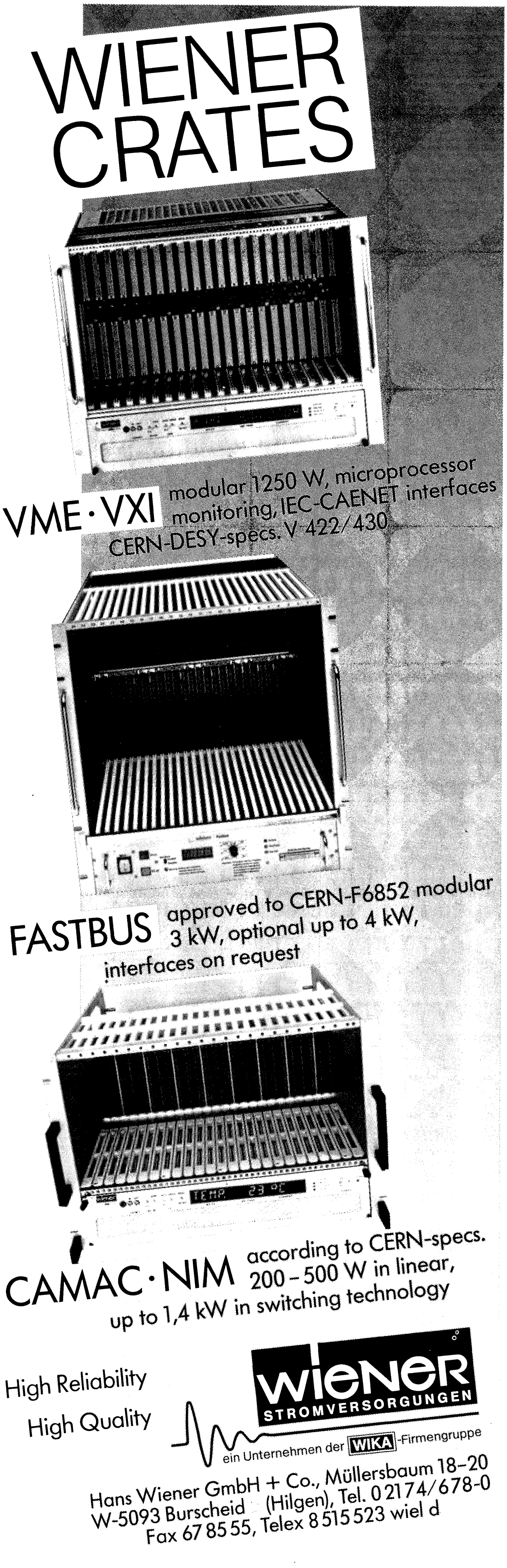
Such a facility would make possible both the quantitative prediction of many experimentally crucial parameters as well as the search for new phenomena in non-perturbative strong interaction physics.

On 27-28 November more than 50 European lattice gauge theorists, together with some experts from condensed matter physics and from computer science, met at CERN with representatives from the computer industry to see if and how this decisive next step could be achieved in Europe.

There is ample expertise on the research level. The APE group in Rome, at the same time as the Columbia University group in the US, pioneered the construction of high performance special purpose supercomputers for QCD. A collaboration of groups from German universities, working at the High Performance Computer Center HLRZ in Jülich has made significant progress in the study of QCD thermodynamics and hadron properties.

Strong efforts from the Edinburgh group have led to the establishment of a UK Grand Challenge Collaboration for the study of non-pertubative QCD.

However the European counterpart to the American supercomputer industry needs urgent and rapid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modular 1250 W, microprocessor monitoring, IEC-CAENET interfaces CERN-DESY-specs. V 422/430
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development. European companies such as AMT, Meiko and Suprenum have to grow and strengthen their products.

The European lattice gauge theory community is strongly in support of a common push into the Teraflop regime and has endorsed further action towards this aim. The Steering Committee of the European Teraflop Meeting (I. Halliday, F. Hossfeld, E. Marinari, M. Metcalf, H. Rollnik, H. Satz (convener), K. Schilling, and D. Wallace) has therefore set up a Technical Working Group to assess the possibility of finding suitable partners in the European computer industry.

The collaboration of the European academic community, which has expertise in both the construction of large-scale special-purpose computers and in large-scale computer simulation, with such an industrial partner could then, given sufficient funding, lead to the construction of the first European Teraflop Supercomputer – on a timescale competitive with that of the US plans.

Collaboration with other research areas, such as condensed matter physics, quantum chemistry and fluid flow, is also being actively sought. If successful, this enterprise could provide a decisive impetus to the further development of both computer simulation and supercomputer construction in Europe.

By Helmut Satz, CERN

EEC Working Group on High Performance Computing

CERN Director General Carlo Rubbia was charged by the Commission of the European Communities to constitute and direct a Working Group with the mandate to prepare a recommendation on a European policy for high-performance computing. The main questions to be answered were:

- What is the present and foreseeable situation in Europe of the high-performance computing domain, both for users and suppliers?
- Is such a situation satisfactory, considering the impact of this domain for the future developments of science, economy and society in Europe and in the world?
- Should this situation not be fully satisfactory, which actions have to be recommended on a European level and which resources would these actions entail?

In response, the 18 members of the Working Group concluded that Europe should make a substantial investment in high-performance computing to become an active participant and a recognized partner at the level of the leading American and Japanese industries (both vendors and users) by the end of the century. To achieve this, the Working Group made five interrelated recommendations.

Promotion of High-Performance Computing

The European Authorities should stimulate the creative use of the most powerful computing systems available. All practical measures should be urgently taken to help spread the know-how associated with their use and to encourage the further imaginative development of such devices. Scientists and engineers should be made aware of and become familiar with techniques such as physical modelling, simulation, multidimensional interactive graphics and scientific data visualization, vector and parallel programming in order to be able to tackle large, complex problems and applications. To this effect the development of an advanced Pan-European High-Speed Network is of strategic importance. The present generation of data communications networks should be rapidly evolved into a large scale high-performance (multi-Megabits/s), multi-protocol backbone, while the necessary research and development is to be encouraged to allow Europe to compete in the Gigabits links race. This involves substantial investments both in hardware and software. This will permit the formation of a European high-performance computing community and would identify the real users' needs and present them to the suppliers.

Development of a European High-Performance Computing Industry

The design and production of advanced high-performance machines should be pursued vigorously. In order to obtain the required computer performance (Teraflops speed by the year 2000) priority should be given to parallel architectures. In these fields there is a high potential for discovery and innovation. A significant effort should be extended to the design and production of innovative computer architectures for specific applications in research and industry. The development of a competitive and credible European industry in this domain will foster the ability of designing and producing all the equipment and software which is required for a leading-edge computing environment, such as high-bandwidth communications, high-performance graphics, data storage systems and workstations.

Development of European Software

A major European effort should be directed at the inventive development of novel software. In view of the revolutionary changes taking place in the architecture of high-performance computer systems as well as in their interactive real-time use, either locally or via networks, entirely new software concepts need to be developed and implemented. Existing application software, as well as the underlying support software, often needs to be adapted or redesigned to take advantage of the rapidly evolving hardware. Major efforts should be deployed to face this challenging software evolution and to exploit the opportunities offered by the emerging computing devices. Part of this effort is the design, enhancement and application of standards which could reduce this effort to the minimum for the end user. Technology transfer mechanisms should be studied and employed to successfully market the high quality software produced by European academia and scientific research. Such mechanisms must, amongst other things, encourage use of new software by the scientific and industrial users.

Research and Development

The existing competence in Industry, Universities and Large Research Laboratories should be effectively mobilized to carry out the basic and applied research necessary to raise the competitive level of European industry in the domain of high-performance computing. It is critical to ensure that close collaboration be achieved between the leading edge users and the emerging industry. The aim should be to supplement the current effort on basic components by an increased emphasis on systems integration. The European Authorities should promote advanced pilot projects involving the best European Institutions, in order to develop the theoretical and practical understanding of the various aspects of high-end computing applications. These projects should actively contribute to the design and implementation of all the software related to the exploitation of parallel machines in Science and Engineering.

