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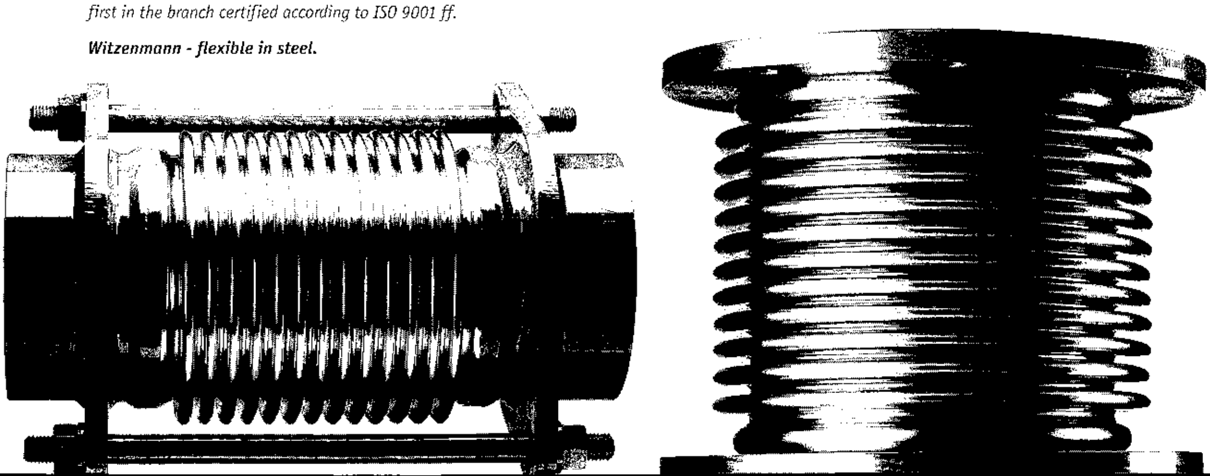

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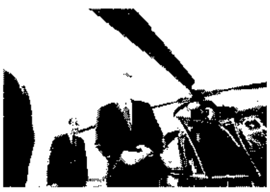
Around the Laboratories



Cover illustration: Swiss Federal Counsillor Kaspar Villiger (right) on arrival at CERN's heliport on 27 February after being greeted by Director General Chris Llewellyn Smith (left). In the background is A. Karrer of the Swiss Federal Department of Finance. Councillor Villiger and the Director General signed an agreement under which CERN will be able to use land for its LHC collider scheduled to be commissioned in 2005 (see page 2).

CES PRESENTS:

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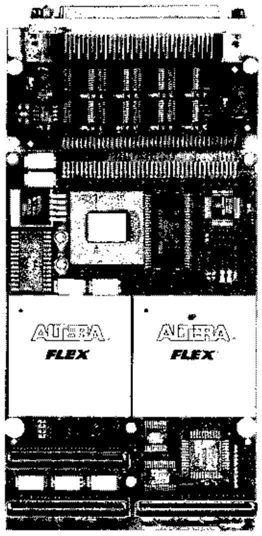

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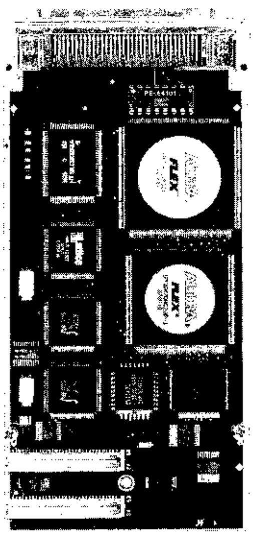

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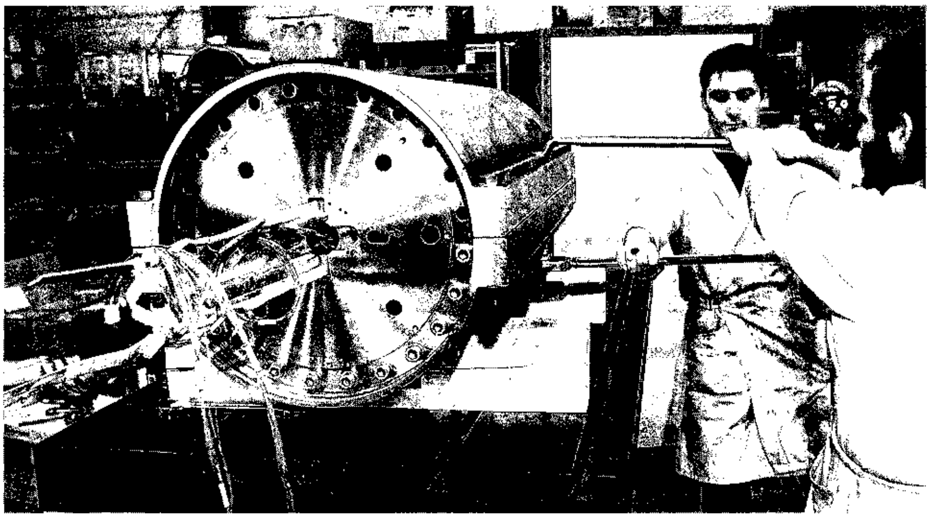
CES CREATIVE ELECTRONIC SYSTEMS

Around the Laboratories



Tightening the bolts on LHC model magnet MBSMS15, the first to be built to the final LHC coil design.

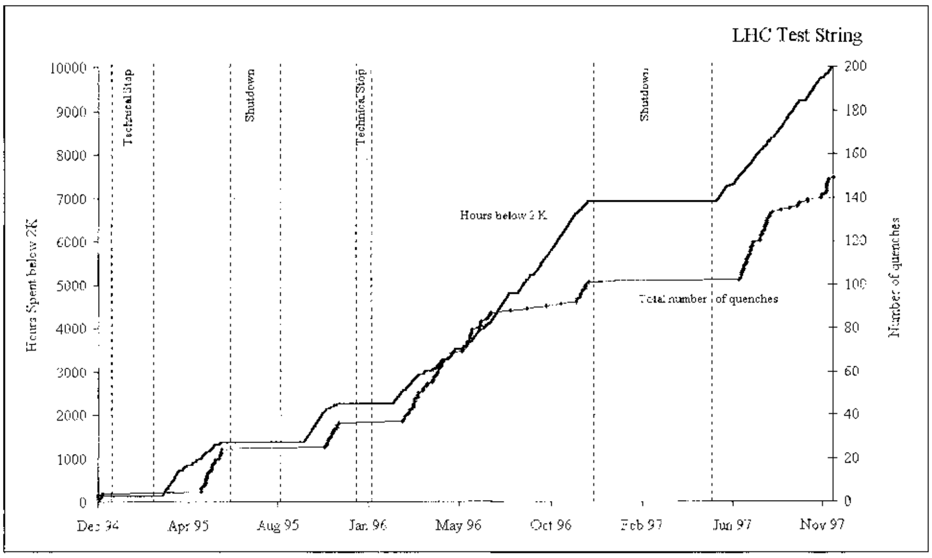
CERN
Magnetic milestones

Measured magnetically, progress for CERN's LHC proton collider is rapid. By the end of 1997, the string of magnets designed to test LHC operating systems had clocked up 10 000 hours below 2 Kelvin with the magnets being powered up to nominal LHC operating current for over 300 hours. CERN's magnet laboratory, which makes short 1 metre model dipole magnets, produced its first magnet to the final LHC coil design. And in December 1997 the first prototype 15 metre long dipole arrived from industry for testing at CERN.

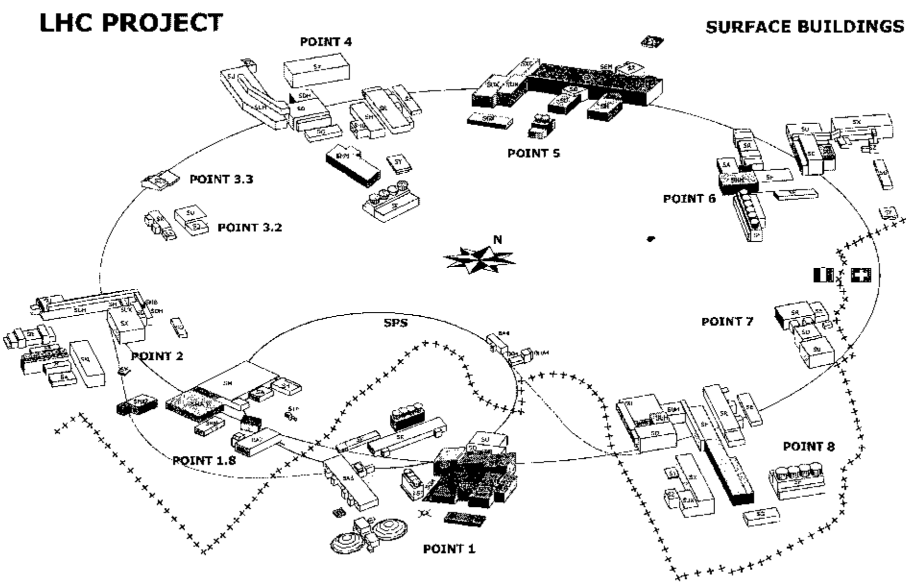
The LHC test string consists of three prototype 10-metre dipoles and a single quadrupole along with all the necessary cryogenics, vacuum, magnet protection, and control systems. One of the main tasks for the string team has been to see how these systems perform when the magnets are repeatedly taken up to full field and back down to almost zero, as they will be in the LHC. Tests in 1996 successfully ran the string through over 2100 short 45 minute cycles. In 1997 cycling tests continued with different cycle types: over 1000 cycles with rapidly changing current, about 50 cycles where nominal current was maintained for one hour, and four cycles with nominal current held for over six hours. Throughout all these cycling tests the temperature of the magnets was held stable to better than 40 thousandths of a degree.

An important actor in these tests is the magnet protection system which must be able to detect when a magnet stops superconducting, or quenches, and within a few tens of thousandths of a second initiate a procedure to prevent irreversible damage to the magnets. The superconducting wire of the magnets must be held below 1.9 Kelvin otherwise it behaves like ordinary wire resisting current flow. LHC magnets carry 13 000 amps, and a typical quench at that current releases 16 Mega Joules of energy. Since being commissioned in December 1994, 150 natural or provoked quenches have been handled safely and under complete control. No magnet in the LHC is expected to see so many in its lifetime.

Whilst the string is the proving ground for LHC control systems,



Since being commissioned in December 1994, the LHC test string of three prototype 10-metre dipoles and a single quadrupole along with all the necessary cryogenics, vacuum, magnet protection, and control systems, has been subjected to a intense series of cryogenic tests, including 150 natural or provoked quenches, which have been handled safely and under complete control.



Civil engineering for CERN's LHC collider goes on above and below ground. Shown shaded are the new surface buildings for the LHC era, alongside the existing ones around the path of the 27-kilometre LEP underground ring. The Franco-Swiss frontier is marked +++++++++. Most of the ring is in France.

magnet development is the responsibility of another team. CERN's model magnet laboratory is geared up to make 1 metre model magnets at the rate of about one a month, each new generation incorporating lessons learned from the last. Because they are so quick to build, model magnets are several generations ahead of those in the string, and towards the end of 1997 the final coil design was achieved in a model magnet code-named MBSMS15.

The main feature of MBSMS15 is its six-block coil design; all previous models and prototypes had five. Adding an extra block makes the design more robust against component and assembly tolerances when full scale production begins.

MBSMS15 performed exceptionally right from the word go, reaching 9.2 tesla on its first quench. Just a few quenches later the field exceeded 10 tesla. The LHC will operate at 8.3 tesla, with an absolute maximum possible field of 9 tesla. MBSMS15 is the first LHC model magnet to exceed this field at the first attempt.

With the final magnet design on the table, it was time to start placing orders. The first magnet component to be ordered was the superconducting niobium-titanium cable for the magnet coils. After a world-wide call to tender, seven contracts will be awarded to firms around the Member States and to the United States and Japan.

A major LHC magnet milestone was the delivery of the first 15 metre dipole prototype to CERN last December. Developed in collaboration between CERN and the Italian Instituto Nazionale di Fisica Nucleare, INFN, the new magnet was completely built in industry. Costs were shared evenly between CERN and the INFN. The main contractors were three Italian firms, with components being purchased from suppliers in nine CERN Member States. The magnet weighs about 26 tons, has a magnetic length at 1.9 K of 14.2 metres, and its twin apertures have a bore of 56 millimetres.

This year, magnet development will continue apace. The string will be thermally cycled to provoke component fatigue in the magnet interconnects and will be used to investigate the effect of magnetic fields on the cable supplying the LHC's auxiliary magnets. The magnet lab will build a number of model magnets identical to MBSMS15 to make sure that their success was not a fluke. Six full scale prototypes of the same design will also be commissioned from industry. And the new 15-metre dipole will be thoroughly tested in preparation for series production.

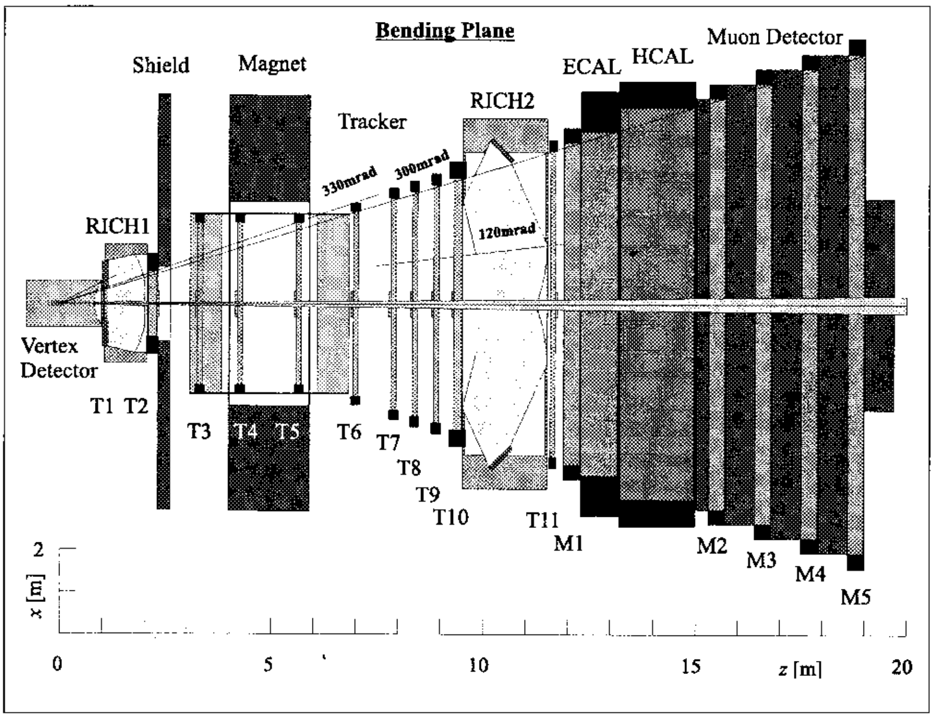
LHC civil engineering

On a drawing of CERN's 27-kilometre LEP/LHC tunnel, the civil engineering needed to accommodate CERN's new LHC accelerator appears minor. However, it is anything but. The total cost of civil engineering will amount to some 50% of the original cost of digging the tunnel (before adjusting for inflation), and because of the amount of work required, contracts are being awarded in three separate packages each valued at around 100 million Swiss francs (July/August 1997, page 2). The only civil engineering work excluded from these packages is one of the tunnels which will carry protons from the existing Super Proton Synchrotron (SPS) to the LHC. This is being built by Switzerland as part of a special host-state contribution to the LHC project.

Following a market survey of 113 firms in seventeen of CERN's member states, calls for tender were sent out in March and April 1997. Decisions to negotiate contracts were then taken by the Laboratory's Finance Committee in November.

Package one is for all the surface buildings and caverns for the ATLAS experiment. It is the only package to

Diagram of the LHCb experiment at CERN's LHC collider which will investigate the physics of particles containing the fifth - beauty or 'b' - quark.



require surface building in Switzerland. Following the go-ahead from the Swiss authorities, a joint venture between Austrian, German, and Swiss firms has started work. Delivery of the surface assembly hall is scheduled for July 2000, with the underground caverns following in August 2002. The ATLAS experiment will be assembled underground, and consequently its cavern will be the first to be delivered.

Package two is for the surface buildings and caverns for the smaller CMS experiment. Although point 5, CMS's home, is relatively undeveloped compared to ATLAS's point one, the sheer size of the ATLAS experiment means that packages one and two involve a similar amount of work. Package two will be awarded to an Italian-Spanish consortium and work is expected to start in June. CMS plans to assemble its detector in modular fashion on the surface before installing it underground. Consequently, the CMS surface buildings are scheduled to be delivered early to CERN, in August 1999. CMS's caverns will be delivered in August 2003.

