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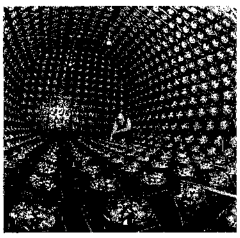

Cover photograph: The inside of the LSND detector at the Los Alamos Meson Physics facility (LAMPF), designed to search for neutrino oscillations with high sensitivity and to measure the strange quark contribution to the proton spin in neutrino-proton elastic scattering. The tank is covered by 1220 8" phototubes and will be filled with 200 t of dilute liquid scintillator. The white spheres hanging from the top of the tank are filled with LUDOX and will disperse pulsed laser light for time and pulse-height calibration.

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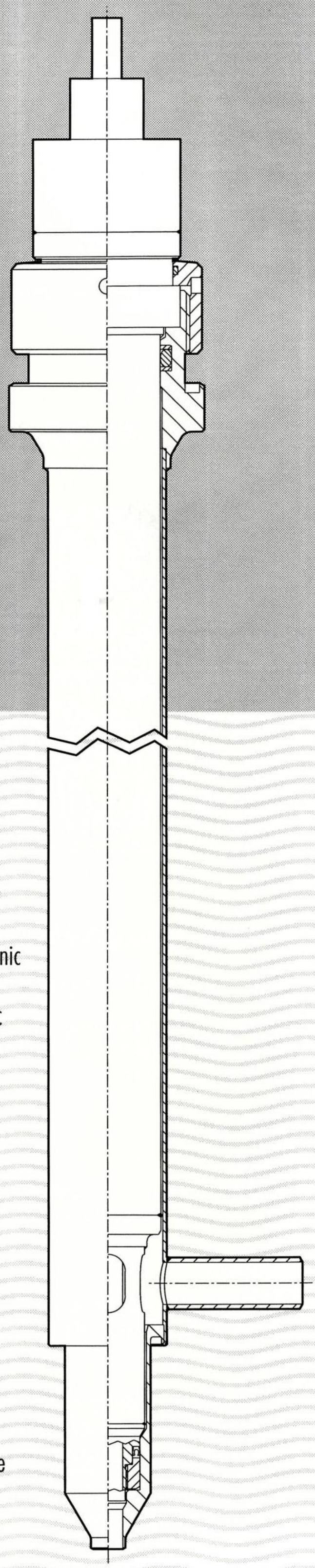

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ICFA on international collaboration

At the recent ICFA 'Future perspectives' workshop at DESY, Hamburg, international collaboration was highlighted in a memorable panel discussion. Participating were, left to right, ECFA Chairman Gunter Flügge (Aachen), B. Richter (SLAC), V. Soergel (ex-DESY, Chairman), A. Skrinsky (Novosibirsk), HEPAP chairman Stan Wojcicki (Stanford), and S. Yamada (Tokyo).

International collaboration in high energy physics is what ICFA - the International Committee for Future Accelerators - is all about. Progress is highlighted every three years when ICFA convenes its 'Future Perspectives in High Energy Physics' seminar to focus attention on major issues and to identify evolving trends.

The latest such seminar, held at the DESY Laboratory in Hamburg from 3-7 May, looked at international cooperation in the construction of major facilities. Status reports across the whole range of existing experimental programmes and ongoing plans gave valuable pointers to future needs. For electron-positron linear colliders (EPLC), research and development work towards the next generation of machines is underway in Laboratories throughout the world.

At previous such seminars, at Tsukuba, Japan (1984), Brookhaven, USA (1987) and Protvino (1990), ICFA, which has no direct power, could sometimes only stand on the sidelines and comment on the emergence of major new national plans. The lessons learnt, ICFA is keen to make sure that the EPLC debut on the world stage will be better choreographed.

In addition to plans for new major experimental facilities, the Hamburg seminar also provided a valuable snapshot of the current scene and the directions in which ongoing research is poised to take. This covered existing facilities and projects, 'factories' to mass-produce specific particles, fixed target studies and non-accelerator experiments as well as the key EPLC development theme. B-physics, the study of particles containing the fifth, or 'beauty' (b) quark, emerged as an important thread running across several machine scenarios.

Culmination of the Hamburg meeting was the endorsement by ICFA of a tripartite memorandum of understanding between DESY in Germany, KEK in Japan, and Stanford (SLAC) in the US, on the research and development work for an EPLC to attain collision energies in the 300-400 GeV range, and a luminosity of 10^{33} per sq cm per s. The consensus view is that 'at most one' such machine should be built. Although the explicit agreement examined by ICFA initially includes only three Laboratories, progress towards these colliders is pushing ahead on a much wider front, and other signatories are welcome.