Promotion of Education and Training

To alleviate the critical shortage of skilled engineers and scientists for the design, development, production and intelligent use of high-performance computer systems, Education and Training in all areas connected with this field should be strongly enhanced. The high-performance computing culture should be spread among scholars of all disciplines as well as in industrial, commercial and financial environments. This can be enhanced via the introduction of the subject in the curricula of universities and engineering schools. In addition, access to leading-edge machines should be encouraged and facilitated.

Léon Van Hove 1924-1990

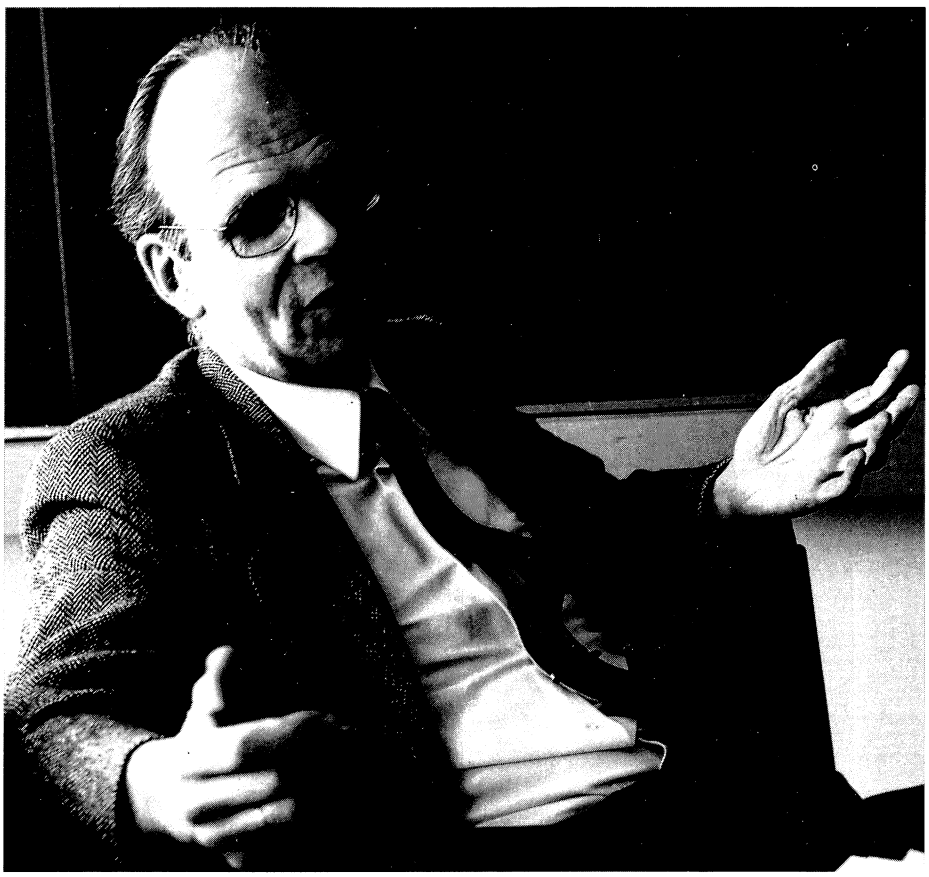
Following the death of Léon Van Hove, distinguished theorist and former CERN Research Director General, on 2 September (September/October, page vii) tributes have continued to come in from all over the world. The CERN Courier benefited considerably from his wisdom and judgement, and it is fitting that we publish some specially commissioned tributes illustrating his multiple talents. We are grateful to André Martin for coordinating these contributions.

Major contributions to science

by André Martin

It may look difficult to describe the scientific contributions of Léon Van Hove, who started his career as a pure mathematician, and then a mathematical physicist, and ended it as a phenomenologist and an ad-

Léon Van Hove – A talented scientist, teacher and administrator.



ministrator. Yet, from statistical mechanics to multiparticle production and quark-gluon plasma, there was a theme, a lifelong interest in systems with a large number of particles. This number can be 10^{23} in gases, liquids or crystals, 100 in high energy collisions, but sometimes 3, in single production events or in nucleons made of 3 quarks. Exceptionally, this number may be 2, but this is only because elastic scattering is the unavoidable shadow of production processes.

Another theme was his sense of rigour. Given a starting point, which may have been a mathematical problem or a physical model with certain given assumptions taken a priori, Léon worked the consequences by purely logical deductions and, from the result, decided whether the initial hypotheses were or were not tenable.

Léon's early work was in pure mathematics. He had been a student in mathematics at the Université libre de Bruxelles, and his first research and publications were in this specific area, from 1945 to 1948. In fact, even after having made contact with physics, he continued until 1952, with two remarkable papers on the topology of analytic functional spaces and infinite group transformations.

It was his acquaintance with Ilya Prigogine, whose clandestine lectures he followed during the war, which led him towards rigorous statistical mechanics. His pioneer work was continued later by many others, including another physicist of Belgian origin, David Ruelle, and several of Léon's students, in particular N. Hugenholtz.

In this domain, his contributions were numerous and fundamental. He showed how an assembly of N gas molecules will exhibit a 'normal' behaviour as N goes to infinity: the energy and the volume, for a given pressure, will be proportional to N if the interaction between molecules is well behaved. He also showed that phase transitions, from liquid to gas for instance, can only occur for infinite N. He also established fundamental properties of the phase diagram of these transitions which violated existing models like the Van der Waals gas. He treated not only gases in equilibrium, but, under the influence of Prigogine, non-equilibrium phenomena, including the approach to equilibrium (the Van Hove limit) and clarified the mystery of irreversibility, which seems to contradict the invariance of intermolecular forces under time reversal.

In this framework, he was naturally interested in the two-body correlation function in condensed matter (gases, liquids, glasses, crystals) and after his meeting with Placek at the Institute for Advanced Study in Princeton, he made fundamental contributions in this area, in particular the celebrated paper where he shows how neutron diffraction can determine the space-time two-body correlation function in condensed matter (a frequently quoted paper). This interest in crystals, combined with his mathematical background, led him to show that the number of possible singularities of the frequency distribution of a crystal were given by the 'Betti numbers' of the 3-dimensional torus, because of the periodicity of the frequency distribution.

Also during that period Van Hove wrote a far-reaching paper on a particular model of field theory, mesons coupled to a fixed source, where he showed that as the cut-off of the theory goes to infinity, the Hilbert space of interacting particles becomes orthogonal to the Hilbert space of free particles. I personally remember feeling distressed when I read this paper as a young student. Was it the end of perturbation theory, apparently so successful in quantum electrodynamics? No, because even if the Hilbert spaces are orthogonal, the observables can have a limit when the cut-off goes to infinity. This kind of phenomena has constantly reappeared in constructive field theory as well as in statistical mechanics.

For these achievements Léon Van Hove received in 1958 the Franqui Prize in Belgium, and in 1962 the prestigious Dannie Heinemann Prize of the American Physical Society. However contrary to popular belief Léon's interests in particle physics did not start only when he became leader of the CERN Theory Division in 1961. Already during the Princeton years he produced papers on the nucleon-nucleon interaction mediated by a pseudoscalar coupling to pions, and the much quoted paper on coulomb effects in pion-nucleon scattering.