Little civil engineering is required by the ALICE and LHC-B experiments, leaving package three to deal mainly with the clockwise transfer tunnel, the two beam dumps at point 6, and various other modifications around the ring to accommodate LHC equipment. Package three will be awarded to a Franco-British consortium, and work will begin in June.

LHCb, a beauty of an experiment

With preparations for the ATLAS and CMS large general-purpose detectors for CERN's LHC collider now advancing (March, page 1), the initial cast for the LHC experimental programme is extended with the publication of a full technical proposal for the LHCb experiment.

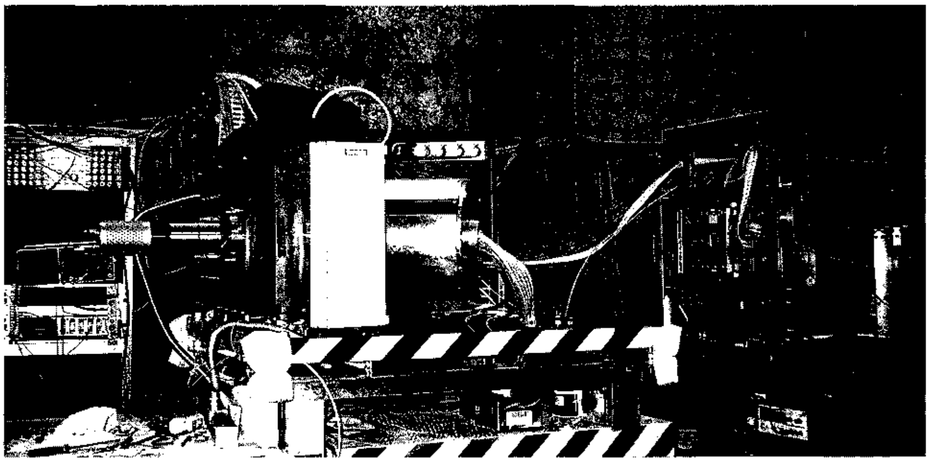
The aim of this experiment is to study in detail the physics of the Standard Model's third (and final) of particles, particularly the beauty, or 'b' quark, contained in B mesons. This third generation of quarks makes possible the mysterious mechanism of CP violation.

When component quarks mutate under the action of the weak force, subtle effects come into play. The first to be discovered was the violation of parity (left-right mirror symmetry) in standard nuclear beta decay. This parity violation is seen even with the up-down quark doublet which makes up protons and neutrons.

Searching for a more reliable mirror to reflect particle interactions, physicists proposed CP symmetry. As well as switching left and right, such a mirror also switches particles and antiparticles - the CP mirror image of a right-handed particle is a left-handed antiparticle.

However having six quarks (arranged pairwise in three generations) opens up the possibility of violating CP symmetry as well. Such effects had been seen in 1964 with neutral kaons. But these kaon phenomena are only a tiny corner of the Standard Model's CP violation potential. Much larger effects should happen in the B sector. The race is now on to collect enough B particles to become the first to glimpse this additional CP violation. The runners are the Babar detector at the PEP-II electron-positron collider B factory at SLAC (Stanford), the Belle detector at the Japanese KEK laboratory's electron-positron collider B factory, CLEO at Cornell's CESR electron-positron collider, the HERA-B experiment at DESY's HERA electron-proton collider, and the proton-antiproton

Quarter-scale prototype of the ring-imaging Cerenkov - RICH - detector planned by the LHCb experiment for particle identification using aerogel and gaseous radiator



collider experiments at Fermilab's Tevatron.

While these will surely reveal more CP violation effects, the full picture will probably only emerge with the interaction rates and energy conditions of the LHC, which will considerably extend the B physics reach. As well as investigating all aspects of CP violation, LHCb would also consolidate our knowledge of particle reactions and explore fully all quark and lepton sectors of the Standard Model.

The LHCb experiment, which so far has attracted some 340 physicists from 40 research centres in 13 countries, aims to exploit the luminosity of 2×10^{32} per sq cm per s which should be available from the LHC from Day 1. For the other experiments, the LHC's collision luminosity will be cranked up to 10^{34}. LHCb expects to harvest about 10^{12} b quark-antiquark pairs each year.

LHCb is a large single-arm spectrometer covering an angular range from 10 out to 300 mrad and will be housed in the 27-kilometre LHC/LEP tunnel in the Intersection 8 cavern nearest Geneva airport, currently the site of the Delphi experiment at the LEP electron-positron collider.

At the heart of the detector is the vertex detector, studied by a CERN/Amsterdam/Glasgow/Heidelberg/Imperial College London/Kiev/Lausanne/Liverpool/MPI Heidelberg/NIKHEF Amsterdam/Rome 1 team. The vertex detector will record the decays of the B particles, which travel only about 10 millimetres before decaying. Each of the 17 planes of silicon (radius 6 cm) spaced over a metre consists of two discs to measure radial and polar coordinates. The arrangement should provide a hit resolution between 6 and 18 microns and 40 microns for the impact parameter of high momentum tracks.

Downstream of the vertex detector, the tracking system reconstructs the trajectories of emerging particles. Using 11 stations spaced over about as many metres, this tracking uses a honeycomb of drift chambers on the outside (where the particle fluxes are lower), enclosing a finer granularity arrangement on the inside. Microstrip gas chambers with gaseous electron multiplication is the prime contender for this part of the detector, but silicon strips and micro-cathode strips are also being investigated. The inner tracker is being investigated by Heidelberg (University and MPI), PNPI St. Petersburg and Santiago (Spain), and the outer by Dresden, Free U. of Amsterdam, Freiburg, Humboldt Berlin, IHPE Beijing, NIKHEF Amsterdam and Utrecht.

LHCb's 1.1 tesla superconducting dipole spectrometer magnet (studied by CERN and PSI Villigen) would benefit from the infrastructure developed for the Delphi magnet at LEP. The magnet polarity is reversible to help the systematic study of CP violation effects.

Particle identification is carried out using the ring-imaging Cerenkov (RICH) technique, with the first RICH station equipped with a 5 cm silica aerogel and 1-metre C4F10 gas radiators behind the vertex detector and the second station with 2 metres of CF4 gas radiator behind the tracker. Cerenkov photons would be picked up by a hybrid photodiode array, the subject of a vigorous ongoing R&D programme (January, page 8). The RICH study group consists of Cambridge, CERN, Genoa, Glasgow, Imperial College London, Milan and Oxford.

Following the second RICH is the electromagnetic calorimeter for identifying and measuring electrons using a 'shashlik' structure of scintillator and lead read out by wavelength-shifting fibres. It has three annular regions with different granularities to optimize readout. Identification of these electromagnetic particles is facilitated by a lead-scintillator preshower detector. Electromagnetic calorimetry is studied by a Bologna/Clermont Ferrand/INR Moscow/ITEP Moscow/Lebedev Moscow/Milan/Orsay/Rome 1/Rome 2 team.

The hadron calorimeter (Bucharest/IHEP Moscow/Kharkov/Rome 1) is of scintillator tiles embedded in iron. Like the electromagnetic calorimeter upstream, it has three zones of granularity. Readout tests with a full-scale module prototype in a beam have already exceeded the expected performance of 50 photoelectrons per GeV.

Downstream, shielded by the calorimetry, four layers of muon detector (Beijing/CERN/Hefei/Nanjing/PNPI/Shandong/Rio de Janeiro/Virginia) uses multigap resistive plate chambers and cathode pad chambers embedded in iron, with an additional plane of cathode pad chamber muon detectors mounted in front of the calorimeters. As well as muon identification, this provides important input for the triggering.

Data handling will use four levels of triggering (event selection), with initial (level 0) decisions based on a high transverse-momentum particle and using the calorimeter and muon systems. This reduces the 40 MHz input rate by a factor of 40. The next level trigger (level 1) is based on information from the vertex detector (to look for secondary vertices) and from tracking (essentially to confirm high transverse momentum) and reduces the data by a factor of 25 to an output rate of 40 kHz. Level 2, suppressing fake secondary decay vertices, achieves another further 8-fold compression. Level 3 reconstructs B decays to select specific decay channels, achieving another compression factor of 25 and data are written to tape at 200 Hz. Data handling and offline computing are being looked at by Bologna, Cambridge, CERN, Clermont Ferrand, Heidelberg, Lausanne, Lebedev, Marseille, NIKHEF, Orsay, Oxford, Rice and Virginia.

LEP in the stratosphere

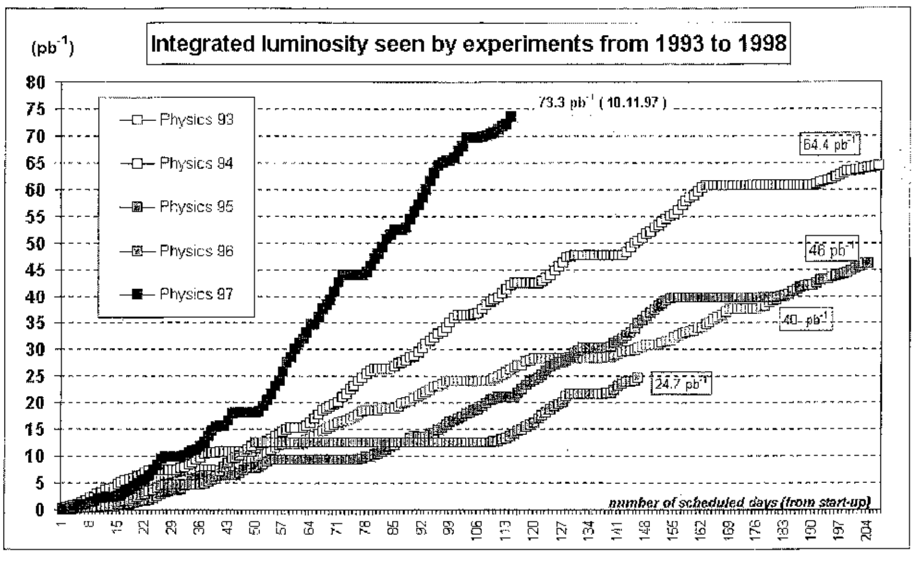
In May, CERN's LEP electron-positron collider begins its tenth year of operation. To mark the occasion, it will be equipped with 272 superconducting (cryogenic) radiofrequency accelerating cavities - 256 of niobium-sputtered copper and 16 of solid niobium - together with 48 remaining copper cavities (operating at room temperature).

In 1989, when it began operation, LEP only had 128 of these copper cavities. The increased accelerating power has enabled the machine to lift its sights from around 90 GeV collision energy (45 GeV per beam) for the Z resonance (the electrically neutral carrier of weak interactions) to around 188 GeV (94 GeV per beam), above the threshold for production of pairs of W particles (the electrically charged carrier of weak interactions).

Last year LEP saw a top energy of 93.5 GeV per beam, although 92% of high energy running was at 91.5 GeV per beam. Most of the running in 1997 was with four bunches per beam, although bunch train options (four bunch trains each of two or four bunches) were also employed to optimise performance for certain runs.

After running for most of 1997 with 90°/60° horizontal/vertical betatron phase advance, another 1997 innovation was recabling of the sextupole magnets for 102°/90° beam optics. This proved a great success, within a very short time equalling the performance of the 90°/60° with luminosities (collision rates) double those of 1996, promising well for 1998. LEP can now routinely deliver more than one inverse picobarn of luminosity per day over many days.

Energy means excitement at LEP. The experimentalists are eagerly hoping to catch a glimpse of supersymmetric particles and maybe even electroweak symmetry breaking (Higgs) effects (April issue, page 17). The higher the energy, the greater the chances, so there is a lot of willpower trying to give the electrons and positrons an extra push. With the operating energy already very close



Luminous LEP. Luminosity (a measure of the particle collision rate) at CERN's LEP electron-positron collider has climbed steadily over the years.

to the operational ceiling, 1998 experience will be valuable in deciding the operating conditions for LEP's final blaze of glory with a complement of 288 superconducting cavities.

The performance of the cryogenic systems were studied in 1997 to determine the requirements for operation at higher energies. Achieving the highest energies requires a higher accelerating gradient in the cavities. The cryogenic power required for the cavities increases with the square of the gradient and is inversely proportional to the resonance Q-value of the cavity, which decreases with gradient.

It is hoped to increase the average accelerating gradient from 6 to 7MV/m and this will increase the cryogenic load by a factor of 1.9. Furthermore, the studies showed that bunch length and beam current are also critical parameters. The total cryogenic power per plant will therefore be boosted to 17.5 kW in 1999 with the aim reaching energies of around 100 GeV per beam.

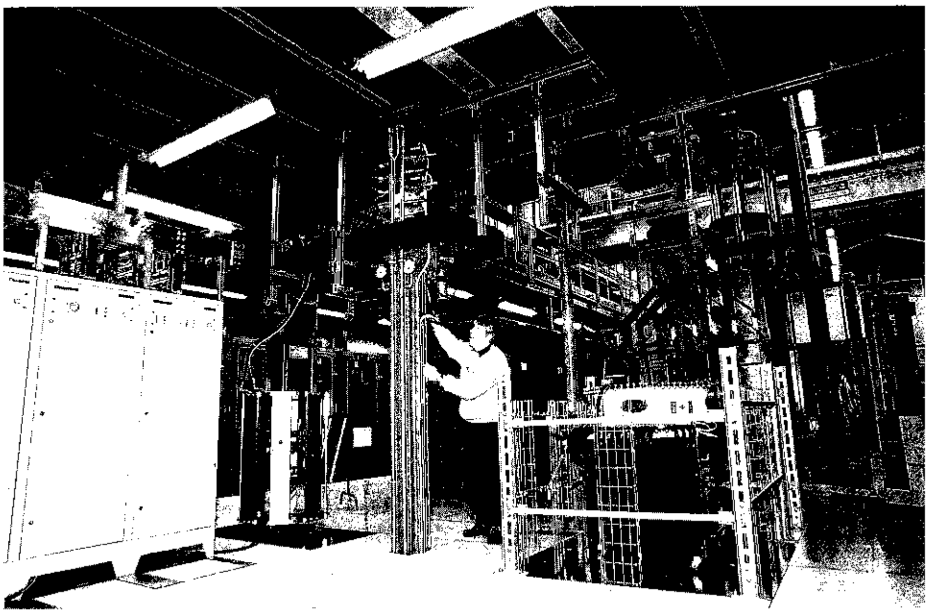
Operating at higher energy levels will surely put a lot of delicate equipment under increased stress. With so much energy being pumped into LEP, the vacuum chamber is already prone to attack by synchrotron radiation. For LEP's next cruise in the energy stratosphere, sensitive equipment has been replaced, temperature monitoring has been improved, and additional safeguards will be taken.

Less glamorous, but still important for physics, is a better fix on the W mass, demanding that the beam energy be calibrated to within 15 MeV by resonant depolarization. This technique only works at lower energies, so additional energy calibration points have been commissioned across a 14 GeV range, as opposed to the previous 5 GeV spread, to provide a longer 'lever arm' for extrapolating measurements to high energy.

Also for beam energy measurement, tests of a special magnetic spectrometer will be made in 1998 to be followed by full implementation in 1999 if successful. The spectrometer will provide accurate measurements of beam deflection within a well calibrated magnet to be cross-calibrated against the resonant depolarization procedures.

Other aspirations are faster turnaround between fills, with more easily reproducible conditions for which the availability of additional feedback techniques should help.

Although LEP is no longer in its youth, the resourceful LEP machine specialists still have plenty of options up their sleeves.