Elsewhere, ICFA has set up a new group under Hans Hoffmann of CERN to examine the practical applications and spinoff of high energy physics. This group complements the existing list of special ICFA panels covering instrumentation, superconductivity and cryogenics, beam dynamics and accelerator technology.

International collaboration was highlighted in a memorable panel discussion. Participating were the members of a special ICFA subgroup - B. Richter from SLAC, A. Skrinsky from Novosibirsk, S. Yamada from Tokyo, and V. Soergel (ex-DESY, Chairman), - complemented for the occasion by HEPAP chairman Stan Wojcicki (Stanford) and ECFA Chairman Gunter Flügge (Aachen).

Soergel set out ICFA's 'league table' of project access - a first stage of national or regional facilities operated by a single host nation; a second stage with major international involvement, as exemplified by the HERA electron-proton collider at DESY; a third stage with several nations sharing the outlay, such as the JET fusion project in Europe, but with no explicit high energy accelerator example so far (although this is the attack used for major collider detectors); and the fourth stage of facilities managed by an international organization like CERN. An immediate aim, said Soergel, is to decide at which of these levels to pitch the ongoing EPLC effort.

Burt Richter surveyed ICFA's dismal track record so far of international collaboration for new machines and looked forward to this collaboration really getting off the ground for EPLC.

Gunther Flügge of ECFA (European Committee for Future Accelerators) pointed to ECFA's successful role in coordinating and furthering major new projects in Europe, where both LEP at CERN and HERA at DESY benefited. For Europe, ECFA's current preoccupation is the LHC collider for CERN's LEP tunnel.

Stan Wojcicki thought the world community to be 'overextended' and recommended involving existing laboratories rather than building new ones. Skrinsky stressed the plight of Russia and other ex-USSR countries, while Yamada thought it too early to 'fix' things with too many avenues still to be explored.

A lofty tone for the workshop came from Lev Okun's introductory 'perspectives' talk. The prime problem is the higgs sector, Okun declared. (He thought it was also time to drop the capital 'H'.) Without the higgs, many fundamental problems of current theory remain a mystery. 'Discovery of the higgs will give insight into one of the most simple yet most complex objects - the vacuum,' he continued.

In the days of the cold war, high energy physics was often a spearhead for new collaboration across political boundaries. 'Now, with the cold war over, more governments ... reverse the nuclear arms race. It would be tragic if high energy physics progress would be sacrificed under the pretext of more urgent needs,' Okun proclaimed.

Leading up to these conclusions, Okun emphasized that the precision electroweak numbers from LEP are still almost devoid of radiative corrections. 'How can it be,' he asked rhetorically, 'that unobserved radiative corrections nevertheless give strong limits on the mass of the (unseen) top quark?' Contributions from top and other virtual particles tend to cancel, he explained.

The workshop then came down to earth for a series of status reports on all major ongoing facilities and projects, including a whole day devoted to EPLC, with contributions from SLAC, CERN, Protvino/ Novosibirsk, KEK, DESY and the widely-supported superconducting TESLA collaboration. A matrix of major collaborations spans several different approaches, including TESLA.

(Interesting and profitable as these status reports were, this ground was retrodden at the May Washington Particle Accelerator Conference. A full report will feature in our next issue.)

Emerging at the Hamburg workshop as a common theme across several experimental routes is B physics (June, page 16). After the door to this research was opened at Fermilab in 1977, a trail was blazed by a range of experiments in the 1980s, with the arrival on the scene of LEP in 1989 providing a valuable boost. The CESR ring at Cornell is making progress (June, page 1) and will continue, but to write a new chapter of B physics needs a lot more particles.

Plans for purpose-built B factories have been tabled by SLAC, Cornell, Novosibirsk and KEK, using existing infrastructure from the PEP, CESR, VEPP and TRISTAN electron-positron rings respectively.