At CERN, using his remarkable ability to assimilate new subjects, he rapidly produced new results on topical questions. This started with elastic and diffractive scattering, where he generalized Pomeranchuk's theorem, examined the possible exchange contributions, and proposed a method of constructing elastic amplitudes from inelastic amplitudes, introducing the notion of the 'overlap function'. He also proposed models of hadron constituents, and, when the fractionally-charged quark model became the favorite candidate, saw the consequences for high energy scattering (with J.J.J.Kokkedee). A crucial development was the reconciliation between the one-particle exchange model and the Regge pole exchange model, showing that they are compatible if the Regge trajectory goes to infinity, i.e. if an infinite number of particles are exchanged. This was a first step towards the Veneziano model which synthesized particle resonances and Regge exchange, and in turn led to the idea of 'strings' describing scattering amplitudes and which have been resurrected in attempts to describe particles themselves by strings.

In the following years, the theme of multiparticle production, never far from his preoccupations, became central for him. To clarify and simplify thinking, he invented the longitudinal plot with which he analysed inelastic events with W. Kittel, and later he also undertook to help to analyse the production of hundreds of particles by the UA5 detector at the SPS proton-antiproton collider. (He had been one of the strongest supporters of this streamer chamber detector, the first to see the beautiful products of 500 GeV proton-antiproton collisions.) Until the end of his life, with his collaborator A. Giovannini, he studied the negative binomial distributions used to analyse these events and proposed a mechanism to explain why they appeared in high energy multiparticle production. At last year's Singapore conference, shortly before his death, Giovannini presented their contribution.

Also important were his interests in two domains in which phase transitions, dear to his heart from the very beginning of his career, play a major role. First hot hadronic matter, in which quarks and gluons are expected to get deconfined, and for which he was among the staunch supporters of systematic laboratory experiments. The second area was the interface between particle physics, astrophysics, and cosmology. This completed a full circle, returning him to his initial preoccupations but in a different context.

These achievements, for which he received in 1974 the prestigious Max Planck medal of the German Physical Society, reflect the diversity of his interests, the ease with which he attacked new subjects, together with a characteristic unity in the choice of the topics but also in the methods, the rigour, and the underlying simplicity. These ingredients of genius will ensure that Van Hove's contributions to Mathematics, Mathematical Physics, and Particle Physics will be of long-lasting importance.

From Brussels to CERN

by Paul Levaux

I knew Léon Van Hove personally at the Free University of Brussels, where he pursued his brilliant academic career leading to a doctorate in mathematics. His work at this time was closer to mathematics than physics and already revealed the utter thoroughness which never left him. From 1945 to 1952, he was assistant lecturer in Mathematical Physics. During this period he spent a year at the Institute for Advanced Studies in Princeton.

In 1952 he left the Free University of Brussels and Belgium for

An early photo of Léon Van Hove, with Kurt Symanzik (right).

good and settled in Princeton where he set himself new research topics under Placzek's influence. His shift towards mathematical physics was now definite.

In 1954, he returned to Europe to head the Institute of Theoretical Physics at the University of Utrecht. It was there that he made a particularly significant contribution to finding irrefutable solutions to a number of thorny problems with which many theorists were wrestling at the time.

In 1961 came the major turning-point in Van Hove's career. He left the University of Utrecht, of which he remained an emeritus professor for several years, and came to CERN in Geneva to take charge of the Theoretical Physics Division which had been housed at Copenhagen during the construction phase of CERN.

In Geneva, he met John Adams who was just completing construction of the accelerator and was briefly to become Director-General on Bakker's death. It was there that I met Léon Van Hove once again. For the next ten years he was to take part in and be a driving force behind the development of physics in the young Laboratory. As Leader of Theoretical Physics Division he earned the respect of Council and Finance Committee members for his thoroughness and clarity of thought.

He was away from CERN from 1971 to 1974 as Chairman of the Max Planck Physics and Astrophysics Institute in Munich, a post which he accepted for a short period to reorientate the centre's activities. This task completed, he returned to CERN and he and John Adams set about building up the installations and infrastructure which formed the basis for today's accelerator programme.

To achieve the particularly thankless task of managing and developing a Laboratory which would satisfy everybody's wishes, the Council had recourse to the special administrative arrangement of entrusting the management of the European Laboratory to the two men who had most helped shape it – Léon Van Hove and John Adams. The former took over responsibility for the Laboratory's research activities while the latter took charge of management and the problems of accelerator construction.

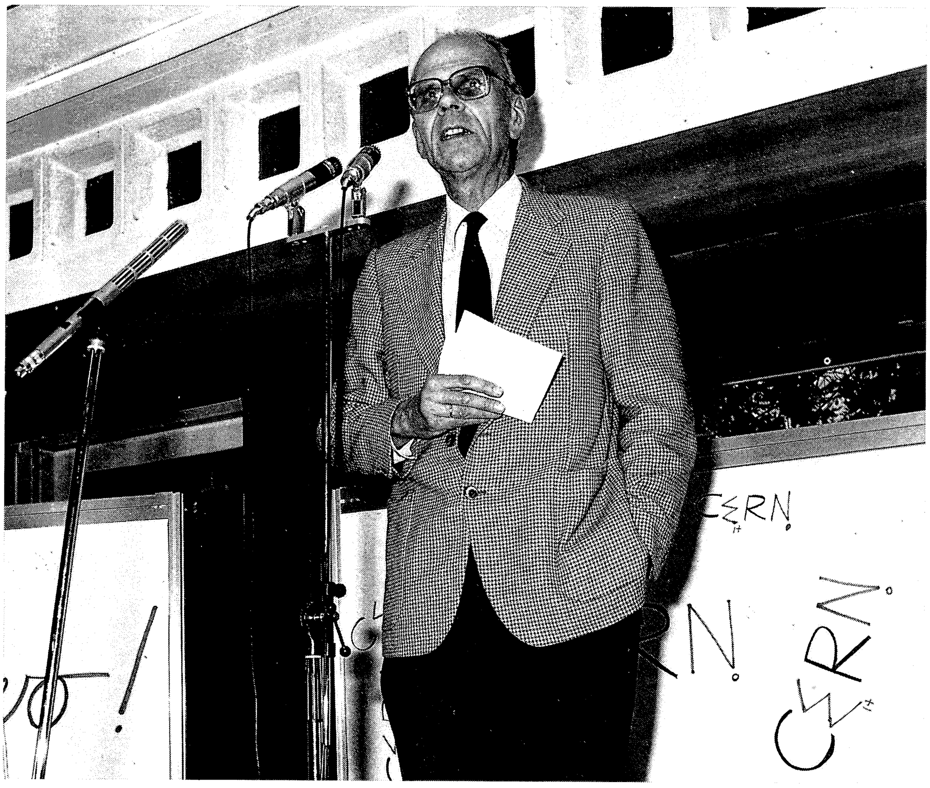
This period was marked by many successes. It was during their terms of office that the research possibilities of a proton-antiproton collider were considered, under their management that the LEP construction project was launched, and that CERN's reputation and position as a model European Laboratory was firmly established.

This was an extremely interesting period in Léon Van Hove's life. It gave him the opportunity to orientate CERN towards its current activities and to lay the foundations and provide the results which would be crucial to the subsequent development of sub-nuclear particle physics in Europe and indeed throughout the world. Some of these results have also had repercussions for the development of other research sectors.

Sadly, Van Hove was unable to contribute as much as he would have liked to Volume 3 of the History of CERN*, which is devoted to this particularly dynamic period of which he was a key figure, and its drafting and publication have necessarily been somewhat delayed.

* (Volume 2, under the North Holland Physics Publishing imprint, appeared last year – September/October, page 48).

1984 – after the announcement of the award of the Nobel Physics Prize to Carlo Rubbia and Simon van der Meer, Léon Van Hove explained the background to CERN's antiproton project. Van Hove's vision helped realize this bold and imaginative project at CERN.



Aside from his great reputation as a physicist, Léon was very cultured and had extensive knowledge of the arts and of other sciences. He had a brilliant intellect and was of course an articulate speaker, but he also had the outstanding gift of being able to communicate science to the layman as well as the cognoscenti. He was a great traveller and spoke several languages. He was much in demand at lectures, seminars and meetings. He was a promoter of Europe and of the need for European cooperation and he believed in its success.