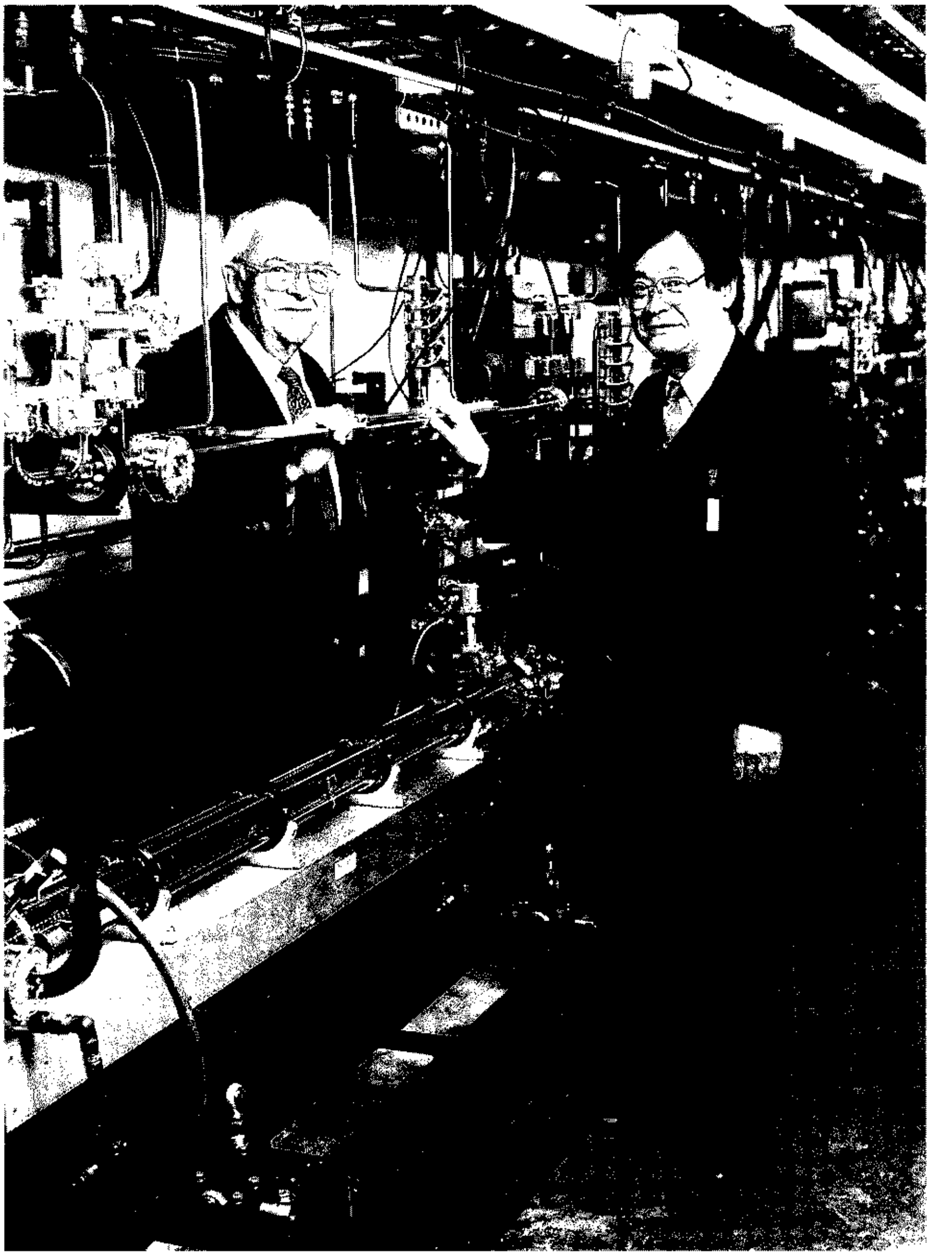
CERN's new current transducer calibration facility. The compact 20 000 Amp power converter can be seen on the left with its regulation cell. This part of the system also forms a prototype for LHC power supplies. In the foreground is a reference transducer with bus bars running overhead to the calibration cell in the background. (Photo CERN AC 21.11.97/3)

Raising the standard

A milestone in metrology was reached recently when CERN's standards laboratory inaugurated a new power converter supplying over 20 000 Amps. The power converter is part of a test-bed designed to calibrate current transducers destined to measure the current of dipole magnets for CERN's LHC proton collider with unprecedented precision. Along with copper bus-bars to carry the current, the power converter is also a prototype for the system which will power the LHC magnets themselves.

The level of precision required by the LHC is unprecedented at the high currents required by the accelerator's main dipole magnets. At CERN's present flagship accelerator, LEP, the main dipoles run at around 4500 Amps and are measured to 10 parts per million (ppm). LHC magnets demand 1 ppm precision at 13 000 Amps, a factor ten better in accuracy at over twice the current. The previ-

SLAC Director Burton Richter (left) and Japanese KEK Laboratory Director General Hirotaka Sugawara at the Next Linear Collider Test Accelerator at SLAC, built cooperatively by the two laboratories.



ous best measurements were done in Canada by the Canadian National Research Council, CNRC, whose interest in current metrology was motivated by applications in the aluminium industry.

The CERN standards laboratory was assisted by a broad international collaboration including the CNRC and Canadian industry (April, page 5). One of the main problems to overcome was reducing the stray electromagnetic fields generated by bus-bars carrying 20 000 Amps. In order to keep these to a minimum, the bus bars, along with the cage housing the transducer under test, have an innovative and pioneering design. The bus bars are configured very tightly in a positive-negative-positive voltage configuration which reduces the external field by a factor of 25 compared to a conventional bi-polar configuration. The cages themselves closely simulate a true coaxial configuration whilst still being compatible with connections to a linear bus bar arrangement. The coaxial set-up minimizes the external magnetic field variations caused by the circulating current and felt by the transducer.

KEK/SLAC Pursuing joint linear collider R & D

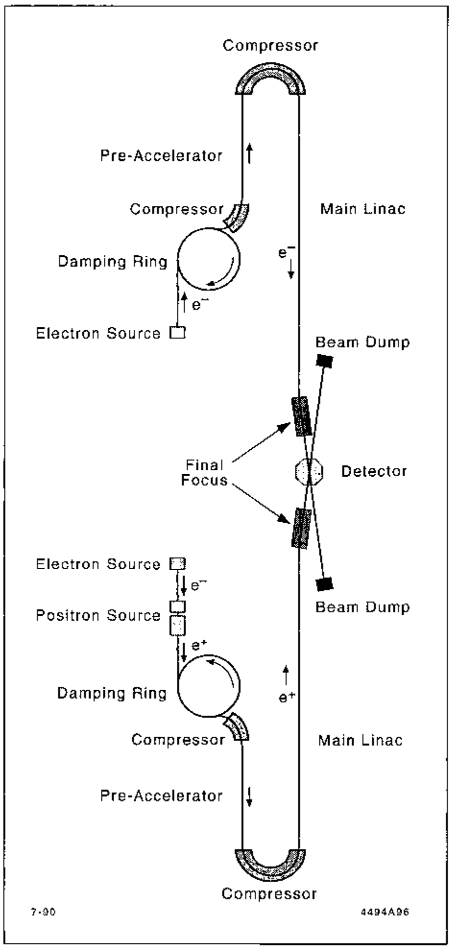
Three recent events have substantially quickened the pace toward eventual construction of a next-generation linear electron-positron collider. Both the US Department of Energy's influential High Energy Physics Advisory Panel (April, page 4) and a select review panel of the National Research Council recommended in February that US physicists should play a major role in an international effort to develop a complete conceptual design for a TeV-scale linear collider.

At about the same time, Japanese KEK Laboratory Director General Hirotaka Sugawara and Stanford Linear Accelerator Center (SLAC) Director Burton Richter signed a memorandum of understanding to do cooperative research and development on linear colliders.

For nearly a decade both KEK and SLAC have been pursing linear collider research along parallel paths, emphasizing room-temperature copper accelerating structures powered by X-band klystrons. Differences between the two labs' designs have been relatively minor - for example, trading off the length of the twin electron and positron linacs versus the accelerating gradient within them. Inked on February 6 at the meeting of the International Committee on Future Accelerators in Paris, the joint R&D agreement is an important step by both labs to work together on pre-design optimization studies.

The document makes official what has increasingly been occurring in actual practice. KEK physicists played a huge role in the design and implementation of the Final Focus Test Beam at SLAC. This $20 million R&D project recently realized its goal of producing beam spots with rms heights of only 70 nanometres - proving that the factor of 350 demagnification needed for a TeV linear electron-positron collider is indeed feasible. And SLAC physicists are making major contributions to KEK's Accelerator Test Facility,

Possible layout of the Next Linear Collider (not to scale).



which will prototype the injectors and damping rings required for such a machine.

Another important international R&D project now being commissioned at SLAC is the Next Linear Collider Test Accelerator (NLCTA), whose purpose is to construct and reliably operate a fully engineered sector of a TeV machine. This 42 metre prototype now incorporates four 1.8 meter copper accelerating structures of slightly different design, powered by two 50 megawatt, 11.4 GHz klystrons built at SLAC. The microwave power from each klystron is first compressed by a factor of four using a SLED-II pulse compression system developed at SLAC. The resulting pulse is then split and 100 MW is delivered to each of two accelerator structures.

The fabrication of three of these structures reflects the international character of the project. In each, some 200 copper cavities were machined to micron tolerances by KEK; assembly and bonding of these cavities was done at SLAC. The NLCTA has already achieved accelerating gradients averaging nearly 50 MV/m with acceptable dark currents of a few microamps, and 70 MV/m is expected in individual 1.8 m structures after two more klystrons have been added to allow the instantaneous power level to reach 200 MW. For comparison, the Stanford Linear Collider and the TESLA Test Facility have achieved accelerating gradients of about 17 MV/m (July/August 1997, p. 1).

In actual operation with a multibunched electron beam traversing these structures, the beam loads down the cavities, resulting in a lower gradient for the succeeding bunches in a given train. Physicists working on the NLCTA compensate for this transient beam-loading effect by selectively shaping the RF pulse fed to the structures. With a flat-top pulse, this effect leads to a 17 percent spread in the output electron energies, but this spread can be limited to a mere 0.3 percent by a suitably shaped RF pulse.

The NLCTA provides an ideal test bed to use in refining the design of a next-generation linear collider and addressing remaining unresolved issues. Initial plans call for two 0.9 m and four 1.8 m structures powered by four 50 MW klystrons, together capable of accelerating an electron beam to 450 MeV. A possible upgrade of two additional 1.8 m structures and a total of seven 75 MW klystrons would be able to generate a 1 GeV beam - corresponding to a gradient of 85 MV/m within the structures. This is approximately the accelerating gradient that will be required for a full-scale TeV linear collider.

ITALY

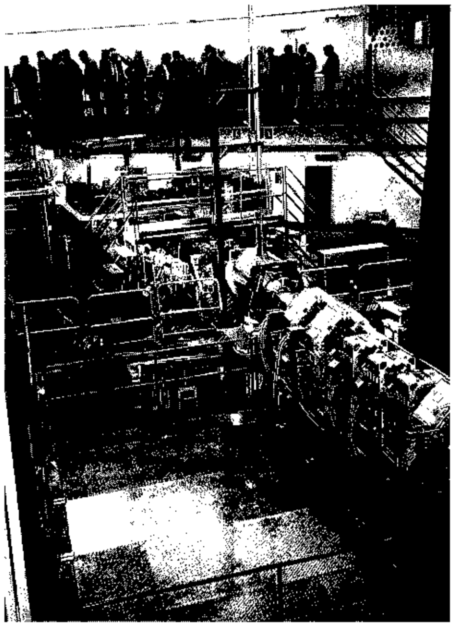
In its continual tour of CERN Member States, the European Committee for Future Accelerators (ECFA) had a major assignment in April when it visited the Frascati and Gran Sasso laboratories to learn about their work and about Italy's continuing impressive commitment to particle physics, at both national and international levels.

The continuing national effort was underlined at Frascati when committee members heard news of the first colliding beams at the new DAFNE electron-positron collider (April, page 24 - an earlier but more comprehensive DAFNE status report appeared in the December 1997 issue, page 12).

Nuclear and sub-nuclear research had a relatively late start in Italy compared to other major European countries. In the mid-1920s, Orso Mario Corbino, influential politician and chairman of Rome physics, pushed for an increased national effort in physics. The figurehead for this effort was Enrico Fermi, recently returned from Göttingen. This science burgeoned, in nuclear physics, in theoretical physics and in cosmic ray research.

After the difficult war years, Italian physics made a new start with the creation of the Centre for the Study of Nuclear Physics and Elementary Particles in 1945, followed by the INFN (National Institute for Nuclear

The European Committee for Future Accelerators (ECFA) visited the DAFNE installations at the Italian national laboratory at Frascati.



Physics) in 1951. In Italy, particle physics is now the major basic physics research effort, a situation unique in the Member States.

Italy benefits from a very high scientific return from CERN. From the very start, exemplified by Edoardo Amaldi, Italian physicists and engineers have played leading roles in the Organization.

All particle physics research is carried out within the framework of the INFN. At present no less than 2050 physicists are working under the general auspices of INFN although most are paid by the universities. This number includes 1450 permanent researchers and 600 postdocs and fellows. There are about 500 pre-doctoral students.

Among the 2050 physicists, 820 (40%) are particle experimentalists, of whom 600 are working on CERN programmes and 28% are theorists. About 14% of INFN physicists are experimental nuclear physicists, but nuclear physics now also covers some of the CERN programme. The remainder (18%) are working on detector, accelerator and software development. Most postdoctoral researchers used to have a permanent position, but a considerable fraction now turn to industry.

Major commitment

Italian physicists participate in nearly all aspects of CERN's work. The considerable activity on LEP at CERN (mainly Aleph, Delphi and L3) corresponds to the equivalent of 212 full-time physicists, although the full roll of Italian members of the LEP collaborations numbers 284. The CERN fixed-target programme counts the equivalent of 217 full-time physicists, and 110 on R&D for CERN's LHC collider.

Besides the high level of activity at CERN, there is also a considerable effort at HERA at DESY (70 equivalent full-time researchers), at Fermilab (45) and at Frascati (60), at SLAC, Stanford (where the contingent is increasing), and PSI in Switzerland (21). There is also considerable and increasing activity in non-accelerator experiments (84).

CERN's LHC will be a vital part of Italian particle physics. For the longer-term future, there is strong interest in the development of an electron-positron linear collider where there is collaboration in the Tesla superconducting test facility at DESY.

Of the physicists working on accelerators, 60% are working at CERN, 25% are working on US facilities and the remaining 15% are equally spread between DESY and Frascati.

With Italian research support staff generally not as numerous as in the other major European countries, Italy looks towards collaborations abroad.

Italy has a strong tradition of outstanding contributions to theoretical particle physics. At present some 500 theorists (including 120 graduate students) work at close to 30 major centres.

About half work in field theory and related domains, a third concentrate on phenomenology, and a sixth on mathematical physics. Besides the

ECFA Chairman Enrique Fernandez (right) with Frascati Director Paolo Laurelli.

After Frascati, the ECFA party continued their mission at the Gran Sasso underground laboratory. Director Alessandro Bettini explains.

500 engaged in particle physics research, 160 theorists work in nuclear physics, also supported by INFN.

A recent development in computational physics is the new APE 100 Gflop machine (November 1996, page 4). APE-100 is now available commercially and in use in Italy and Germany. INFN APE funding for 1997 was at the level of 4 million Swiss francs.

Italy is also host to the Abdus Salam International Centre for Theoretical Physics in Trieste and to the European Centre for Theoretical (nuclear) physics in Trento. In both cases Italy provides a large fraction of the funding. Italian theorists have always played a prominent role at CERN.

The Italian contribution to CERN (126.6 million Swiss francs in 1997) comes through the Foreign Ministry, while the Ministry of Universities and Research supervises INFN.

With the exception of university salaries, the INFN is the only source of funds for research in nuclear and sub-nuclear physics within Italy. Its present annual budget (therefore excluding the CERN contribution) amounts to almost 440 million Swiss francs. The particle physics effort is shared between accelerator-based physics at CERN and elsewhere, investment in experiments at CERN, HERA and Fermilab, and personnel and travel costs. Considerable funding is earmarked for the LHC detectors (ATLAS, CMS and ALICE).

INFN (Istituto Nazionale di Fisica Nucleare)

The INFN, a public body financed by Parliament, serves to promote, coordinate and finance Italian research in nuclear and sub-nuclear physics. The INFN 's decentralized structure is based on 19 research units or sections (sezioni) in leading Italian universities, together with smaller units (gruppi collegati), each associated with a section.

The 19 sections are at Torino, Milano, Pavia, Genova, Padova, Trieste, Bologna, Ferrara, Firenze, Pisa, Perugia, Roma-1, Roma-2, Napoli, Cagliari, Bari, Lecce and Catania and at Roma-Sanita (which now becomes Roma-3). All sections cover both experimental and theoretical particle physics. "Gruppi collegati" with activities in particle physics are in Trento, Parma, Udine, Cosenza and L'Aquila. The INFN also operates four national laboratories - Frascati and Gran Sasso, and the nuclear physics laboratories of Legnaro (near Padova) and del Sud (near Catania).

The INFN works in close collaboration with the universities and supports university staff besides its own. The research scientists working with the INFN include 950 university physicists in addition to 500 INFN employees. Technical and administrative personnel number 1300.

The INFN has joint programmes with other public organizations, mainly the CNR (National Research Council), the ENEA (energy and environmental research) and the INFM (condensed matter). In terms of spending power it ranks fourth among the Italian research organizations after the CNR.

Under the Ministry of Universities and Research and, to a lesser extent, the Ministry of Industry, the INFN has its own Council of 37 members (34 being active scientists). The president (and acting director) is currently Luciano Maiani, who will become CERN Director General next January. He will be succeeded as INFN president by Enzo Iarocci (see page 31).

INFN's Council is advised by five national committees formed by representatives from each of the sections and which provide a sense of unity to an institution with widely distributed activities.

At present the chairman of the committee for sub-nuclear physics with accelerators is M. Calvetti, the committee for sub-nuclear physics without accelerators is chaired by F. Bobisut and the committee for theoretical research by C. Becchi. The two other committees, covering nuclear physics and technological research, are chaired by A. Bertin and C. Sciacca, respectively.

Proposals which eventually define the research programmes originate from the community of researchers and are evaluated by the national committees and INFN management, which shapes general strategy.