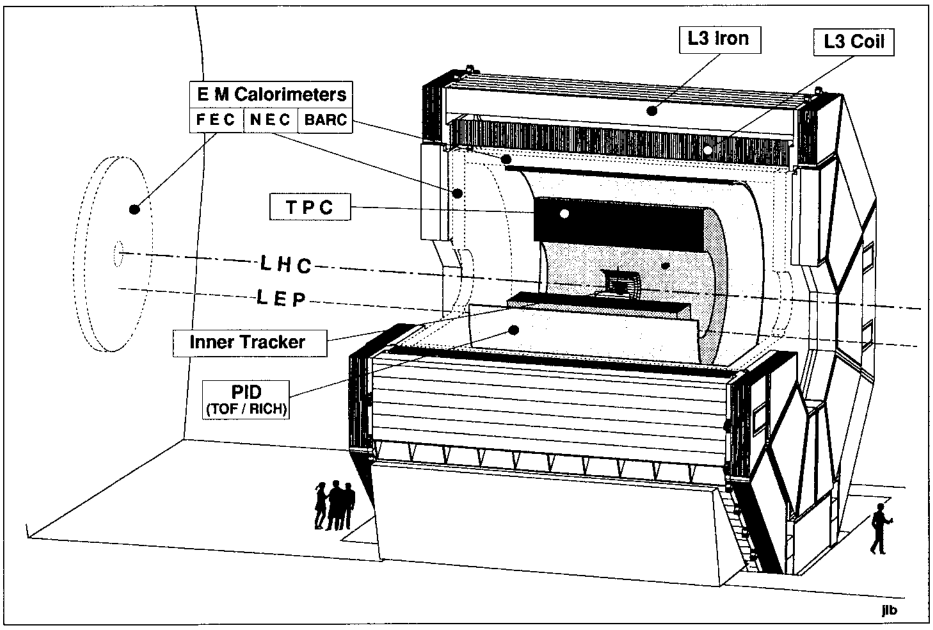
But B particles will also be manufactured in large numbers at existing proton machines as the performance of Fermilab's Tevatron and DESY's HERA proton ring is cranked higher. With many B achievements to their credit, the Argus collaboration at DESY's small DORIS electron-positron ring has stopped data-taking, and members are looking at the possibility of new studies at HERA.

LHC at CERN and the SSC in the US will open additional hadronic doors to B production, and the LHC Experiments Committee at CERN is currently looking at initial ideas for experiments. In the US, a special Fermilab-SSC Snowmass summer workshop is looking at B physics possibilities.

Concluding the Hamburg meeting, ICFA Chairman and Fermilab Director John Peoples underlined the value of addressing scientifically and politically controversial issues. Describing ICFA as a 'facilitator' towards world research, he maintained that ICFA is indeed facilitating.

Around the Laboratories

The proposed ALICE detector to study heavy ion collisions in the LHC ring to be built in CERN's 27-kilometre LEP tunnel.



CERN
ALICE in the looking-glass

While proton-proton collisions will provide the main research thrust at CERN's planned LHC high energy collider to be built in the LEP tunnel, its 27-kilometre superconducting magnet ring will also be able to handle all the other high energy beams on the CERN menu, opening up the possibility of both heavy ion and electron-proton collisions to augment the LHC research programme.

A major new character in the LHC cast - ALICE (A Large Ion Collider Experiment) - has recently published a letter of intent, announcing its intention to appear on the LHC stage.

Three letters of intent for major LHC proton-proton experiments were aired last year (January, page 6), and ALICE, if approved, would cohabit with the final solution for the proton-proton sector (see box).

Only a single major heavy ion experiment is envisaged. The proton-proton detectors have some heavy ion capability, but could only look at some very specific signals.

(Detailed plans for LHC's electron-proton collision option are on hold, awaiting the initial exploration of this field by the new HERA collider which came into operation last year at the DESY Laboratory in Hamburg.)

Describing the ALICE detector and its research aims, spokesman Jurgen Schukraft echoes T.D.Lee's observations on the state of particle physics. It is becoming increasingly clear that resolving some of today's particle puzzles require a deeper understanding of the vacuum. Rather than being an empty void, the vacuum is full of all virtual processes allowed by the Uncertainty Principle - mechanisms funded by borrowed energy, and subsequently paid back in full.

Rather than pumping in more and more energy to pinpoint finer structures, Lee advocates probing this rich vacuum by another approach - investigating bulk phenomena by smearing out high energy over an extended volume. This is where heavy ion physics comes in.

Current high energy heavy ion physics at CERN's SPS synchrotron and the future programme at Brookhaven's RHIC collider aim to see signs of quarks breaking loose from their proton and neutron confinements to form the long-awaited 'quark-gluon plasma'. This new state of matter for the laboratory would recreate conditions a fraction of a millisecond after the Big Bang.