Léon Van Hove expressed his opinions frankly and scorned private interest to devote himself exclusively to science. He had a great humanistic quality. We appreciated his desire to share his experience and knowledge and always to give the weakest the opportunity of expressing themselves.

First and foremost, we lament the untimely passing of a friend. His death leaves a great void in the world of physics. Science will remember a great physicist; we remember a great man.

On behalf of CERN's scientific community

by Erwin Gabathuler

Léon Van Hove was an outstanding European scientist dedicated to the development of high energy physics in Europe through CERN and its Member State universities and research institutions.

He was a tremendous worker with a razor-sharp intellect and a dedication to detail which made him a natural leader in defining new scientific directions. My first real contact with him occurred when I went to CERN in 1974 to initiate the physics programme of the European Muon Collaboration (EMC). It was very clear to him at that time that the muon and neutrino programmes at the SPS would be a very important part of the physics programme of that accelerator. However I was surprised to find that he took very detailed interest in the beamlines and the detectors since he was not convinced that the users of CERN, coming from a large number of different outside institutes, could match the accelerator physicists in skill, originality and coherence when it came to the development and exploitation of their detectors. This was a difficult period in the history of CERN, since earlier experiments had failed to discover charm.

He was appointed Research Director-General in 1976, sharing the responsibility of running CERN with John Adams, the Executive Director-General. It is to the credit of both men, coming from very different backgrounds, that they worked so well together, since it was during their period in office that the future direction of CERN was established, taking European high energy physics into the 21st century.

He was very conscious of the importance of maintaining close links between CERN and the outside users, especially the very large bubble chamber community who had invested heavily in scanning and measuring facilities in their own institutes. He played a key role in setting up the hadronic physics programme of the rapid cycling bubble chamber European Hybrid Spectrometer facility (EHS), which provided data on pion and kaon induced reactions. This became the springboard for the development of very small chambers which were used to study the properties of charmed particles with short lifetimes. He also saw the EHS as a bridge for the users to facilitate the transition from bubble chamber physics to counter-based physics, since he realised that the future of high energy physics was mainly in storage rings.

The proposal by Carlo Rubbia to turn the SPS accelerator into a proton-antiproton colliding beam facility was very strongly supported by Léon Van Hove since he realised immediately that the great strength of CERN's machine builders would enable European high energy physics to lead the world through the possible discovery of the intermediate vector bosons. During the early stages of this proposal, he worked tirelessly behind the scenes in convincing the more conservative accelerator physicists and engineers that this speculative project was much more important than extending the energy of the SPS as a fixed target accelerator, the current thinking at that time. He also supported the idea of having two major experiments and was instrumental in the decision to have a small simple exploratory experiment to look for new forms of matter suggested from cosmic ray events at very high energies.

The idea that CERN should enlarge its programme of physics by building electron-positron colliding beams was somewhat foreign to the CERN tradition and again it was Léon Van Hove who played a key role in preparing the groundwork for the decision to build LEP. The fact that the tunnel circumference is its present size is directly attributable to him, since at one stage many senior scientists believed that LEP should be built only to produce the Z boson otherwise the project could not be approved. Léon was adamant that it was crucial to study the production of charged boson pairs and to make the ring as large as possible since he felt that the long term future of CERN lay in hadron colliders, and it was important to invest in tunnel estate for future generations of physicists. How right he was!

He maintained close links with his theoretical colleagues and continued to publish papers on his own theoretical ideas. It was as a result of this work that he was in a very strong position to support the 'gamble' of searching for quark-gluon plasma in high energy nuclear collisions. Relativistic heavy ion collisions are now a major part of the CERN programme and the odds will be further shortened by the introduction of a lead-ion source.

I was very fortunate to have worked closely with Léon Van Hove when he invited me to take up the post of EP Division Leader in 1978. He was well informed, always doing his homework, and had a very clear vision of the future direction of particle physics. He had a great sense of humour and was very warm-hearted despite his tough exterior. I remember on one occasion he was making a presentation to a group of journalists on how the CERN neutrino programme involved four large detectors, two counter experiments and two bubble chambers, situated one behind the other. One of the journalists asked him why the detectors were on an inclined plane. He stopped and Adolf Minten stepped in to explain that the protons were underground. Léon threw back his head, laughed loudly and explained to the group that he was not an experimentalist.

There is a saying 'behind every great man there is a good woman'. In Léon's case that was certainly true. An evening spent at the Van Hove apartment with its excellent view over Geneva was always entertaining and stimulating due to the charm and kindness of Jenny Van Hove.

Léon was a passionate man, who believed strongly in scientific collaboration across national and international boundaries. He was chairman of the Scientific Directorate of the Max Planck Institute for Physics and Astrophysics in Munich from 1971 to 1974 and played a key role in the interface between CERN, the European Southern Observatory (ESO), and the European Space Agency (ESA). He was unique in that he was an outstanding theorist, a leader of science, and a first-class administrator who used all his skills in the pursuit of excellence. His death is a great loss to European Science as he had much more yet to do.