The INFN traditionally has close relations with CERN. Its long-time "Minister for Foreign affairs", M. Gigliarelli-Fiumi, served in many key capacities at CERN, including

chairman of the Finance Committee. He has now retired, and is replaced by Roberto Pellegrini.

INFN programmes cover five-year period, the present one spanning 1994 - 98. The first version, presented in 1992, had to be revised lower in view of economic difficulties and a new version approved by the National Council for Science and Technology in June 1993 includes rescheduling for some of the investments. The approved version increased by almost 40% over the period 1994 - 8.

While this is encouraging, budgeted funds and allocated funds are now showing some significant differences - funds available in 1997 were about 5% lower than in 1996.

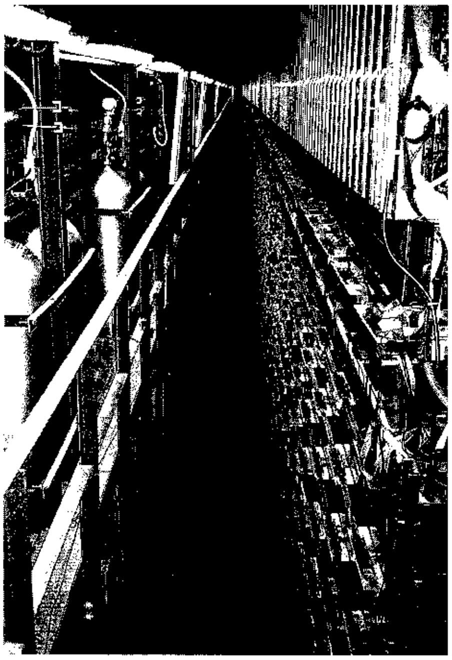
The five-year INFN plan

The 1994 - 98 five-year plan seeks a budget increase of about 8% per year (probably 2% in real terms). The sub-nuclear physics areas targeted are:

• The continuation of the LEP experiments;
• Fixed-target physics at the Tevatron (Fermilab) and Babar (SLAC);
• Preparation for LHC experiments;
• Exploitation of HERA (DESY);
• Completion and exploitation of DAFNE (Frascati);
• Development of the experimental programme at Gran Sasso;
• Detection of gravitational waves, in particular Virgo (see below).

Relativistic heavy ion collisions at CERN is considered under nuclear physics.

The new plan (1999-2004), now in the approval stage, will show a slight decrease. It includes completion of Babar at SLAC and Borexino at Gran Sasso. There will be an effort toward a neutrino beam from CERN to Gran



The MACRO installations at Gran Sasso

Sasso, using the Icarus experiment.

The INFN has already significantly extended its activities to include astroparticle physics. The substantial involvement in the detection of gravitational waves reflects its desire to cover fully all basic interactions. Two important bar detectors using 100 mK technology, Auriga, at Legnaro, and Nautilus, at Frascati, are nearing completion. These follow Explorer, at CERN, using 2.5 K technology. The two new detectors should reach a sensitivity of 10^{-19} at 103 Hz. The Virgo interferometer, built in Pisa as a Franco-Italian project, should eventually reach 4 orders of magnitude lower.

The INFN submitted itself to an international review last year. The review panel consisted of B. Richter (chair), P. Kienle and V. Soergel, with G. Ross as consultant for theory. The report was very positive but expressed concerns about the lack of mobility of researchers within Italy and about the small number of postdoc positions which hinders the mobility of younger researchers.

CERN and Italian industry

Italian industry is involved with high-tech equipment at CERN, and in particular, with the assistance of the INFN, in the development of superconducting radiofrequency cavities for LEP and LHC superconducting dipole magnets. Italy has a well-developed and diversified industrial base with major companies (Ansaldo, Olivetti) and dynamic small ones involved in work for CERN. This is also the case for major international companies established in Italy. Particle physics has opened a market for nuclear instrumentation companies.

Gran Sasso

The Gran Sasso underground laboratory represents a major research effort. At present the laboratory serves 500 users from 10 nations (half the users are Italian).

In 1997 ECFA invited the Director of the Laboratory to become, together with the directors of CERN and DESY, an ex-officio member of Restricted ECFA, reflecting ECFA's interest in non-accelerator based particle physics.

The Laboratory, near the town of L'Aquila, 120 km North-East of Rome, is alongside a 10 km road tunnel through the Gran Sasso range in central Italy. It has of 3 large underground experimental halls, about 100 m. in length and 20 m. in height.

Construction was approved in 1982 after a proposal of then INFN president Antonino Zichichi in 1979. Civil engineering was completed in 1987 and Gallex obtained its first result on the solar neutrino flux in 1992.

The annual budget (excluding salaries) is of the order of 12 million

Swiss francs. This does not include the cost of the experiments which are funded by the INFN and the other institutions participating in them.

Current experiments are dedicated to the study of solar neutrinos, the "watch" for supernovae, the study of cosmic rays and the search for dark matter studies. There are also experiments on rare decays (four double beta-decay experiments). The main experiments are LVD (neutrino watch), Macro (magnetic monopole search and cosmic ray muons), Borexino (solar neutrinos) and Icarus (proton decay and neutrinos), together with DAMA and CRESST (dark matter searches) and LUNA (nuclear astrophysics).

The pioneer Gallex solar neutrino experiment is now completed, but a second-generation gallium neutrino observatory will continue this valuable work. On the top of the mountain, just above the underground laboratory, is an extensive air shower experiment (EAS-TOP) linked to LVD and MACRO.

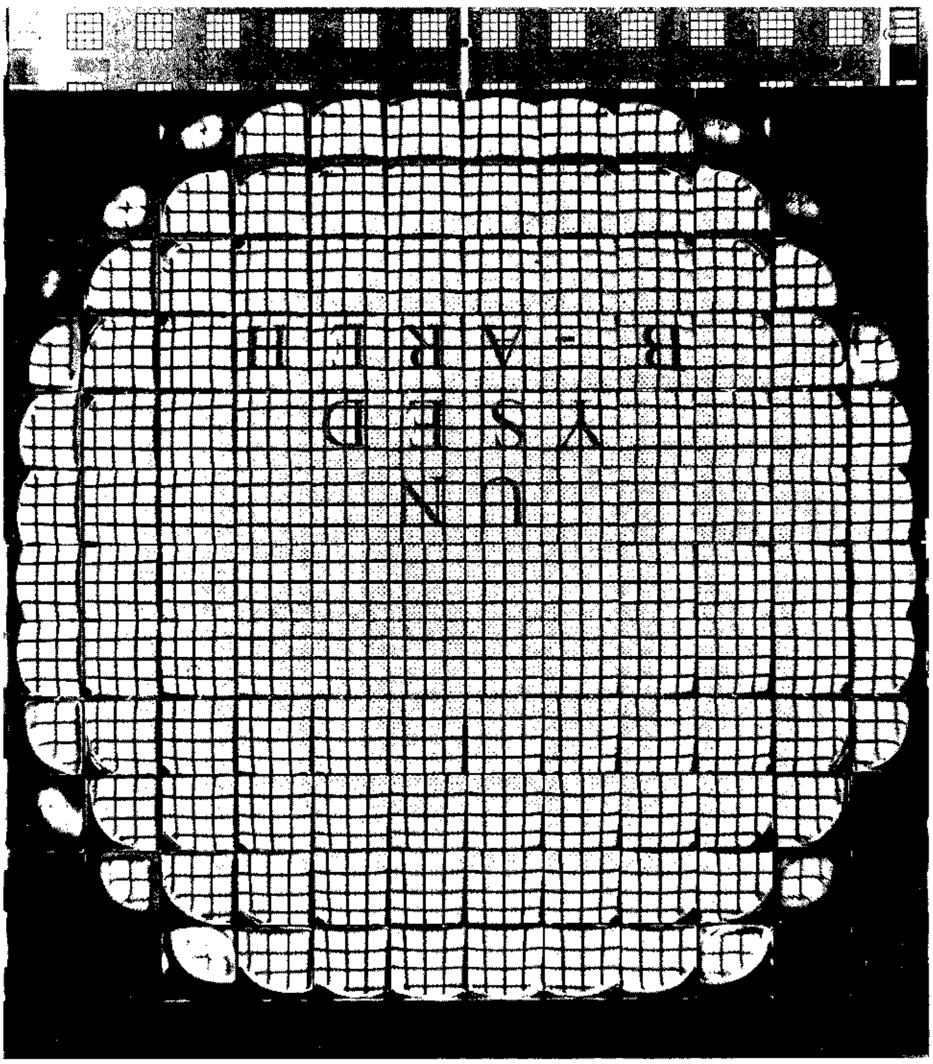
The laboratory plans two more halls. The present halls, pointing toward CERN, are suitable for a long base neutrino experiment.

The international review praised the success of the Gran Sasso effort, but expressed concern about the scientific monitoring and eventual termination of the current experiments since the competition for space will increase.

DESY
Better photo coverage

In experiments looking for extreme photosensitivity, one of the current limitations of photomultipliers is the relativity low photo-sensitive fraction of the exposed photomultiplier area. Packing the detectors as close together as possible achieves an efficiency of only some 40%, and this coverage is further reduced, for example by space constraints for the associated electronics, to about 25%.

An ingenious solution developed by the HERA-B RICH group working at DESY's HERA electron-proton collider is to use a lens system to direct light (in this case ring-imaging Cerenkov - RICH - photons reflected



Change of focus. Just visible at the top is a photosensitive matrix for the HERA-B experiment at DESY's HERA electron-proton collider. The difficulty of fitting the elements together results in a light collection efficiency of some 25%. However the main image is of the same photosensitive matrix as seen through a lens system specially developed for the HERA-B Ring Imaging Cerenkov (RICH) system to direct light towards photosensitive areas. This increases the light collection efficiency to 65%. Note the way the lettering 'DESY HERA-B' is transmitted.

the abdus salam international centre for theoretical physics

Call for proposals

Partnership in North-South Cooperation

Since its creation in 1964, the Abdus Salam International Centre for Theoretical Physics (ICTP), an international research institute funded by the Italian government, UNESCO and IAEA, has sought to promote the advancement of science in developing countries as a vital instrument for economic progress and international cooperation. With this aim in mind, we implement several programmes both in Trieste and in the developing world.

Distinguished collaborators have found their association with the ICTP an inspiring experience. Our collaborators have had opportunities to meet thousands of people from diverse cultural backgrounds, share the common language of science and work together in research while at the same time addressing problems associated with economic inequities and global environmental degradation.

At this moment in our long and successful history, we feel a need for renewed input from the international community to encourage broader and more active participation of scientists from around the world. We call on all those who share our ideals to help us fulfil our mission.

To reach the largest number of scientists, the ICTP is issuing a *Call for Proposals* for many of our programmes in the calendar years 1999-2000. We also contemplate a second *Call for Proposals* for the remainder of our programmes (Associate and Federation Schemes, Affiliated Centres, Donation, Diploma, Networks and Training and Research in Italian Laboratories).

This first *Call for Proposals* covers:

1. Schools, Conferences, Workshops and Extended Research Workshops

Each year, the ICTP organizes about 40 training and research activities in all areas of physics and mathematics (both theoretical and experimental, including interdisciplinary areas that use mathematical tools). Since 1964, more than 65,000 scientists from developing and developed countries have participated in these activities. Schools normally cover general topics, are reasonably self-contained and last from 4 to 5 weeks. Workshops are shorter in length and deal with more specific subjects covering the latest developments in the field. Conferences are at most one week long and attract specialists from both developing and developed countries. We have recently implemented "Extended Research Workshops", in which some 20 researchers come to Trieste for 6 to 8 weeks to collaborate and exchange information on specific research subjects. Our *Call for Proposals* invites submissions for the organization of Schools, Conferences, Workshops (and/or Extended Research Workshops) in Trieste.

2. Partnership in the Associateship Scheme

The ICTP Associateship Scheme was created to enable renowned scientists, who were born and work in developing countries, to remain in contact with the most recent developments in their fields through visits to the ICTP. The Scheme also helps scientists to build scientific communities in their home countries that are designed to address local needs. This effort, which benefits between 500 and 600 scientists annually, is widely acknowledged to be one of our most effective programmes. The recognition we have received has led to substantial additional support from the Swedish International Development Cooperation Agency (Sida). In this *Call for Proposals*, we invite scientific institutions, research groups and individual scientists in developed countries to become "Partners in the Associateship Scheme". Successful applicants will be asked to host our Associates and make training programmes and research facilities available to them. The arrangement will take the form of a "Memorandum of Understanding" between the ICTP and the partner institution, which should be prepared to share the additional costs.

3. Research and Training at the Abdus Salam ICTP

Within the framework of its research activities in physics and mathematics, the ICTP makes available on a regular basis positions for post-doctorates and short- and long-term visiting scientists. Our *Call for Proposals* invites established physicists and mathematicians to apply for short- or long-term visits, including sabbatical leaves, to the ICTP. A key responsibility of our visitors will be to assist and interact with our younger scientists in residence.

4. Scholars-Consultants Programme

The ICTP's Office of External Activities offers substantial support for scientific activities and select institutions in developing countries. This *Call for Proposals* invites applications from scientists willing to make extended periodic visits at an institution in a developing country, particularly one of our Affiliated Centres. A primary purpose of these visits will be to initiate and develop joint research programmes.

5. Partners to Networks

The ICTP's Office of External Activities also oversees our Networking programme, which offers support for the mobility of scientists between developing country laboratories cooperating on the same scientific project. Our *Call for Proposals* invites research centres in developed countries to become partners in these Networks. The ICTP will continue to cover South-South mobility costs, while partner institutions will be expected to cover North-South mobility costs.

The guidelines for making proposals as well as deadlines and criteria can be found at: http//www.ictp.trieste.it/proposals

Please note that the preceding 1. to 5. modalities can be used separately or combined consistently in a structured project.

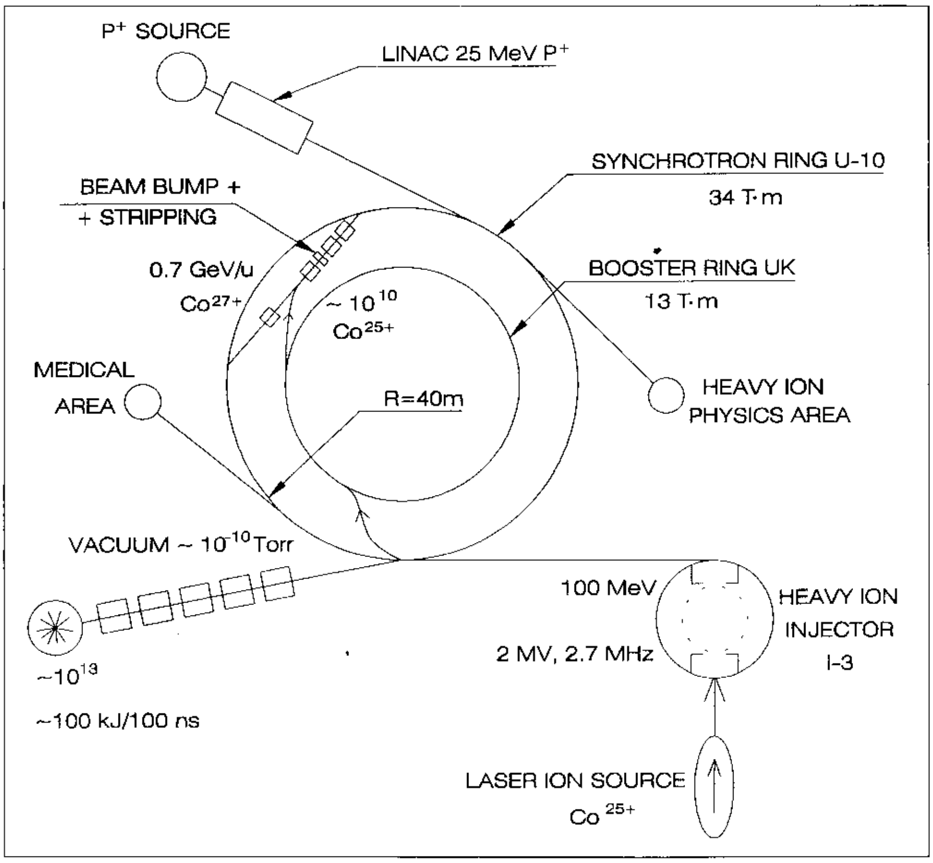
For additional information, please contact: **proposals@ictp.trieste.it**

the abdus salam international centre for theoretical physics
strada costiera, 11 – p.o. box 586 – 34014 trieste, italy

www.ictp.trieste.it/proposals

Jointly operated by UNESCO and IAEA

Layout of the TWAC (TeraWatt Accumulator) project at Moscow's Institute of Theoretical and Experimental Physics (ITEP) to produce intense heavy ion beams for a range of applications.



by a spherical mirror) towards photosensitive areas. This boosts the light collection efficiency to 65%, a substantial improvement. The system will be commissioned this year.