Even if ongoing experiments see initial signs of this plasma, LHC heavy ion studies would be poised to study the plasma under better conditions. 'At these very high matter and energy densities, something is bound to happen!', say the LHC heavy ion experimenters confidently.

A particular requirement for heavy ion physics is having to deal with the thousands of secondary particles produced. In addition, quark-gluon plasma is expected to announce itself in subtle ways, through new thresholds, for example in J/psi or upsilon production.

The ALICE configuration would be offset from the beam axis to optimize size and cost. The existing magnet from the L3 experiment at the LEP electron-positron collider in its location at LEP/LHC Intersection 2 is high on ALICE's want list, but an alternative solenoid design has been tabled. As well as the L3 magnet, the BGO electromagnetic calorimeter and some of its muon chambers could also be taken over.

Secondary particles would be picked up on an event-by-event basis. For inner tracking a range of possible ALICE technology is under study, silicon pixels close to the beam pipe, augmented further out by silicon drift chambers, silicon strips and/or microstrip gas chambers.

Beyond the inner tracker would be a Time Projection Chamber for additional tracking and momentum measurement and time-of-flight or ring-imaging Cerenkov counters for particle identification. All this would be contained in the ALICE central barrel, with single arm electromagnetic calorimetry outside and supplemented by forward-backward detectors very close to the beam direction.

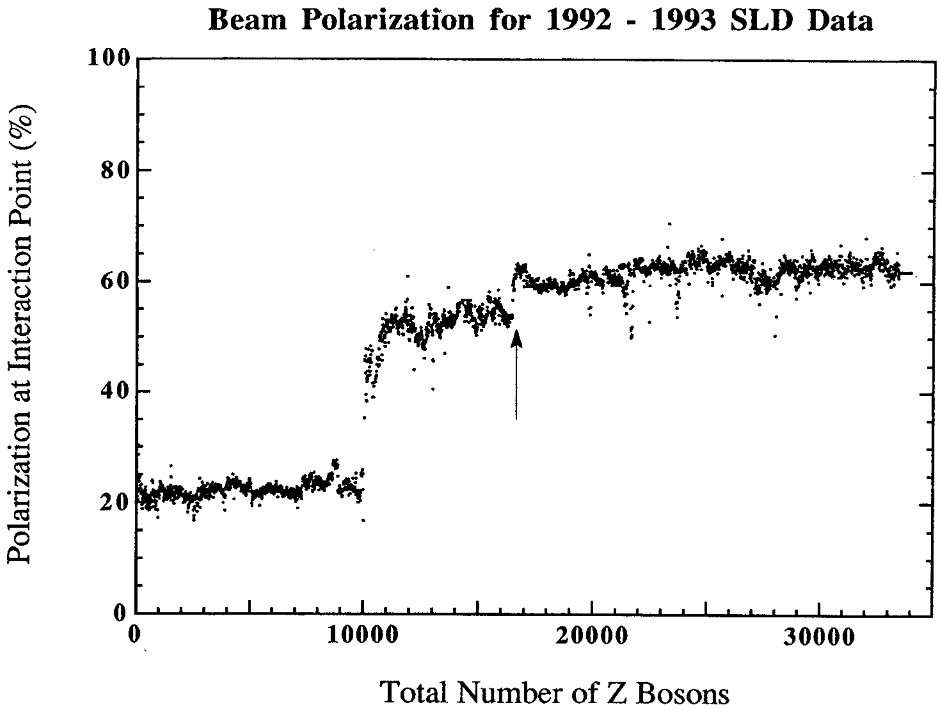
A full programme of ALICE detector component development work geared to the special requirements of heavy ion physics is underway.

Heavy ion physics and ALICE will add a third dimension to LHC physics, with main proton-proton studies attacking the high energy frontier and secondary proton studies looking at the high precision frontier of particles containing heavy quarks.

LHC proton-proton experiments

Last year, three letters of intent - ATLAS, CMS and L3P - were submitted for major detectors to study proton-proton collisions in the LHC ring to be built in CERN's 27-kilometre LEP tunnel. After discussions in the LHC Experiments Committee and CERN's Research Board, the ongoing decision is that the main thrust of the LHC proton-proton programme should be based on two core designs, ATLAS and CMS. In view of the tight funding, further optimization of the two designs is expected to make the two detectors more complementary.

Now using 'strained' semiconductors, 1993 polarization levels at the Stanford SLC linear collider are considerably up on those of 1992. The arrow shows when the wavelength of the laser beam illuminating the photocathode was increased from 853 to 865 nanometres.