Physics and astronomy

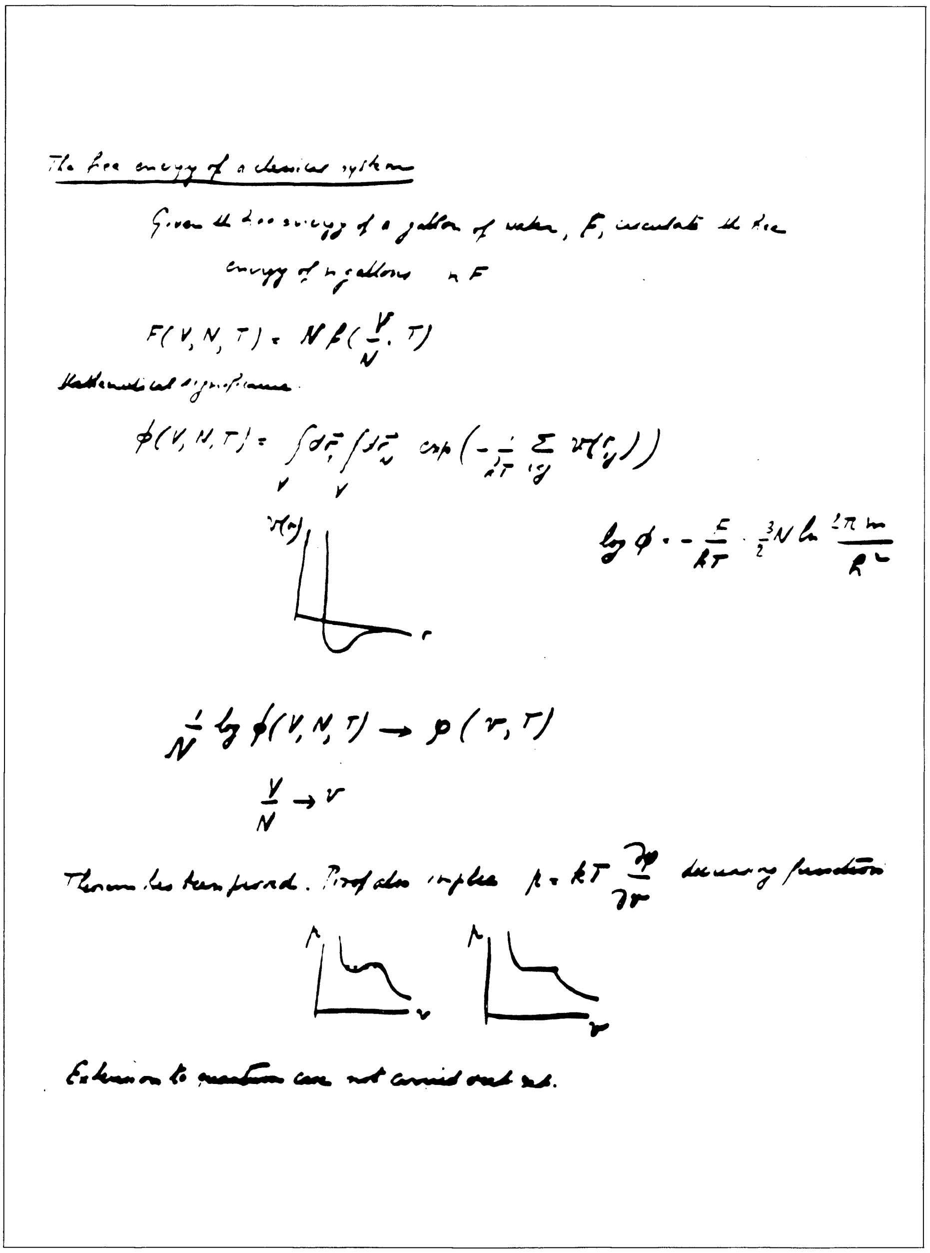
by L. Woltjer

Good fortune made me meet Léon Van Hove nearly 30 years ago. A.D. Fokker, the relativist, was in the habit of from time to time inviting the Dutch theoretical physicists for a weekend at his home near Apeldoorn in the Netherlands; I had been invited to talk about some aspects of plasma physics remote from the interests of the other participants. I still vividly remember Léon's curiosity about subjects so far removed from his own research fields, his quick grasp of the essentials and his broad culture in physics.

Our ways crossed again in 1975 when I became Director General of

1.

From notes prepared by Léon Van Hove for his talk at the meeting of the American Physical Society when he received the Heinemann Prize. 1 – a representation of the intermolecular potential producing the 'good' behaviour for N going to infinity and two gas-liquid diagrams, one in agreement with Van Hove's Theorem and one violating it. 2 – the frequency distribution of a crystal, with a certain number of singular points, and the associated torus.



ESO – the European Southern Observatory. At that time the scientific-technical departments of ESO were located on the CERN campus. To see if everything was running smoothly between the two organizations we had an annual directors' meeting, and rarely have the business parts of the meetings been as short as those. Léon was always ready to provide assistance whenever possible; but it was also clear that astrophysics had begun to be part of his very broad interests.

Unfortunately, European politics decided that ESO had to leave CERN in 1980, just when scientific developments brought physics and astronomy much closer. At the inauguration ceremonies of the new ESO headquarters in Garching in 1981 Léon gave a review of 'Particle Physics in the Early Universe'. It is a pity that this beautiful lecture has been published in a relatively inaccessible book 'Evolution in the Universe' (ESO, 1982). Long before 'particle astronomy', as he called it, became popular, he gave a concise account of the subject that even today has lost none of its actuality.

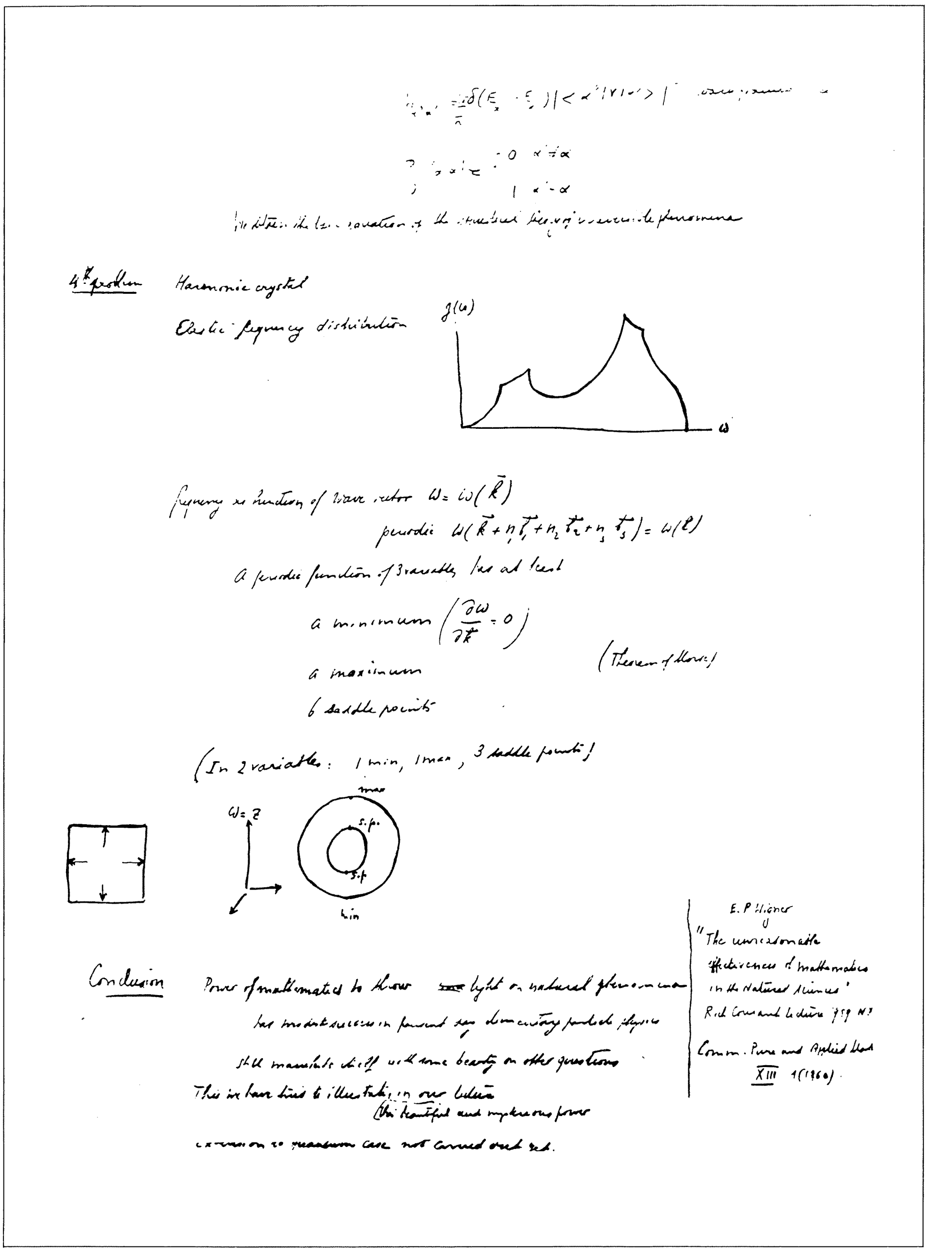
'By necessity, work on early cosmology is highly speculative, and so are the recent theoretical developments in particle physics. Detailed considerations have to choose among many possibilities, and arguments of simplicity or even of taste are bound to come frequently into play. But the history of some recent discoveries, like the weak neutral-current interaction and charmed particles in high energy physics or neutron stars and the cosmic background radiation in astrophysics, has reminded us of the fact that even very daring scientific speculations deserve to be taken seriously.'

It was not Léon's style to make wild speculations, but he certainly had the taste needed 'to choose among many possibilities'.

It was only natural that when CERN and ESO decided to create a series of 'ESO-CERN Symposia', Léon Van Hove (together with Giancarlo Setti) undertook the task of organizing these. Three highly successful symposia resulted (1983 at CERN, 1986 at ESO, 1988 in Bologna).

European astronomy is indebted to Léon in many ways. He participated very actively in the creation of the 'Horizon 2000' long term programme of the European Space Agency which he later served as chairman of the Science Programme Committee. His profound and critical insight in so many aspects of physics, his vision tempered by realism and his natural authority made a large impact on 'Horizon 2000' which for the first time gave Europe a long term view of its future in space science.