MOSCOW Terawatt heavy ion beams

The TWAC (TeraWatt Accumulator) project at Moscow's Institute of Theoretical and Experimental Physics (ITEP), aims to produce TeraWatt power (100kJ/ 100ns) intense heavy ion beams concentrated on experimental targets. The project, which began in 1997, is based on the existing ITEP accelerator chain - the 2MV/2.7 MHz I-3 heavy ion injector, the UK 13 Tm booster ring, the U-10 34 Tm synchrotron, a system of beam transfer lines and a laser ion source of helium-like medium ions. Its scientific programme includes a number of challenging issues in accelerator physics, matter physics at high energy density, and heavy ion physics.

The use of external (non-Liouvillian) techniques to control the (phase space) distributions of particle beams enables a heavy ion synchrotron to be adapted for high intensity related experiments. TWAC will stack pulses accelerated in a synchrotron in a storage ring, with full stripping of helium-like medium mass ions providing high efficiency.

The laser ion source is capable of producing adequate (10^{10} - 10^{11}) highly charged ions of atomic mass 40-60 at 1Hz repetition rate by plasma generation by a laser beam focused by a mirror system (or a lens) on a solid target. Candidate ion species under consideration include sulphur 32 (14+), calcium 40 (18+), and cobalt 59 (25+).

The laser source produces about 5 x 10^{10} cobalt ions, which are accelerated in the I-3 preinjector up to 1.6 MV/nucleon, then injected into the UK booster ring. After acceleration up to 0.7 GeV/nucleon, a 250 ns bunch is transferred in a single turn to the U-10 synchrotron using a stripping process - the charge state changing from 25 to 27+ by passing the beam through a foil of about 5 mg/cm^2.

The synchrotron ring serves only as a storage ring: no acceleration is planned. To minimize the effect of the stripping foil, the accumulated beam in the storage ring is directed onto the stripper only during injection of the next bunch of ions from the booster. For this, a beam-bump system, based on two fast coherent deflectors, has been installed. Since the cross section of the accumulated beam is at least 25 times larger than the surface of the stripper, beam quality does not deteriorate significantly by scattering. This process is repeated a thousand times until the Laslett space-charge limit is reached in the synchrotron with 1.2 x 10^{13} ions, corresponding to about 100 kJ of stored energy. A rapid switch in the ring's radiofrequency compresses the accumulated bunch from 1000 ns to some 100 ns, after which the bunch is extracted, transported and focused on an experimental target.

The beam emittance of 5 cm mrad gives a focus spot of 1 mm diameter.

The expected TWAC output energy on the target 100 kJ in 100 ns, or 1 TW of beam power. The deposition power is 10 TW/g in a radius of 500 microns. Such energy deposition generates hot strongly compressed matter with extremely high energy density (more than 1 MJ/g), producing intense shock waves. The temperature reached in a solid gold target is calculated to be up to 40 eV.

Such conditions open up experiments addressing some fundamental issues in the physics of dense plasmas like equations of state, thermodynamics of strongly compressed matter, plasma phase transitions etc, together with other studies on the physics of heavy ion fusion, especially with cylindrical targets and magnetized fuel.

If the TWAC acceleration-accumulation scheme succeeds in delivering the planned high output parameters of heavy ion beams, an upgrade might be considered. Adding several superconducting storage rings to be filled from the synchrotron would increase the available energy and beam power.

Instead of accelerating the ion beams in the UK booster ring, the option to use the U-10 synchrotron up to energies of some 3 GeV/nucleon is being left open. Slow ejection of the beam will be provided by a septum magnet with a beam transport line to the heavy ion physics experimental area. This will open up the investigation of nucleus-nucleus interactions and the availability of exotic and radioactive beams gives the possibility of investigating elastic and non-elastic interactions of light nuclei.

The suitability of accelerated carbon ions for medical applications invites construction of a dedicated ion beam transport line to the ITEP Oncology Centre for tumour therapy.

Upgrading the ITEP accelerator complex to a powerful heavy ion facility promises to give by the end of 2000 a valuable tool for experimentation in high energy density in matter physics, heavy ion physics, and accelerator physics as well as for medical applications.

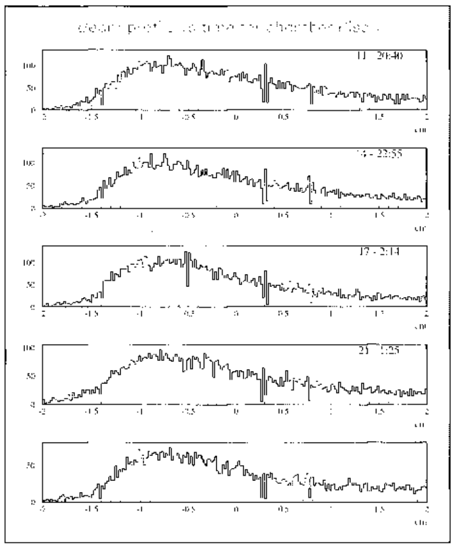
From Boris Yu. Sharkov, ITEP Moscow

Physics monitor

Getting wired in Vienna

When the first Wirechamber Conference was held in Vienna in 1978 only a few farsighted people thought that wirechambers would become the most used detector technology in high energy physics. The invention of the technique by Georges Charpak has been reinforced by a steady stream of new developments and improvements. The award of the 1992 Nobel prize to Charpak acknowledged the role that the wirechamber and related technologies now play in modern physics and instrumentation.

In 1978, even fewer people would have thought that the Vienna Wirechamber Conference will become a long and successful series. Twenty years after the first conference, the 8th Vienna Wirechamber Conference took place from 23 -27 February. Again a large number of participants (about 300) from far afield took part in the detector festival.



Beyond the wire: high intensity beam test of a microstrip gas chamber (MSGC) detector for the CMS experiment at CERN's LHC proton collider, showing the beam profile seen by the detector before, during and after a run lasting 225 hours.

Wire chamber specialist Dieter Schinzel of CERN (right) with Gert Viertel of ETH Zurich at the recent Vienna meeting.

As so often in the past, Vienna was a meeting place for scientists from east and west. Making use of several national and international programmes, the conference organizers could support a large number of excellent physicists from the former Soviet Union and other eastern countries. The largest contribution came from the exchange programme of the Austrian Academy of Sciences. As well as money, in many cases such support meant logistic help to overcome bureaucratic obstacles not only in scientists' home countries but also in Austria after visa repercussions following the Schengen agreement on European frontier crossings.

The invited talks (9), other talks (about 40) and posters (about 45) were customarily selected with the help of a very active scientific advisory committee, ensuring topicality. However attendance at the accompanying industrial exhibition was rather low, reflecting economic constraints. This was offset by a grant from the European Commission and modest support from the European Physical Society.

The conference opened with a review of "Gaseous detectors: recent developments and future perspectives", by F. Sauli of CERN. This included an review of anniversaries - the first single wire proportional chamber (H. Geiger and E. Rutherford, 1908), the Geiger-Müller counter (H. Geiger and W. Müller, 1928), the multiwire proportional chamber (G. Charpak, 1968) and the microstrip gas chamber (A. Oed, 1988).

Contributed talks and posters reflected a wide range of activities. The majority of contributions were related to instrumentation for high luminosity proton colliders (LHC at CERN, Tevatron at Fermilab), quark factories (Cornell, Frascati, SLAC and Novosibirsk), ion colliders (Brookhaven, LHC) and space experiments.

After the first day devoted to applications of gaseous and solid state detectors in biology, medicine and space science, D. Schinzel of CERN reviewed high resolution noble-liquid calorimeters, emphasizing how to achieve the best possible energy resolution and showing the most recent developments for ATLAS, NA48 and Icarus.

Many talks reflected further progress on classic wire chamber designs. Improved understanding of operational principles and elaborate construction have led to large drift chambers with a position resolution of about 100 microns.

In this category impressive results were shown for the drift chambers for KLOE at Frascati's DAFNE collider (G. Bencivenni, Frascati) and for BaBar at SLAC's PEP-II B factory (G.Sciolla, SLAC). G.Mitselmakher (Florida) in his review talk on muon detectors at hadron colliders covered not only ATLAS and CMS at the LHC but also the upgrade programmes of CDF and D0 at the Tevatron. Subsequently several short talks and posters gave details and results for full scale prototypes of monitored drift tubes for ATLAS, and the cathode strip chambers and drift tubes for CMS.

In the field of new developments of gaseous detectors, the audience saw a veritable inflation of novel and improved microstructure detectors - MSGC, MGC, MICRO-DOT, GEM, MICROMEGAS, ... B. Schmidt (Heidelberg) opened this session with an overview of microstrip gas chambers (MSGC). R. Bellazzini (Pisa) explained the large MSGC system foreseen for CMS, presenting results from many tests using final prototypes. Signal-to-noise, efficiency, rate capability and robustness will meet the requirements for the CMS tracker.

Studies using a GEM (gas electron multiplier) structure were presented by J.-M. Brom (Strasbourg), M. Capeans (CERN), R. Chechik (Weizmann Inst.), V. Peskov (NASA), R. Bellazzini and others. I. Giomataris (Saclay) explained MICROMEGAS a novel high-rate position detector strongly advocated by co-author Charpak. Although this detector is probably too far in the

future for ATLAS or CMS, its potentially excellent properties have attracted much attention.

The conference subtitle "Recent trends and Alternative Techniques" attracted contributions not using wires or gases. Clearly the most important complementary technique is solid state detectors. After the review talk of W. Trischuk (Toronto), the CMS silicon tracker (R. D'Alessandro, Florence), the new silicon vertex detector for CDF (P. Azzi, Padova) and the silicon detectors for PHOBOS (H. Pernegger, MIT) were presented. Finally H. Sadrozinski (Santa Cruz) made an excursion into space explaining GLAST - Gamma-Ray Large Area Space Telescope - a new NASA mission which intends to send about 87 m^2 of silicon microstrip detectors into orbit.

Important for all detectors is front-end electronics, reviewed by P. Weilhammer of CERN, who also discussed radiation hardness, crucial for the inner LHC trackers. The NA48 experiment at CERN, now in operation, is a recognized testbed for LHC-type electronics and triggering. The NA48 40 MHz neutral trigger system was presented by G. Fischer (CERN).

On the last day, Vienna computer scientist H. Bischof addressed track finding and fitting. His invited talk presented an algorithm, originally developed for computer vision, demonstrating its potential for high energy physics. Still on mathematical modelling, R. Veenhof (NIKHEF) gave an inside look into his well known program Garfield.

The summary talk was the unenviable task of M. Turala of CERN, who engaged the audience's attention before the traditional "Heurigen" dinner marking the end of the conference.

With many members of the ICFA instrumentation panel present, its chairman T.Ekelöf (Uppsala) held a one-day meeting, while immediately after the conference, one of its organizers (W.Bartl), held a workshop on applications, mostly concerned with medical imaging.

Participants left Vienna with the impression that even after several decades, there is no slowing down of invention and development around wire chambers and alternative techniques. On the contrary there were so many new ideas that everyone wondered which of them will survive until the next conference in three years and eventually become new standard technology. But although the wire chamber and its conference is now a physics classic, one might wonder when a "wireless" chamber conference will be held.

M. Krammer and M. Regler

Accelerators under control

The increasing interest in control systems for major research facilities was reflected in a record attendance at ICALEPCS'97, the 6th in the series of biennial International Conferences on Accelerators and Large Experimental Physics Control Systems, held in Beijing from 3-7 November. The attendance was boosted by the organizers' decision to allow industrial companies to invite clients - mostly Chinese - to participate in topical seminars.

Thus some 450 specialists from 26 different countries worldwide and representing more than 100 organizations in science and industry heard the latest developments and trends in control systems for accelerators and major experimental physics facilities.

After Xu Zhihong, Vice President of the Chinese Academy of Sciences, Zhu Xuan, General Secretary of the Academy, and Fang Shouxian of the Academy formally opened the conference, Institute of High Energy Physics Director and conference co-chairman Zheng Zhipeng introduced the host laboratory. Since the completion of the Beijing Electron Positron Collider (BEPC) in 1988, IHEP has gone on to attain a leading position in world tau-charm physics, and has benefited from close international co-operation.

In his welcome speech, conference co-chairman Axel Daneels of CERN recalled that the series had begun 10 years before in Villars-sur-Ollon, Switzerland, following several earlier initiatives. ICALEPCS'97 thus was embarking on its second decade. He expressed the community's gratitude to the Chinese Academy of Sciences and IHEP for having been invited to hold the conference in Beijing, the capital city of one of world's most ancient civilizations, the birthplace of many advanced technologies and which introduced several early standards (notably cart wheelbases and banknotes).

In these cost-conscious times, money is a major concern. In addition to the traditional status reports of ongoing control projects, trends in hardware and software, man-machine interfaces, databases, networks and fieldbusses, etc, several sessions addressed financial implications: inexpensive systems, industrial off-the-shelf systems, software sharing, promising hardware and software technologies, etc.

Several presentations on non-accelerator control systems hinted at

At ICALEPCS'97, the 6th biennial International Conference on Accelerators and Large Experimental Physics Control Systems, held in Beijing from 3-7 November, left to right, local organizing committee co-chairperson Jijiu Zhao, Noriichi Kanaya of KEK, Japan, and Chunhong Wang of Beijing's Institute of High Energy Physics.

looking outside high energy physics in search of new solutions. The ultimate goal of any control system is fully autonomous operation and some sessions were devoted to control theory, feedback and automation.

The oral presentations were supplemented by a large number of poster contributions.

Status Reports

Many new control systems can be characterized by their size and the large number of computers (often more than 100) connected in highly distributed networks. All these are based on what throughout successive ICALEPCS has been referred to as the 3-level "standard architecture" (workstations and servers, front-end, equipment controllers), but with a tendency to incorporate more and more commercial and public domain products.

Size and complexity demands the use of modern software engineering (e.g. the European Space Agency's ESA-PSS-05 standards), and project management practices. ESA-PSS-05 was initiated in 1984 and brought into the public domain in 1994. It has gained acceptance in several scientific organizations and forms the basis for many quality management systems. Industrial project management practices are now seen as vital to the success of modern control systems.

Software Sharing and Object Oriented Technologies

Several laboratories are basing their control systems on the evolving EPICS (Experimental Physics and Industrial Control System), using its Common Message LOGging System (CMLOG) and the Common DEVice (CDEV).

Organizations, people and information are naturally distributed and so are their computer systems. However, these systems should be integrated and interoperable. Modern object-oriented technologies such as CORBA (Cooperative Object Request Broker Agency) supports flexible and reusable distributed services and applications and hence provide independence of platform, network technology, operating systems and programming languages.

Hardware

DSP (Digital Signal Processors) are widely used for fast, high precision data processing in the control of accelerator beam orbits or radiofrequency, for processing plasma movement in Tokamaks, etc. Transient recorders are used for r.f. and quench protection because of their very high sampling rates. Transient recorders are in general not synchronized and ongoing work aims to integrate these into a global system.

Feedback and automation

Control systems often require high dynamical performance and robust behaviour, yet at the same time are expected to cope with complex processes and to provide full automation. Such "Intelligent Systems" are based on PID, FSM, fuzzy logic, neural networks, and knowledge-based decision-making mechanisms.

Such techniques have demonstrated their value for optimizing operational conditions, for automating complex event scheduling operations, for automatic beam alignment, for real-time orbit feedback systems, or for the alignment of accelerator components sensitive to floor motion.

Man-machine interfaces and more systems

The World Wide Web is becoming popular as an interface for viewing information. Many commercial interfaces provide the required functionality and performance at low cost. These systems were reviewed in the light of object-oriented technol-

ICALEPCS'97 co-chairmen Axel Daneels of CERN (left) and Zheng Zhipeng, Director of IHEP, Beijing.

ogy and Java programming, with the emphasis on user friendliness.

In parallel, industrial control systems increasingly offer internet interfaces, allowing world-wide access. The Web is therefore increasingly popular for accessing process information and documentation, on-line logbooks, historical trend data, life status displays, and database updates, and for interfacing to trouble-reporting systems, etc. Finally, object-oriented technology simplifies the development of fully encapsulated components in a distributed environment. All these technologies have found their way into experimental physics controls.

Since the inception of ICALEPCS, and despite attempts to extend the scope of the meetings, the conferences have been dominated by accelerator control systems. However ICALEPCS'97 was a platform for reports of control systems in other environments such as liquid waste treatment, radiochemical processes and medical applications (cancer therapy). The latter is characterized by the need for tight and stable control of beam position and energy to ensure patient safety.

Previous meetings often alluded to the increasing use of industrial, off-the-shelf systems and Programmable Logic Controllers (PLCs). At Beijing, these aspects were the subject of a dedicated session on the problems of using industrial systems for experimental physics.