It was with much justice that the University of Bologna when celebrating its 900th anniversary awarded him a Laurea Honoris Causa in Astronomy. On that occasion he said 'Twenty-eight years ago I left university teaching to join CERN, the European Laboratory for High Energy Physics. Somewhat surprisingly, it is at CERN that I fully realized the importance of the universities for the advancement of science, because, as I discovered, it still is the university system which best provides the lasting intellectual symbiosis between research and learning, between eager students and experienced teachers, a symbiosis which is the lifeblood



2.

of scientific progress.' Also at CERN, Léon Van Hove was an experienced teacher who could clarify complex issues in simple terms and who took pleasure in doing so. The European physics and astronomy communities have lost one of their most distinguished members.

A gifted teacher

by N.M. Hugenholtz

Notwithstanding his many and important papers on basic problems in physics, it may well be that Léon Van Hove's influence on the physics community is in a large part due to the fact that he was a gifted and devoted teacher. It is perhaps unfortunate that the period of his life during which he was a university professor and gave basic training to young students in theoretical physics was rather short. Nevertheless those six years at the University of Utrecht from 1954 to 1960 left a lasting impression on physics in the Netherlands. Many Dutch physicists still remember his classes on Statistical Mechanics, Quantum Mechanics and Field Theory. He as no other mastered the art of organizing a subject and then presenting it with extreme clarity, without hiding the difficulties. No wonder that his lecture notes on these subjects were much in demand. When in 1960 Léon decided to accept a position at CERN, the University of Utrecht hastened to offer him an extraordinary chair so that the physics community in the Netherlands could continue to profit from his talents.

Of course his role as a teacher was not restricted to teaching young students. There are many physicists in Holland and elsewhere who learned essential parts of their speciality in either Statistical Mechanics or Particle Physics from the advanced courses Léon presented all over the world. For many years after he had left Utrecht he returned regularly, first to Utrecht, and later to Nijmegen to give courses on advanced subjects. In the spring of 1982 he was Lorentz-Professor in Leiden. These were occasions where all Dutch physicists would meet to enjoy his lectures and learn about the latest developments in particle physics. The topics he chose for these lectures were not his personal hobbies but they were what he considered to be the most significant developments in the field. He presented these subjects clearly, elegantly and with no more mathematics than strictly necessary. One always came home after such lectures wishing to learn more. It is no wonder that he was always a welcome speaker in Les Houches and other summer schools.

However there was another, even more important, aspect to his teaching. I profited most from my personal interaction with Léon. He taught me how to do research. I remember the period I worked for my PhD in Utrecht under his guidance as most stimulating due to our daily discussions. He helped, made suggestions, criticized and all that in such a way that a lasting friendship developed. I know that many others had such experiences during one phase or another in their scientific career. They have fond memories of the many discussions they had with Léon, mostly but certainly not always about physics, and always leading to better understanding.

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Participate in the SSC superconducting magnet test program at FNAL, BNL, and SSCL.

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People and things

Wolf Prize – Maurice Goldhaber (right) and Valentine Telegdi.

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CEBAF Laboratory, USA
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Wolf Prize

The prestigious Wolf Foundation Prize for Physics is awarded to Maurice Goldhaber of Brookhaven and Valentine Telegdi of ETH Zurich.

Goldhaber is cited particularly for his work on the photodisintegration of the deuteron with Chadwick in 1935, on dipole vibrations of the nucleus with Teller in 1948, on the classification of nuclear isomers and their shell model interpretation (1951), and on the helicity of the electron neutrino with Grodzins and Sunyar (1958). Later he stressed the importance of looking for proton decay.

Telegdi's award recognizes his major contributions to measurements of parity violation, including pioneer demonstrations of the effect in pion decay; work on muon capture; the measurement of the helicity of the muon neutrino; the study of 'muonium'; an innovative method for determining the muon magnetic moment; and several elegant and influential experiments on the neutral kaon system. His early work showed the 'universal' character of weak interactions, where electrons and muons have the same affinity.

Goldhaber's and Telegdi's studies are characterized by their incisiveness and elegance.

On people

As well as the W.K.H. Panofsky Prize for Gerson Goldhaber of Berkeley and François Pierre of Saclay (January/February, page 23), the 1991 American Physical Society (APS) Awards include the J.J. Sakurai Prize for Vladimir N. Gribov of Moscow's Landau Institute for Theoretical Physics. The citation reads 'for his pioneering work on the high energy behaviour of quantum field theories and his elucidating studies of the global structure of non-Abelian gauge theories.

The APS 1991 Forum Award goes to Victor Weisskopf 'for his lifelong effort to stimulate public awareness of the beauty of science and the dangers of its abuses'.

The Prix Ricard of the Société Française de Physique has been awarded to Marcel Banner of Saclay, leader of the Saclay team in the UA2 experiment at CERN's proton-antiproton collider during its first phase of operation (1981-85). He was elected a member of CERN's Scientific Policy Committee in 1986 and is now Head of Experimental Physics in Saclay's Depart-

ment of Elementary Particle Physics.

Odd Dahl honoured

In a simple ceremony in Bergen last year, Norwegian physicist Odd Dahl was presented with a special Honorary Stipend from the Royal Norwegian Council for Scientific and Industrial Research. The citation read 'for his contributions in the furtherance of research and technological development spanning a professional breadth and depth that places him in a special class, both nationally and internationally'.

Dahl played a crucial role in the early days of CERN, leading the machine group which in the 1950s was studying an accelerator 'for energies greater than 10 GeV and in particular the problems of building a scaled-up version of the Brookhaven Cosmotron'. A visit to Brookhaven convinced him of the value of the new principle of strong focusing and he set his sights on a new machine in the 20-30 GeV range which became CERN's Proton Synchrotron. Over 30 years later, this remains the hub of CERN's unique interconnected particle beam system.

Dahl is now retired and living at Skandia Aldershjem, Kong Oscardsgate 22, 5017 Bergen, Norway.

D.V. Skobelzyn 1892-1990

D.V. Skobelzyn, who died on 16 November, was well-known for his many pioneering contributions to cosmic ray and particle studies which helped provide a solid foundation for modern physics. Beginning in 1923 in Leningrad, these early cloud chamber studies included the observation of several new fundamental processes. His research also led to the development of ionization calorimeters, and the idea of using solid iron magnets for studying penetrating particles. From 1929-31 he visited the Curie Laboratory in Paris.

Shortly before the Second World War he moved to Moscow's Lebedev Physical Institute, where he went on to serve as Director for more than twenty years (1950-72).

Carl D. Anderson 1905-1991

Carl D. Anderson, best-known for his discovery of the positron in 1931, died on 11 January. As student of Robert Millikan at Caltech, he received his PhD in 1930, and at Millikan's suggestion began to look at cosmic rays using a cloud chamber, building a detector with the highest magnetic field then available (25 kilogauss).

Suggestions of particles moving in the 'wrong' direction in this field were confirmed by mounting a sheet of lead across the chamber, and the discovery of the positron – the antiparticle of the electron – followed, confirming Dirac's contemporary theory. At the time Anderson said 'I knew about the Dirac theory... but was not familiar with it. I was too busy operating my equipment....'.

Subsequently, with Seth Neddermeyer, he continued cloud chamber cosmic ray studies, finding initial evidence for what they called a 'heavy electron' and only ten years later was finally identified as the mu-meson, or muon.

For his positron discovery, he was awarded the 1936 Nobel Physics Prize, sharing it with Viktor Hess of Innsbruck, who was honoured for his discovery of cosmic rays. For his entire research career Anderson remained at Caltech, retiring in 1976.

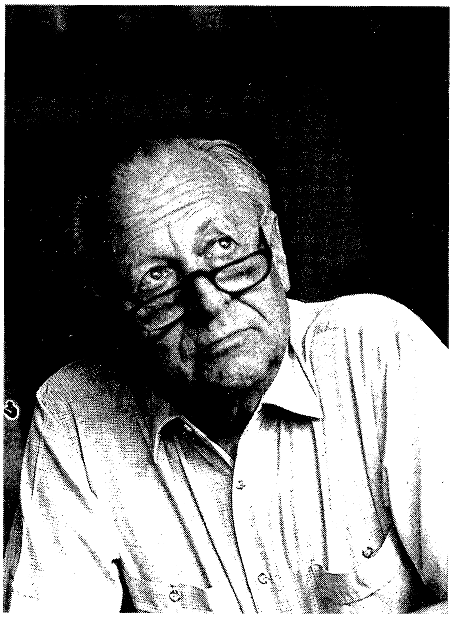
Meetings

Physics in Collision XI will be held from 20-22 June in Colmar (France). Attendance is by invitation only. Information e-mail PHYSCOLL at FRCCSC21 or phone D. Huss – (33) 89 42 48 46, or J.-M. Brom – tel (33) 88 28 62 72.

The International Symposium on Hypernuclear and Strange Particle Physics will be held in Shimoda, Japan, from 9-12 December, organized by Tokyo's Institute for Nuclear Study (INS) as the 20th INS International Symposium. Information from Osamu Morimatsu, Institute for Nuclear Study, University of Tokyo, 3-2-1 Midori-cho, Tanashi, Tokyo 188, Japan, phone 0424-61-4131 ext 222, fax 0424-62-0763, e-mail (bitnet) hyper91 at jpnutins or (decnet) 41729::hyper91

The 8th Meeting of the International Radiation Protection Association will be held in Montreal from 17-22 May, 1992. Further information from IRPA 8, 2155 Guy Street, Suite 820, Montreal, Quebec, Canada H3H 2R9; fax (514) 932-9419.

A Conference on Liquid Noble Gas Detectors and their Applications will be held in Stockholm from 21-23 August. Planned topics include state-of-the-art of detector systems, applications to LHC and SSC, double beta-decay, astrophysics, etc. Suggestions are welcome. CERN Research Director W. Hoogland will talk about the R&D for LHC, and F. Engstroem, director of



Albert Burger 1923-1991.

ESA's European space station, will cover space activities. Information from Thomas Lindblad, MSI, S-104 05 Stockholm, Sweden; phone +468 16 11 09; fax +468 15 86 74; bitnet LINDBLAD at VAND.PHYSTO.SE

1991 CERN School of Computing

The 1991 CERN School of Computing, to be held from 23 August to 2 September, is organized in collaboration with the Swedish Physical Society's Section of Particle Physics and will take place at Ystad, 60 km east of Malmo. The programme will evolve around four main themes – Requirements for LHC, Artificial Intelligence, Computer Architecture, Operating Systems and Languages. Information from Mrs. I. Barnett, CN Division, CERN, 1211 Geneva 23, Switzerland; e-mail barnett at cernvm.cern.ch

DESY Theory Workshop

The 1991 DESY Theory Workshop will take place from 30 September – 2 October, the title being 'The Standard Model at High Temperature and Density'. Organizing committee chairman is Helmut Satz of Bielefeld, currently at CERN's Theory Division (bitnet satz at cernvm.cern.ch). Registration requests should be sent to Helga Laudien, DESY Theory Group, Notkestrasse 85, D-2000 Hamburg, Germany.

Books

Cosmic Rays and Particle Physics once used to overlap considerably, but since the advent of high energy accelerators have tended to diverge slightly, isolating their research communities. This is a pity, because much of the central subject matter remains common ground. However this trend is rectified in a new book 'Cosmic Rays and Particle Physics' by Thomas K. Gaisser published by Cambridge University Press (ISBN hardback 0 521 32667 2, paperback 0 521 33931 6). It concentrates on the highest energy cosmic rays, their possible origin and their means of detection.

From North Holland comes 'Astrophysics of Cosmic Rays' by V.S. Berezinskii, S.V. Bulanov, V.A. Dogiel, V.L. Ginzburg (editor) and V.S. Ptuskin (translated from Russian, ISBN 0 444 88641 9) which concentrates on the main issues and provides a useful introduction and survey.

Noell extends magnet interests

Noell GmbH of Würzburg, a member of the Preussag industrial group, is extending its interests in magnet technology, and the relevant product range of ABB Mannheim was taken over at the end of last year.

Noell supplied 120 superconducting quadrupoles for the HERA electron-proton collider soon to be commissioned at the German DESY Laboratory in Hamburg, and has recently been awarded a CERN order for four prototype full-length (10 m) twin aperture dipoles for the LHC proton collider proposed for CERN's 27-kilometre LEP tunnel.

A total of eight of these prototypes have been ordered by CERN from various firms, and two have been ordered by the Italian INFN from Ansaldo. As well as the four from Noell, CERN has also ordered two from Ansaldo, and one each from Elin in Austria and Alsthom-Jeumont in France.

Albert Burger 1923-91

Albert Burger, one of CERN's earliest staff members, died on 20 January. He joined the Organization in 1955, and gained valuable experience at the Synchrocyclotron of the Carnegie Institute of Technology, Pittsburg, Pennsylvania, where he took part, under the direction of Professor Ashkin, in an important experiment on pion-proton scattering.

On his return to Geneva in 1957, he joined the hydrogen bubble chamber group and participated actively in the construction of CERN's first bubble chambers. In 1961 he became deputy to Charles Peyrou, head of the Track Chambers Division. His very efficient and characteristically modest management of TC administration, personnel and financial affairs was a major contribution to the Division's success, whose major task was the construction and operation of the 2-metre chamber and BEBC. The large number of pictures produced and distributed all over Europe contributed greatly to the early participation of outside groups in particle physics.

His organizing talents greatly facilitated the restructuring of TC into EF Division, and in particular his financial skills in the face of limited funding allowed the Division to provide the necessary support for the construction of the LEP detectors.

After leaving CERN in 1988, he represented retired personnel in CERN's Staff Association.

Faculty Position in Experimental Particle Physics
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The present High Energy Physics group has an active program at BNL, CERN, FNAL, and SSC. At Brookhaven National Laboratory the group is playing a leading role in the construction of a major new experiment (E852) in precision meson spectroscopy including searches for hybrid and glueballs, using an upgraded MPS. The Indiana group is constructing a 3000 element lead glass array. The MPS upgrade also include a CsI barrel veto, new chambers and a Cerenkov counter. At CERN we are members of the OPAL collaboration, working on the silicon microvertex chamber and on a forefront offline analysis facility utilizing RISC processors that access data via ULTRANET. Physics interests include electroweak interaction and heavy quark physics, especially B decays. LEP will be the premier accelerator to study the B_s. The Fermilab program includes a running fixed target dimuon spectrometer, E672, and participation in the D0 detector on the Tevatron collider. The D0 group is working on the muon system and offline analysis, with emphasis on central tracking. We are members of the SoLenoidaL Detector Collaboration (SDC) at SSC and are working on both hardware development and computer simulation for a wire chamber tracking system.