In the struggle to save money, several institutes have satisfactorily implemented even large control systems using rather inexpensive PCs with Windows NT and/or Windows 95. Some have even gone as far as introducing front-end PCs, e.g. inside regulators for beam transport magnets.

Databases and networks

Control systems have become indispensable, both for physics and for linking to information technology infrastructure. Controls are no longer stand-alone systems but rather part of a weblike Computer Integrated Manufacturing (CIM) environment in databases play a major role.

Due to their functionality and flexibility, Relational Data Base Management Systems (RDBMS) and, more recently, the Object Oriented Data Base Systems (OODBS) have been given great attention. Advanced techniques support quality control and assist in understanding machine behaviour by tracking the data needed to improve machine performance.

Networks are an integral part of the "standard architecture" for current experimental physics control systems. Approaches were recommended for improving redundancy and for monitoring performance.

Fieldbusses are increasingly used to provide flexibility and are the subject of ongoing developments. Where groups need to connect into common systems, it is essential to avoid a proliferation of fieldbusses. Under the auspices of the European Physical Society's Interdivisional Group on Experimental Physics Control Systems (EPS-EPCS) and CERN, a working group evaluated various products and made recommendations.

Other attractions

The development of highly sophisticated components that should have a significant impact on control efficiency is one pointer to the future. Also commendable is a Russian federal programme for a nation-wide network of supercomputers for science and education.

Discussions revealed that for large systems with considerable social impact, it is difficult to predict the resulting technical and human implications.

ICALEPCS'97 closing remarks from conference technical secretary In Soo Ko of PAL, Pohang, Korea.

An accompanying industrial exhibition gave several advanced high technology industrial companies the opportunity to demonstrate their latest products. Among them were Hewlett-Packard, Motorola, Digital Equipment, Force Computers, Creative Electronic Systems (Switzerland), Vista Control Systems, Mitsubishi, Yokogawa, Hua Guang (China) and IMAG Corp. (China).

The Conference was preceded by a three-day training session, attended by about 100 people, on "Development Tool Kits for Control Systems" during which EPICS and Vsystem (Vista Control Systems Inc.) were introduced.

In Soo Ko from Korea's Pohang Accelerator Laboratory concluded the conference by highlighting its technical content whilst Shin Ichi Kurokawa of Japan's KEK closed the event on a poetical note, reflecting the community's enthusiasm by citing a poem of Cao Cao (A.D. 153 - 220), the king of Wei in the "three countries period":

Old horse, obliged to lie in a stable,
His will leaps over one thousand miles,
Brave man, although in the evening of life,
Can not help being enthusiastic.

Credits

ICALEPCS'97 was organized by the Institute of High Energy Physics (IHEP) of the Chinese Academy of Sciences (CAS) and co-organized by the European Physical Society's (EPS) Interdivisional Group on Experimental Physics Control Systems (EPCS) and the Center for International Scientific Exchanges. It was chaired jointly by Zheng Zhipeng, Director of IHEP and Axel Daneels of CERN.

Local organization was in the hands of Jijiu Zhao and Shuhong Wang and their IHEP colleagues, who spared no effort to ensure a successful meeting. The conference was supported by China's National Committee for Nature Science, the Bureau of International Cooperation, the Chinese Academy of Sciences, the Beijing Legend Computer Group Corporation, EBG Company and Hewlett-Packard. Hewlett-Packard have supported the EPS-EPCS group since its foundation in 1985-1986.

ICALEPCS'99, will be held in fall 1999, hosted by Sincrotrone Trieste. Further information from: Daniele Bulfone, Trieste Synchrotron Radiation Facility ELETTRA, Accelerator Division, Controls Group, SS 14, Km 163.5 Basovizza 34012 Trieste Italy, Tel: +39 40 375.8579, E-mail bulfone@elettra.trieste.it Details will be made available via http://www.elettra.trieste.it

From In Soo Ko (PAL, Pohang, Korea) and Axel Daneels (CERN)

LeCroy on LeCroy

LeCroy has become a household name in physics instrumentation. This interview with LeCroy Corporation founder and Chairman Walter LeCroy was conducted on the CERN Courier's behalf by George Blanar, Director of the LeCroy Research Systems (LRS) Product Group. LeCroy today employs 600 plus people world-wide with sales in excess of $140M a year.

Let's start with your early career.

In a brief flirtation with non-science, I entered Alabama as journalism major, but soon moved to Columbia as a physics major. After graduation, I initially took a job as an electrical engineer with ITT Labs, but soon went to Columbia to help commission a 2000-channel, 100 ns time-of-flight spectrometer for James Rainwater's thermal neutron experiments at the Nevis cyclotron. When this apparatus went to Nevis, I went with it to keep it running - which proved a challenging task. The Williams tube in particular, used to achieve the blazing 10 MHz storage rate, defied adjustment. I rigged a parity checker on it that rang a doorbell chime whenever it made an error, which proved so frequent that the technicians objected to the racket.

Who was at Nevis around 1960 when you were there?

Well, James Rainwater, as I mentioned, then Mel Schwartz, Jack Steinberger, Leon Lederman, Sam Ting and Carlo Rubbia. Also at Columbia though not at Nevis were T. D. Lee, C. S. Wu, Polykarp Kusch and Charles Townes. Others that come to mind include Warren Goodell, Alan Sachs and Sam Devons. Jerry Rosen and Lee Pondrom were postdocs, along with

Against a backdrop of his company's data acquisition and trigger equipment, research electronics instrumentation supplier Walter LeCroy with an early NIM module. "Physicists are our secret weapon", says LeCroy.

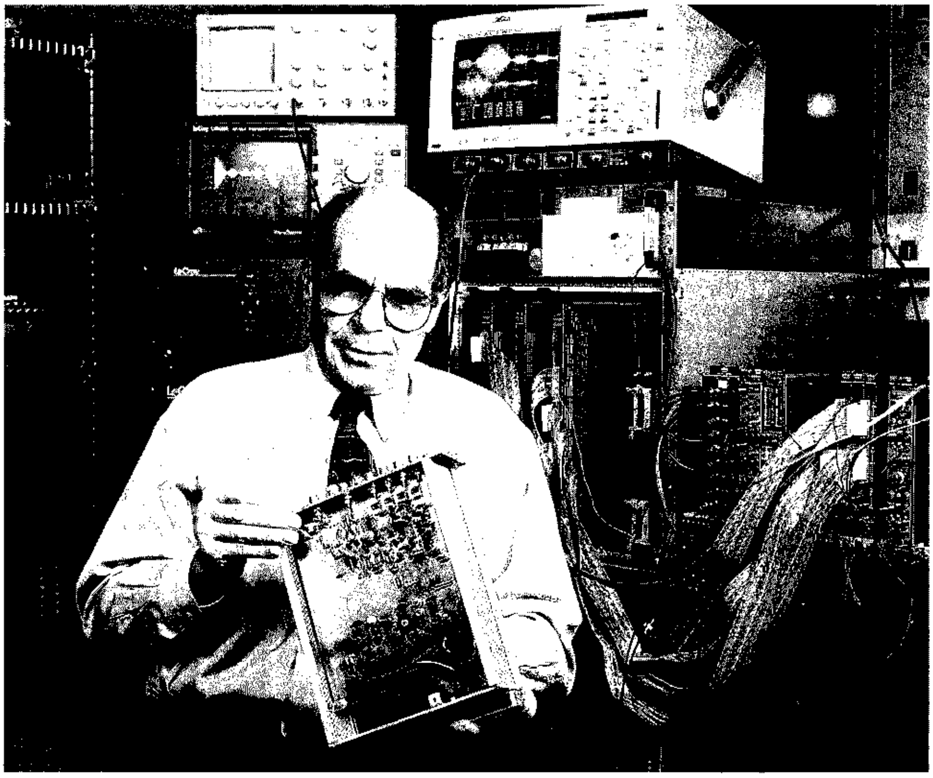
Aldo Michelini, Mimo Zavattini, Paolo Franzini and Juliet Lee. Rainwater was doing thermal neutron spectroscopy using time of flight on a mechanically chopped beam. Steinberger, Schwartz, Lederman and Ting were working at Brookhaven, mostly, using Nevis as a testing and staging area. The 380 MeV cyclotron at Nevis was already not too exciting a machine. Later I became chief electronics engineer at Nevis.

What kind of electronics were you making?

I began doing a series of small 10 MHz logic cards in plastic relay cases that plugged into vacuum tube sockets, and then a 100 MHz fast-logic series in modules bolted together out of aluminium rods and sheets. That was in the very early days of transistors and printed circuit technology. We painted our conductor runs with nail polish directly on the copper-clad boards and etched them with nitric acid scrounged from the chemistry lab. We soon graduated to tape on mylar, photoresist, and half-hour exposures in sunlight (longer if it was cloudy). The transistors were all germanium. Silicon transistors were there, but not fast enough yet and there were no ICs at all. My circuits were distinguished by being direct-coupled in contrast to the capacitor- or transformer-coupled designs prevalent then, and so were substantially free of rate effects, important for particle physics.

Why did you leave Nevis?

By 1963 I had been at Nevis for seven years. I had had a great opportunity to learn, and received a lot of encouragement from many people, including Leon Lederman, who succeeded James Rainwater as



director. I knew nothing about running a business, but was intrigued by the possibility of doing something useful, and a commercial enterprise seemed to be a good way to do it. After initial ideas for a transistor tester and a strip chart recorder for readout of digital data in graphical form, I received orders for fast logic modules based on an evolution of my Nevis designs.

Did you start out of a garage like Bill Hewlett and Dave Packard?

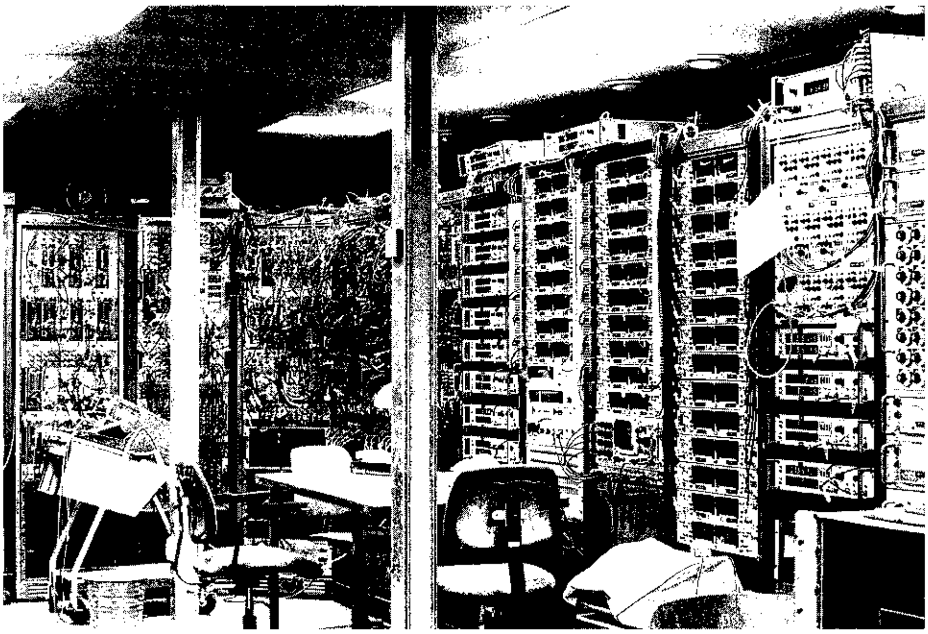
I started out in an old laundromat. The present New York facility was once a hospital, though the building has been extensively expanded and modernized. However, our thick film hybrid circuits are manufactured in the old maternity wards and the glass viewing windows are still there! Initially we concentrated on our 100 MHz logic modules, which soon included a rather experimental 6-bit ADC, followed by a more polished 7-bit unit. These ADCs were housed one channel per NIM #2 module, and included a neon indicator light on the front panel for each bit. They were never very popular, but were the predecessors of the popular multichannel CAMAC ADCs beginning with the Model 2248 in the mid-70s.

Who was your competition?

Our main competition was Chronetics and EG&G, who were doing several million dollars a year at that time. We were very small fry, always strapped for cash.

How did you sell?

At the very beginning, I was the main salesman. Then I got a phone call from a stranger who said he had heard we manufactured interesting scientific instruments, and asked if we were represented in Europe. We were not represented in New York, *An important early LeCroy success was supplying trigger and data acquisition electronics (behind the cabling, centre left) for Sam Ting's first experiment at DESY around 1967.*



let alone Europe! In London I met a network of representatives lined up by the mystery caller, Dieter Zander, owner of a sizeable import-export chemicals and instrumentation business. So we began making sales in Europe before we had any sales network in the States! Dieter's helpfulness extended far beyond lining up reps. He became our guide, counsellor, and before long, banker. He did all of this on faith, step by step. Eventually, he was handling all our paperwork and administration in his New York offices. He advanced funds against orders, then when payment was received took a percentage, an arrangement known as "factoring" that is common in the garment trade. It kept us afloat for several years. We would never be able to repay Dieter, however, for his guidance and confidence that enabled us to survive those early years.

Who were your first major customers?

Lee Pondrom, at Wisconsin, placed a major order for logic modules which set us on course. Other large early customers included the Penn-Princeton Accelerator (Tom Droege), DESY (Sam Ting), and Nevis itself. Our first important success was undoubtedly supplying the electronics for Sam Ting's first experiment at DESY around 1967. It was a landmark experiment mounted in record time, and we rapidly supplied innovative electronics, including the first ADCs used in high energy physics. Sam, who was at the beginning of his career, showed a lot of courage in going with an unknown upstart instead of an established vendor. Our business at CERN began in the mid-70s with the advent of our first CAMAC ADC, the well known Model 2248.

How did you get involved with NIM and CAMAC?

The US Bureau of Standards introduced NIM in about 1964-5. At that time, each manufacturer of modules, including us, had its own physical and electrical standard, each of course better than the others and all incompatible. The laboratories wanted to standardize, and we made the change faster than some others. However the switch was painful for everyone - in proportion to our size we had to throw out just as much aluminium. CAMAC came later of course, with the pressure coming this time from Europe and particularly CERN. We put our ADCs into CAMAC for European customers, and this introduced CAMAC into the US. The wisdom of the time held that you couldn't put an ADC into a CAMAC module - all that digital stuff flapping around and the lack of shielding. The argument was persuasive, but incorrect, as we demonstrated. And then that led directly to FASTBUS and VME. Today we also build in the new VIPA - VME International Physics Association format.

How did you get established in Geneva?

CERN was potentially a huge customer. The first product that we successfully introduced was the 2248 ADC in the mid-70s. In response to CERN's buy-European policy, we needed to have a design and manufacturing facility in Europe. A pioneer project was the Mont Blanc tunnel neutrino physics experiment that needed custom, low-cost electronics for its streamer tubes. Today we have almost 200 people working less than 100m from the CERN perimeter fence!

Did LEP change the scale of operations at CERN?

Sure. For LEP experiments we supplied tens of thousands of channels of drift chamber readout - preamps, discriminators and TDCs, hadron calorimeter readout - preamps and ADCs, high voltage for almost every part of the detector, second level trigger including the

Physicist George Blanar, Director of the LeCroy Research Systems (LRS) Product Group.

FERA ADCs. This taught us to reach beyond present limits in speed, precision and cost - the new detector-mounted 17-bit dynamic range charge ADC was originally developed for both CLEO at Cornell and BELLE at KEK and the ground-breaking new 25 ps common-stop time-of-flight TDC came from studying the needs of BELLE.

Oscilloscopes make up the bulk of LeCroy's business today. Where did the idea come from?

Our experience with digitizers began with our early TDCs and integrating ADCs for particle physics. We saw very early the applicability of this technology to digital oscilloscopes, and in 1970 we introduced a very basic 1 Gs 8-bit digital oscilloscope, just a digitizer with a display and no input conditioning. This instrument, the WD2000, boasted a record length of 20(!) samples, and we sold just 20 of them before they succumbed to scan-converter competition that offered more samples. We resisted the urge to make more competitive oscilloscopes and opted instead to put our limited resources on a new line of high energy physics products, and did not introduce another scope until the famous 9400 - an 'oscilloscope gap' of nearly 15 years.

Who designed the 9400 and the very popular, even today, 9450?

Geneva - the same group that started out on streamer tube electronics and then precision spectroscopy TDCs. This was in the early to mid-80s, just after we had done all that work for LEP and were ready for a new major project. Our newest scope, the 584, is up to 8 GS/s with 8 MS of memory. These are very powerful, general-purpose instruments with broad applicability.

How many physicists work at LeCroy and what do they do?

Physicists are our "secret weapon" We employ over 25, a few in marketing and sales but mostly leading project groups in engineering hardware and software. Physicists tend to assimilate new ideas quickly and are used to solving problems in innovative ways instead of just trying to upgrade existing techniques. A taste for the unconventional seems to be a part of their make-up, and we like that.

What is the role of the LeCroy Research Systems Group?

They continue to play a vigorous role supplying high density custom ADC and TDC components, NIM, CAMAC, FASTBUS, VME, and now VIPA modules to high energy, astro, nuclear, heavy ion, atomic and medical physics customers. Of late, we have been discussing applying our unique talents in manufacturing high density SMT printed circuit board assemblies for experiments that could not get the quality from other vendors. With decades of FASTBUS, 9U VME and now VIPA instrument production, we have this experience. We also are planning a new line of multiple input, fast waveform digitizer modules this spring and expanding the ViSyN high voltage system product line for new detector systems.

In which direction do you see your company going?

Still doing physics instrumentation. We'll be doing scopes faster and with longer memories and more features to make them even better tools. We'll also be entering other market areas such as LAN diagnostics and telecommunications. The common link is the technology, which is still based on the high-speed, low-noise multi-channel techniques developed for particle physics.

The dark side of the Moon

Assignment: To look for traces of solar neutrinos

Position: Paraguana Peninsula, Eastern Venezuela

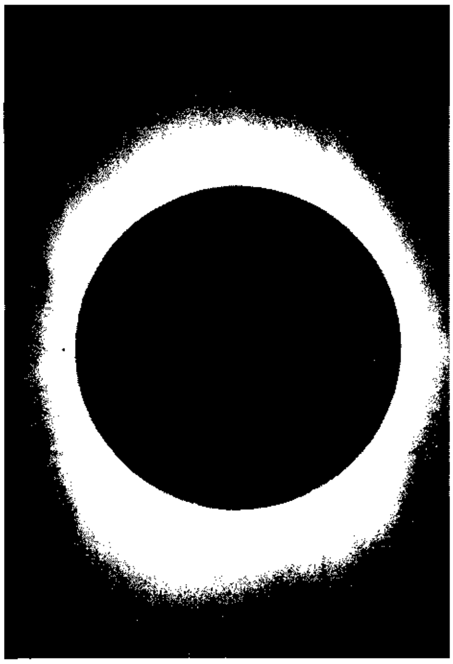
Date and time: 14.04 local time, 26 February

The appointment was very precise, because time, tide and total eclipses of the sun wait for no man.

But what does an eclipse have to do with neutrinos? The sun produces neutrinos in gigantic quantities - theory predicts 60 billion per sq cm per second at the earth's surface. The puzzle is that experimentalists only see a fraction of them.

The generally accepted interpretation is that the electron-type neutrinos generated in the sun oscillate, spontaneously changing

During a solar eclipse, solar neutrinos pass through the Moon but still have 370,000 km before they reach the Earth. If they have mass, they could decay to produce lighter neutrinos and photons, which would show up in the moon's shadow.



their 'flavour' before reaching the earth, where experiments are still expecting electron neutrinos.

The oscillation phenomenon is closely connected to the problem of neutrino mass, and the apparent shortfall in solar neutrinos suggests a link between the masses of the two oscillating neutrinos - the difference between the squared masses of the two neutrinos could be of the order10^{-5} eV^2.

The idea of neutrino mass is also interesting to cosmologists looking to explain part of the missing mass of the Universe ('dark matter') as being due to neutrinos with masses of a few electronvolts.

Thus neutrinos with different masses would help solve certain riddles. They also allow new phenomena: for example, one neutrino could decay into a lighter neutrino and a photon. And if neutrinos have a mass of a few electronvolts and the mass relation between the parent and daughter neutrino is the one supported by the solar shortfall, then the resultant photon should be visible.

The experiment therefore seems simple - detecting light from the sun. The sun sends some 10^{17} photons per sq cm per second, and under normal conditions a few extra would be hard to detect. So an eclipse - when the moon cuts off 8 orders of magnitude of direct sunlight - provides a great opportunity.

Though the moon absorbs photons, it lets through neutrinos, which have another 370,000 km to go before they reach the Earth and have a chance to decay. Any decay signal would consist of additional photons seeming to come from the centre of the Moon, but in fact due to neutrinos generated in the heart of the sun.

The Paraguana Peninsula consists of arid sand and cactus scrub, populated by wild asses and a few rattlesnakes. Against this stark backdrop the eclipse took on a beauty all of its own. For three magic minutes, photos were taken like the one shown. However a CCD telescope picked up no faint light at the centre of the sun's shadow. More refined analysis will allow a limit to be set for the possible disintegration of any neutrinos with mass.

From Francois Vannucci

Bookshelf

Ecrits de Francis Perrin, rassemblés par Jean Pierre Baton et Monique Neveu, CEA (Commissariat à l'énergie atomique) ISBN 22 7272 0191 5

Francis Perrin (1901-92), son of 1926 Nobel prizewinner Jean Perrin, was a major figurehead in French science over several decades and was very instrumental in building French support for CERN. In an introduction to this 724-page collection of Perrin's scientific work and other papers, High Commissioner for Atomic Energy Robert Dautray underlines Perrin's important role as a founding Commissioner for Atomic Energy from 1946 - 51 and as High Commissioner from 1951 - 70 when the Atomic Energy Commission contributed much to the postwar revival of French physics research.

Reflecting the interests of the man, the book is divided into two main parts - 'the man of science' and 'the public figure'. The former covers mathematical physics, with an

Francis Perrin (1901-92) was a driving force in the postwar revival of physics research in France. A new book (in French) collects together his major papers.

introduction by Marcel Froissart; molecular optics, introduced by Alain Aspect; nuclear physics, introduced by Louis Michel; and other areas, introduced by Jean Pierre Baton.

The 'public figure' portion covers areas in which Perrin played a vital role, particularly the development of scientific research in general and atomic energy in particular in France, and the creation and development of CERN. He was a member of the small band of French pioneers who in the late 40s first thought of a European laboratory, an idea which took root when it received UNESCO blessing in 1950. French delegate to initial CERN meetings of CERN Council, Perrin also served as the Council's vice-president in 1952. His signature appears for France on the 1953 Convention document which created CERN. After the formal creation of the organization, he remained as French delegate to CERN Council from 1955 - 72 and was a member of the Scientific Policy Committee from 1960 - 74. After the commissioning of CERN's first accelerators, he pushed strongly for an ambitious and continual development programme for the Laboratory, leading to ambitious new machines and ensuring that it remained in the forefront of the world scene, and with a strong French involvement.

A monumental book on a monumental figure.

People and things

Jacob's ladder

Official 'retirement' from CERN is not the end of Maurice Jacob's ladder. With a strong phenomenological flair focussing on topical issues, his scientific career has centred on major laboratories, particularly CERN, where his association has spanned 31 years, including a spell as head of Theory Division from 1982 - 89. Tireless campaigner in many research crusades, his energy, commitment and drive have also thrust him into key management and advisory roles, at CERN and elsewhere.

He has served as President of the French Physical Society in 1985 and as President of the European Physical Society from 1991 - 93. Maurice has also left his mark on scientific publishing, where he worked with leading North Holland/ Elsevier journals from 1968 - 85, a period during which these European journals reflected a shift of research fortunes eastwards across the Atlantic. His zeal and sense of purpose in these roles are vividly related in his book 'In the Wings of Physics', published by World Scientific.

A talented and enthusiastic presenter, orally and in writing, and in several languages, his culture and communications skills have been widely sought. Here the CERN Courier has been particularly fortunate. When CERN Research Director General Leon Van Hove set up the CERN Courier Advisory Panel in 1981, Maurice Jacob was its first Chairman. He showed an deep understanding of the objectives, and difficulties, of a journal published by CERN but aimed at a worldwide community.

He has continually ensured that the CERN Courier benefits from his wisdom and from intelligence gathered during his ambassadorial travels. Producing his compact camera wherever he goes, his lively photographs have considerably enriched our coverage of outside events.

Maurice Jacob - the CERN Courier's indefatigable 'man on the spot'.

The Jacobfest at CERN was prefaced by a talk by Maurice Jacob's longtime colleague Claude Cohen-Tannoudji of the Collège de France and École Normale Supérieure, who shared the 1997 Nobel Prize with Steven Chu of Stanford and William D. Phillips, of the US National Institute of Standards and Technology, for their development of methods to cool and trap atoms with laser light.

Enzo Iarocci of Rome's 'La Sapienza' succeeds CERN Director-General-designate Luciano Maiani as President of the Italian Istituto Nazionale di Fisica Nucleare (INFN).

Colleagues, students and friends of Ryugo S. Hayano gathered at the International House of Japan in Tokyo to celebrate his Inoue prize and to wish him well in his future research. Left to right: John Eades (CERN), Ryugo Hayano (Tokyo), Sumiko Horikoshi-Widmann, Eberhard Widmann (RIKEN), Haruhiko Outa (KEK) and Toshimitsu Yamazaki (Japan Society for the Promotion of Science).

New INFN Director

Enzo Iarocci of Rome's 'La Sapienza' has been appointed President of the Italian Istituto Nazionale di Fisica Nucleare (INFN), replacing Luciano Maiani, soon to become Director General of CERN. Well known for his development of the streamer tube detector technique, Iarocci was was Director of INFN's Frascati Laboratory from 1990 - 96. He chaired CERN's Detector Research and Deveopment Committee from 1990 - 93 and has been Chairman of the LHC Experiments Committee since 1995.

On people

Ryugo S. Hayano of Tokyo receives the coveted Inoue prize for his role in studies of sigma hypernuclei at the Japanese KEK Laboratory and metastable antiprotonic helium atoms at CERN's LEAR low energy antiproton ring. The Inoue foundation awards five such prizes each year for outstanding contributions to basic research in natural science by researchers under 50 years of age. As spokesman for the ASACUSA experiment (April, page 9) being prepared for CERN's Antiproton Decelerator, Ryu Hayano will continue to be a frequent visitor to CERN, as he was during the LEAR era.

ICTP Dirac Medal

Peter Goddard, Master of St. John's College, Cambridge, and David Olive, of the University of Wales, Swansea, received the prestigious 1997 Dirac Medal of the Abdus Salam International Centre for Theoretical Physics, Trieste, for their work on strings, monopoles and duality in the 1970s and 1980s which helped prepare the ground for the current theoretical physics superstring revolution. The Dirac Medal, first presented in 1985, recognizes outstanding contributions to the fields of theoretical physics and mathematics.

New Russian medal

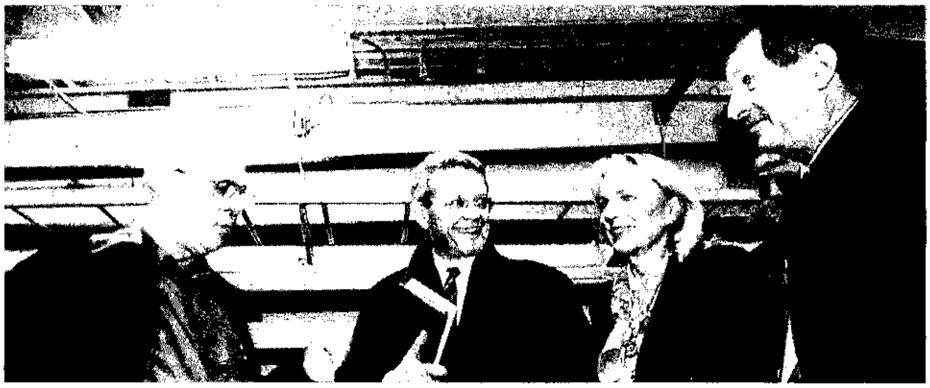
On 17 March, the Russian Academy of Sciences initiated a Gold Medal to commemorate the celebrated Russian physicist and mathematician Nikolai N. Bogoliubov, who from 1965-89 was Director of the Joint Institute for Nuclear Research (JINR), Dubna. The Academy's prestigious award will be presented for the first time in 1999, the 90th anniversary of Academician Bogoliubov's birth.

Major JINR meeting

A regular meeeting of the governing body of the Joint Institute for Nuclear Research (JINR) - the Committee of Plenipotentiaries (CP) of the Member States - took place in Dubna on 12-13 March. Based on the report presented by JINR Director Vladimir Kadyshevsky, the Committee considered the results of JINR's activity in 1997, the budget and research plans for 1998, and the scientific programme for the 1998-2000.

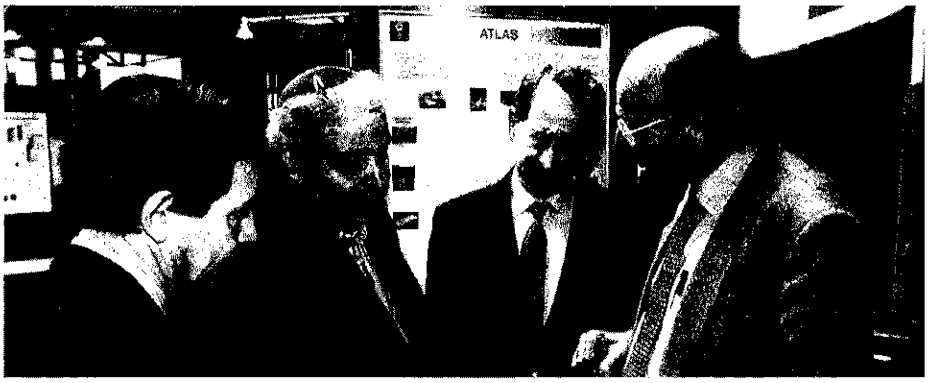
The CP approved the concept and plans of reforms for JINR submitted by the Director. Following the expiration of the mandate of the previous membership of the JINR Scientific Council, the CP approved a new list of Council members, composed of 44 persons, for a term of five years. The newly appointed Scientific Council includes delegates from JINR's 18 Member States and representatives of leading research centres in Brazil, France, Germany, Italy, and the USA. The new Council includes three CERN scientists: CMS spokesperson Michel Della Negra; senior research physicist Friedrich Dydak; and former CERN Director General Herwig Schopper.

Swiss Secretary of State Charles Kleiber (second from left) at CERN with (left to right) Hans Hofer and Felicitas Pauss of ETH Zurich and Maurice Bourquin of Geneva.



Meetings

The Fifth International WEIN'98 Symposium will be held in Santa Fe, New Mexico, USA from 14-19 June. WEIN'98 will focus on searches for physics beyond the Standard Model at low and intermediate energies, including theoretical studies in these areas. In addition, selected topics in the physics of the Standard Model will be included. Searches for new physics at high energy facilities, and topics in nuclear and particle astrophysics and in cosmology will also be discussed. WEIN'98 is an open conference. Further information at http://hana-mana.lanl.gov/wein/ or from WEIN98@LANL.GOV.



Mordechai Bishari, Director General, Israel Ministry of Science (second from left) at CERN with (left to right) Giora Mikenberg of the Weizmann Institute, Scientific Attache Michael Wolff and ATLAS spokesman Peter Jenni.

Under an agreement between CERN and the Spanish Centre for Industrial and Technological Development (CDTI), each year several young engineering graduates come to CERN for training in accelerator-based high technology. Left to right: CERN's Member State Affairs Coordinator Maurice Jacob, Isabel Bejar Alonso, Dolores Escalera Rodriguez, CERN's Fellows and Associates coordinator Jose Salicio Diez, Diego Camacho, Juan Ejea Marti, Maria Montserrat Pol Fraga, Maria del Pilar Lozano Bernal.

Love Boson

The Standard Model of Physics
has four forces in it:
the Strong, the Weak, Gravity
and the Electromagnetic.
But I've discovered a new force
that rules from high above.
Let me propose to you
a Unified Theory of Love!

Gluons are Strong!
They make a quantum-chromo glue
binding quarks into atoms
like I am bound to you.

Z's and W's are Weak!
They make particles decay
and atoms radioactive
that's how I feel when you're away.

Photons mediate E&M -
both particle and wave - they're so yin-yang!

Gravitons attract
both mass and energy
they make the world go round and round
that's what you do to me.

And so I'm searching for the boson
that mediates the force of Love!
But you can't measure it!
You can only feel it!

Pulling on the superstrings of your heart!
We should add it to the Standard Model Chart
the force that rules from high above
in a Unified Field Theory of Love!

Lynda Williams
'The Physics Chanteuse'
San Francisco State University
http://www.physics.sfsu.edu/~lwilliam

No Standard Model - Physics Chanteuse Lynda Williams

External correspondents

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Stanford Linear Accelerator Center, (USA)
M. Riordan

TRIUMF Laboratory, (Canada)
M. K. Craddock

Institute of Physics and Astronomy
Aarhus University

Post Doctoral Research Position

The Centre for CERN related Atomic and Nuclear Physics under the Danish Natural Science Research Council invites applications for a post doc position in experimental atomic physics. The position is open from September 1, 1998 for a 2 year period with the possibility of extension.

The successful applicant shall participate in an experimental program which aims to investigate the interaction between slow antiprotons and atoms. Phenomena such as energy loss, ionization and channelling will be studied. The program has as one long term goal the production and characterization of antihydrogen. The experiments will be designed and tested at Institute of Physics and Astronomy, Aarhus University, and will be carried out at the AD facility at CERN (Geneva) under the ASACUSA and ATHENA collaborations. The applicant shall work closely together with the members of the former PS194 and NA43 collaborations.