To apply, please send a complete vita (including a description of research interests, accomplishments, and a list of publications) as well as the names and telephone numbers of at least three references to be sent to

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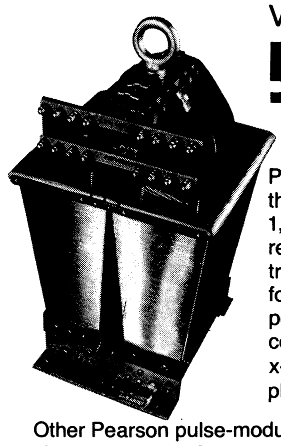

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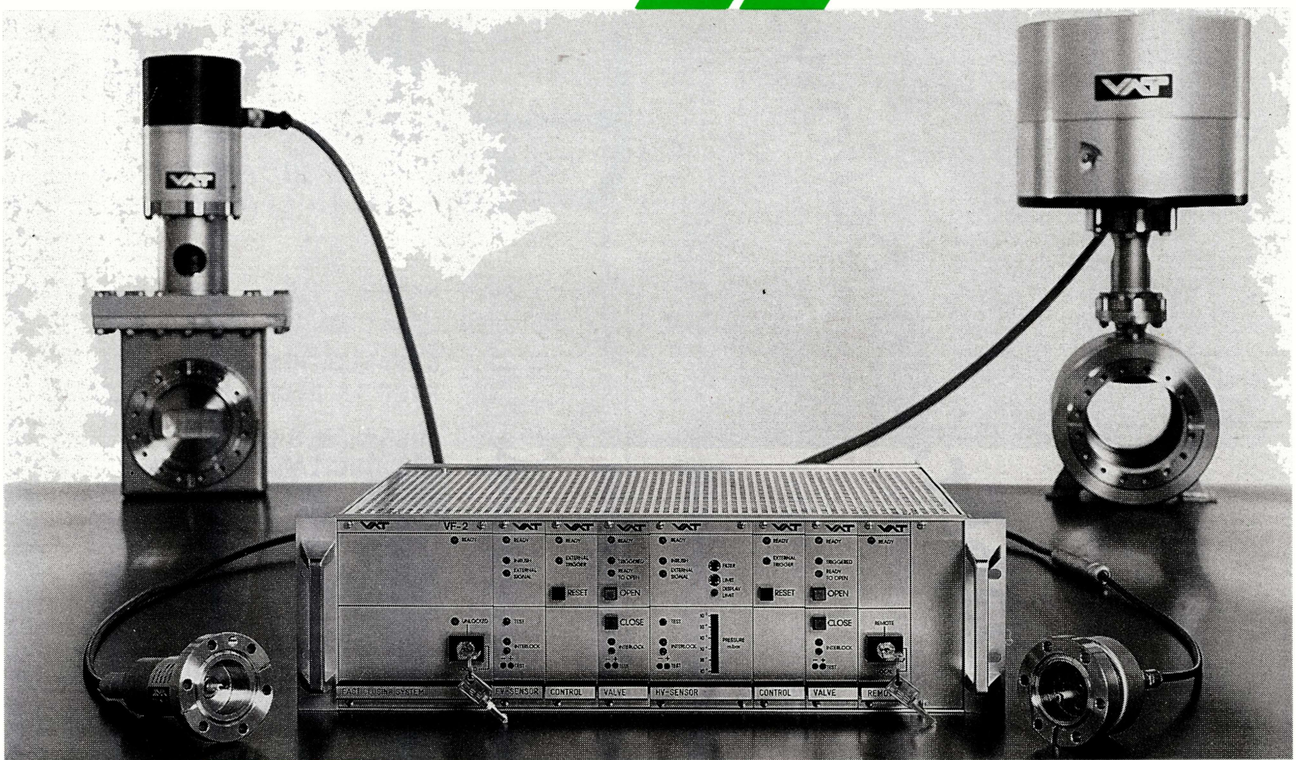

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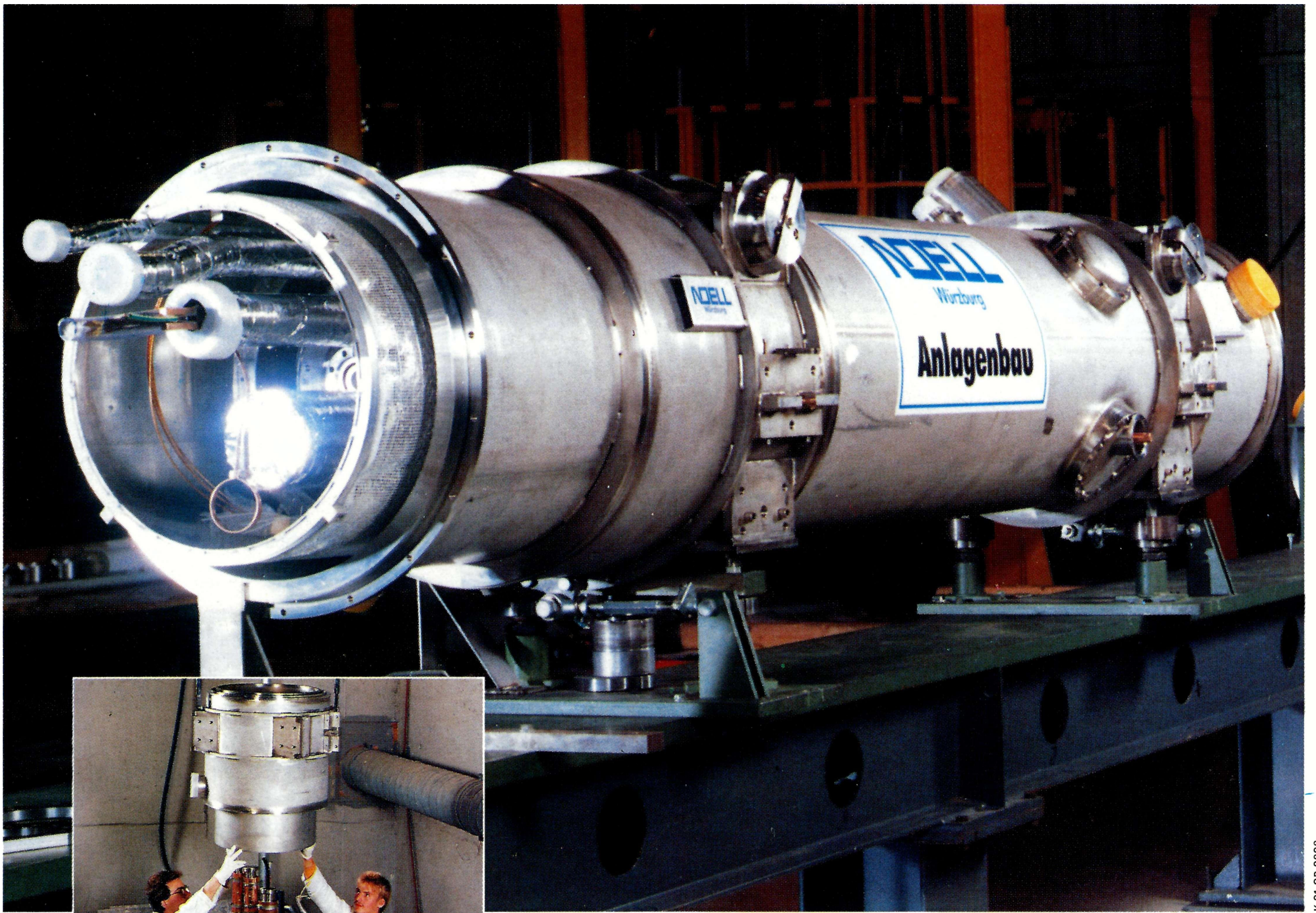

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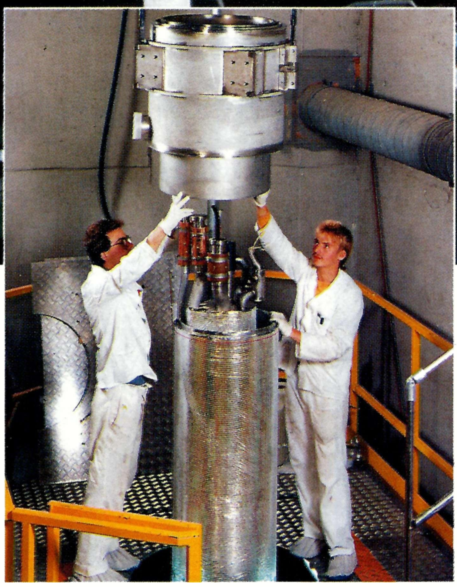

Cryostat on the measuring platform

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