Applicants with experience in atomic collision experiments and/or experimental work at CERN will be preferred.

A PhD degree in experimental physics (or the equivalent) obtained within the past five years is a recommended pre-requisite. The salary depends on seniority as agreed between the Danish Ministry of Finance and the Confederation of Professional Unions.

Applications should include a curriculum vitae giving evidence on which the evaluation of the applicant's scientific qualifications can be based, a complete list of publications with an indication of those which the applicant selects as the most relevant for the application. The applicant must, upon request, submit further material required by the selection committee in its evaluation.

Applications (4 copies) including two letters of reference should be addressed to Faculty of Science, University of Aarhus, Ny Munkegade, Building 520, DK-8000 Aarhus C, Denmark, and marked 212/5-127. The deadline for the receipt of all application material is August 3, 1998.

For further information, contact Dr. Helge Knudsen, Institute of Physics and Astronomy, Aarhus University, DK-8000 Aarhus C, Denmark. Phone: (+45) 8942 3607, E-mail: hk@dfi.aau.dk . Information about the Institute can also be found at http://www.dfi.aau.dk

POSTDOCTORAL RESEARCH IN EXPERIMENTAL PARTICLE PHYSICS

University of California, Riverside

The Department of Physics invites applications for postdoctoral research positions in experimental particle physics. The appointed individuals are expected to participate in the on-going research projects of the group, which include the e^+e^- experiment OPAL at LEP and the CMS at LHC. Candidates, who are recent recipients of the Ph.D., should submit a resume and list of publications and arrange for three letters of recommendation to be sent to: **Professor Benjamin C. Shen, Department of Physics, University of California, Riverside, CA 92521, USA.** Review of applications will begin on May 15, 1998 and will continue until the position is filled. The University of California is an Equal Opportunity, Affirmative Action Employer.

COMPUTER FACILITY MANAGER

MIT

The Laboratory for Nuclear Science seeks an individual who possesses excellent organizational skills to ensure that quality computer support services are consistently delivered to meet the requirements of researchers, administrative staff, and the laboratory directorate.

Requirements: an advanced degree in MIS, CS, or technical field, preferably with a background in physics. Must have a minimum of five years of relevant experience, at least two of which must be managerial experience at a complex computing facility, preferably in an education and/or research environment. Must also possess excellent written and verbal communication and interpersonal skills. A full description of the position can be found at http://mitlns.mit.edu/~elsye/Jobs.html.

Interested candidates should submit a resume and cover letter referencing ***Job No. 98-0173R*** *to:* ***Kenneth Hewitt, MIT Personnel, PO Box 391229, Cambridge, MA 02139-0013.***

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

University of Copenhagen
Niels Bohr Institute for Astronomy, Physics and Geophysics
Associate Professorship in Experimental Particle Physics

A position as associate professor (lektor) in experimental particle physics at the Niels Bohr Institute for Astronomy, Physics and Geophysics (NBIfAFG) will be open from December 1, 1998.

The particle physics groups are located at the Niels Bohr Institute, a department of the NBIfAFG, and the experiments are performed at CERN, Geneva, Switzerland, and at DESY, Hamburg, Germany. The group at the NBI is involved in the LEP experiments ALEPH and DELPHI, in the ATLAS experiments planned for the coming Large Hadron Collider at CERN and at HERA-B at DESY.

The chosen candidate will be based in Copenhagen but is expected to take on a significant role in the building up of ATLAS and in HERA-B. The candidate must have documented experimental research at an international level and have documented abilities in the construction of complex experiments. It is expected that the appointed candidate will participate in the continuous dialogue with the theory groups and will contribute to the physics of the experiments.

The position also demands participation in university teaching programs at all levels. The chosen candidate must be able to teach undergraduate physics courses in Danish within two years from the appointment.

The position is tenured under a contract between the Confederation of Professional Associations and the Ministry of Finance. The requirement of documented research mentioned above is mandated by the current Ministerial Circular on Job Structure. The annual salary depends on seniority, and the scale ends at a yearly salary of DKK 338,300 after contribution to the pension scheme and including a seniority independent yearly increment of DKK 65,400. In case the applicant does not have sufficient teaching experience, the first 1 1/2 year will be a probational period.

Deadline for applications is June 15, 1998, at noon. This announcement is an extract of the full legal announcement. The latter must be followed and can be found on the Institute homepage: http://www.nbi.dk/NBIfAFG/ or obtained from the Institute Director, Professor Ole Hansen, Niels Bohr Institute for Astronomy, Physics and Geophysics, Blegdamsvej 17, DK-2100 Copenhagen Ø, Denmark (E-mail: oleh@nbi.dk).

DIRECTOR
Fermi National Accelerator Laboratory

The Fermilab Board of Overseers of Universities Research Association, Inc. (URA) has initiated a search for a new Director of the Fermi National Accelerator Laboratory in Batavia, Illinois. The position, for a term of five years, renewable, will be available July 1, 1999. The Search Committee welcomes applications and nominations for this position. It is recommended that such applications or nominations be accompanied by curriculum vitae and other information bearing on the candidates' qualifications for the Directorship. Relevant qualifications include scientific stature, leadership capability, and management skills. Communications should be sent as soon as possible, preferably before June 12, 1998, and should be addressed to:

Ezra Heitowit
Vice President
Universities Research Association, Inc.
Suite 400
1111 19th Street, N.W.
Washington, D.C. 20036
e-mail: search@ura.nw.dc.us

A consortium of eighty-seven major research universities, URA operates Fermilab under contract with the U.S. Department of Energy.

URA is an equal opportunity employer.

UNIVERSITY OF GENEVA

The Department of Nuclear and Particle Physics has an opening for a

Research Associate

The position is available for participation in the L3 experiment at LEP. Candidates must have a PhD degree in physics with appropriate experience in particle physics and be not more than 32 years of age. Responsibilities will include working with the charged track trigger of L3, analysis of L3 data, and teaching duties, in French, at the University. The position is available for a maximum period of 4 years. The closing date for applications is 15th June 1998.

Candidates should forward a curriculum vitae and the names of two referees to:

Prof. Maurice Bourquin
Département de physique nucléaire
et corpusculaire
24, quai Ernest-Ansermet
CH - 1211 Genève 4

DEUTSCHES ELEKTRONEN-SYNCHROTRON DESY

is offering a

Research position

in the field of Experimental High Energy Physics.

The ZEUS Group at DESY in collaboration with Hamburg University has an opening for a research position in experimental high energy physics.

The applicants are expected to participate actively in the research program of the ZEUS collaboration and coordinate in the fields of detector physics and physics analysis.

Applicants should have a Ph.D. in the area of experimental high energy physics and have worked several years in this field. Good experiences with modern particle detectors, especially silicon detectors and fast analogue readout electronics are required.

The salary is determined according to tariffs applicable for public service work.

Interested persons should send their application including a resume and the usual documents (curriculum vitae, list of publications) until 29 May 1998 to

DESY-Personalabteilung
Notkestraße, 85, D-22607 Hamburg
Code-name: Koop-Hamburg

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

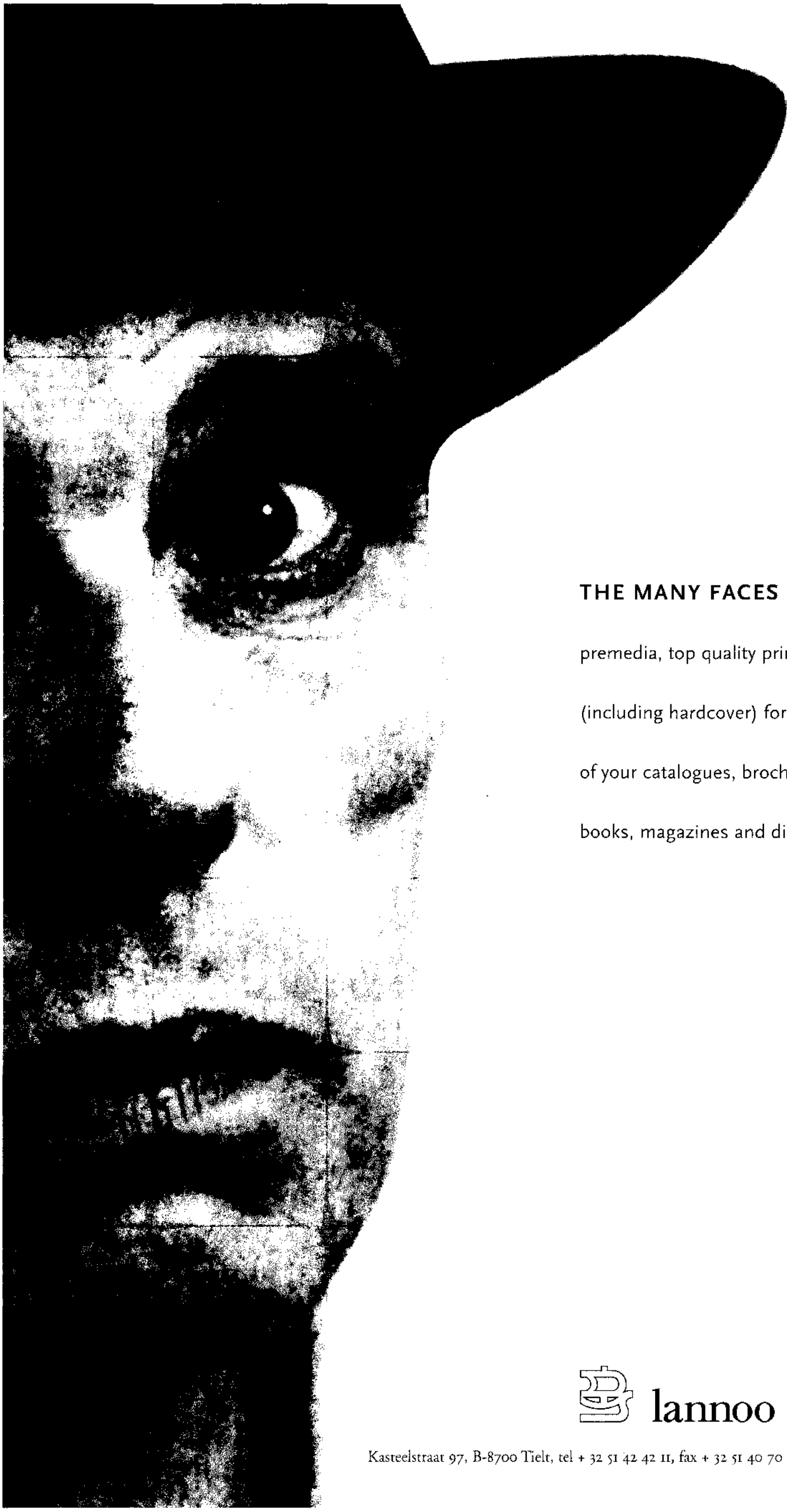
MICHIGAN STATE UNIVERSITY

Ion Source Physicist
National Superconducting Cyclotron Laboratory
Michigan State University

The National Superconducting Cyclotron Laboratory (NSCL) at Michigan State University is searching for outstanding applicants to fill the position of Group Leader for Ion Sources. The NSCL is funded by the National Science Foundation and Michigan State University for research in nuclear physics, accelerator physics, and related instrumentation R&D. The successful candidate will lead the ion source group, which is responsible for developing beams of highly charged positive ions for cyclotron injection, maintenance and operation of the present complement of electron cyclotron resonance (ECR) ion sources, design and construction of advanced ion sources, and research directed towards furthering the fundamental understanding of ECR ion sources. Requirements include a PhD in Physics or related area, or equivalent experience. Knowledge in the areas of space charge limited beam transport, low energy beam injection, and plasma physics are highly desirable.

Positions in the NSCL Continuing Appointment system parallel tenure system ranks at MSU. The position will be filled within the Continuing Appointment system at the level commensurate with the successful applicant's experience. Applicants should send a resume and have three letters of reference sent to **Ms. Chris Townsend, Laboratory Administrator, National Superconducting Cyclotron Laboratory, Michigan State University, East Lansing, MI 48824-1321** by June 15, 1998.

Michigan State University is an Affirmative Action/Equal Opportunity Institution



21st Century's TDCs

To meet the requirements of the next generation HEP Experiments, two leading European Physics Research Institutes have developed two ASIC
Multihit Time-to-Digital Converters
in VLSI technology.

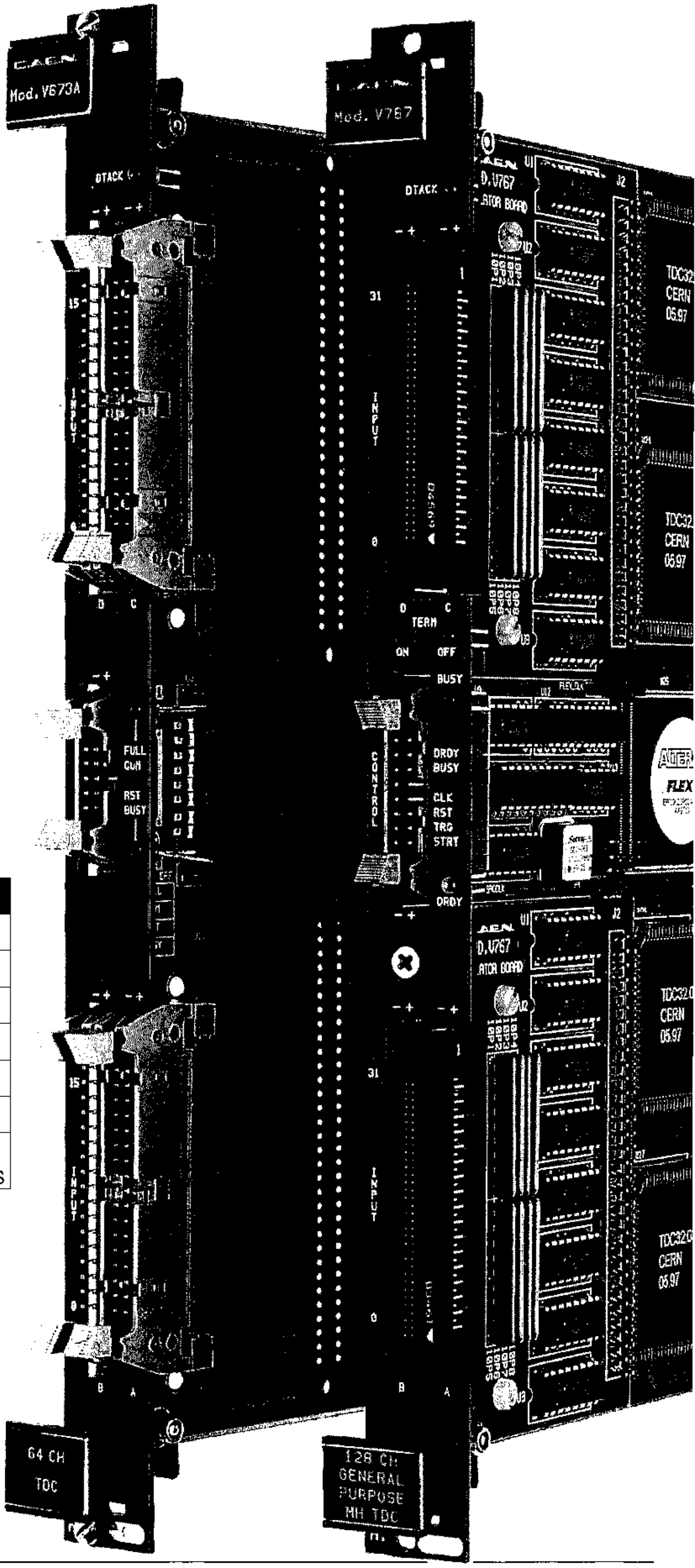
By integrating them in two single-width, 6U VME modules we have created two modular TDCs featuring an **unprecedented density** and the **lowest price per channel** achieved to this date.

They are available now to allow today's experiments to take advantage of **next century's' technology.**

Type*	V667	V673A	V767	V693
Width	1 slot	1 slot	1 slot	1 slot
Channels	64	64	128	128
Bits	21	16	20	16
LSB	780 psec**	1 nsec	780 psec**	1 nsec
DPR	10 nsec	5 nsec	10 nsec	5 nsec
Conv. Time	Nil	Nil	Nil	Nil
Output Buffer	2KWords	4 events 6KWords	32KWords	4 events 12KWords

*VME 6U Units ** 520 psec with speed graded ICs and 60 MHz Clock

The V667 and V767 are based on an IC developed at CERN by the ECP-MIC Group
The V673A and V693 are based on an IC developed for the KLOE experiment by INFN-Roma



UNI EN ISO 9001
CERTIFICATE N° 9105.CAEN

C.A.E.N.

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Iscritta all'Albo dei Laboratori di ricerca (Decr. Min. 25/3/90)

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