STANFORD
Highly polarized SLC electron beams

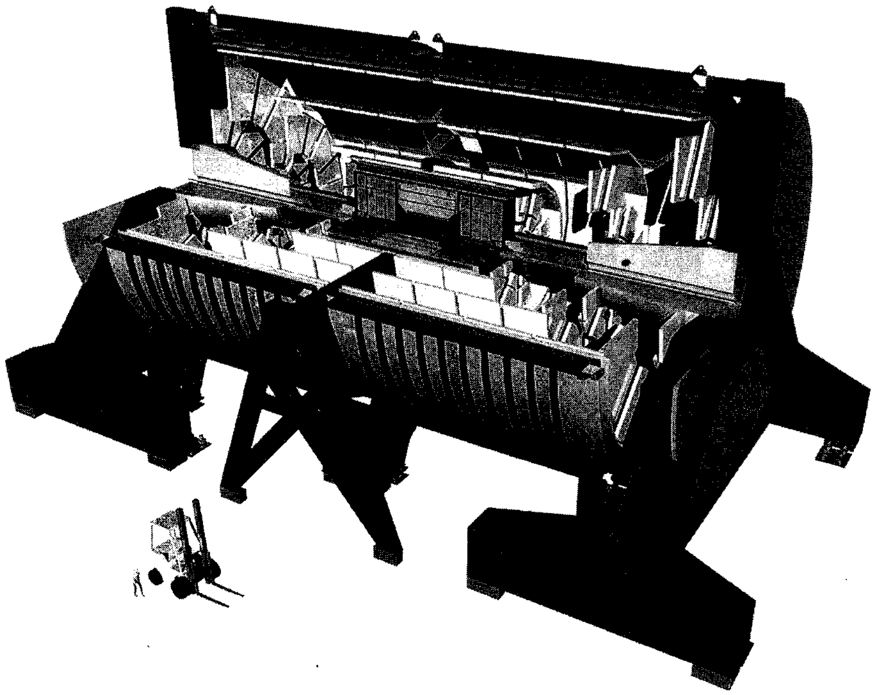
Using specialized photocathodes made with 'strained' gallium arsenide, physicists at the Stanford Linear Accelerator Center (SLAC) have generated electron beams with polarizations in excess of 60 percent a year ahead of schedule. Together with recent luminosity increases, this breakthrough will have a major impact on the physics output of the Stanford Linear Collider (SLC).

Beam polarization was almost tripled using photocathodes in which a gallium arsenide layer was grown epitaxially over a substrate of gallium arsenide phosphide. The mismatch between these two layers deforms the crystal structure and removes a degeneracy in the valence band structure, permitting selective optical pumping of one unique spin state. Whereas conventional gallium arsenide photocathodes are limited to 50 percent polarization because of this degeneracy (and realistic cathodes fall substantially below this theoretical limit), such strained crystal lattices have the potential to yield polarizations close to 100 percent.

Polarization enhancement with strained lattices was first demonstrated in 1991 by a SLAC/Wisconsin/Berkeley group (May 1991, page 6) with a 71 percent polarization in a laboratory experiment. More recently this group has achieved polarization in excess of 90 percent, reported last November at the Nagoya Spin Symposium. (In a complementary development, a Japanese KEK/Nagoya/KEK obtains polarized beams using a 'superlattice' - May 1991, page 4.)

The 1993 SLC run, the strained gallium arsenide photocathode technique's debut in an operating

The GEM detector: jewel of the SSC.



particle accelerator, has proved to be a resounding, unqualified success - as have physics experiments on the Z particles produced by the highly polarized beam.

A conservative approach was called for, due to concerns about possible charge saturation effects. A relatively thick (0.3 micron) gallium arsenide layer was used for the photocathode in the SLC polarized electron source. With a titanium-sapphire laser operating at 865 nanometres shining on this photocathode, electron beam polarization has exceeded 75 percent at the source and has reached 65 percent at the SLC interaction point. Most of the loss occurs as the electron beam traverses the north SLC arc. Still higher polarization levels are expected using presently available cathodes, which will soon be tested under actual operating conditions.

This marked increase in polarization and a recent doubling of the SLC luminosity are together having a dramatic effect on the collider's physics potential. Because the figure of merit for the accuracy of certain key measurements - e.g. the weak mixing angle - is proportional to the polarization, the SLD collaboration can look forward to major improvements over the 1992 results. A banner SLC year is anticipated.

SUPERCOLLIDER A GEM of a detector

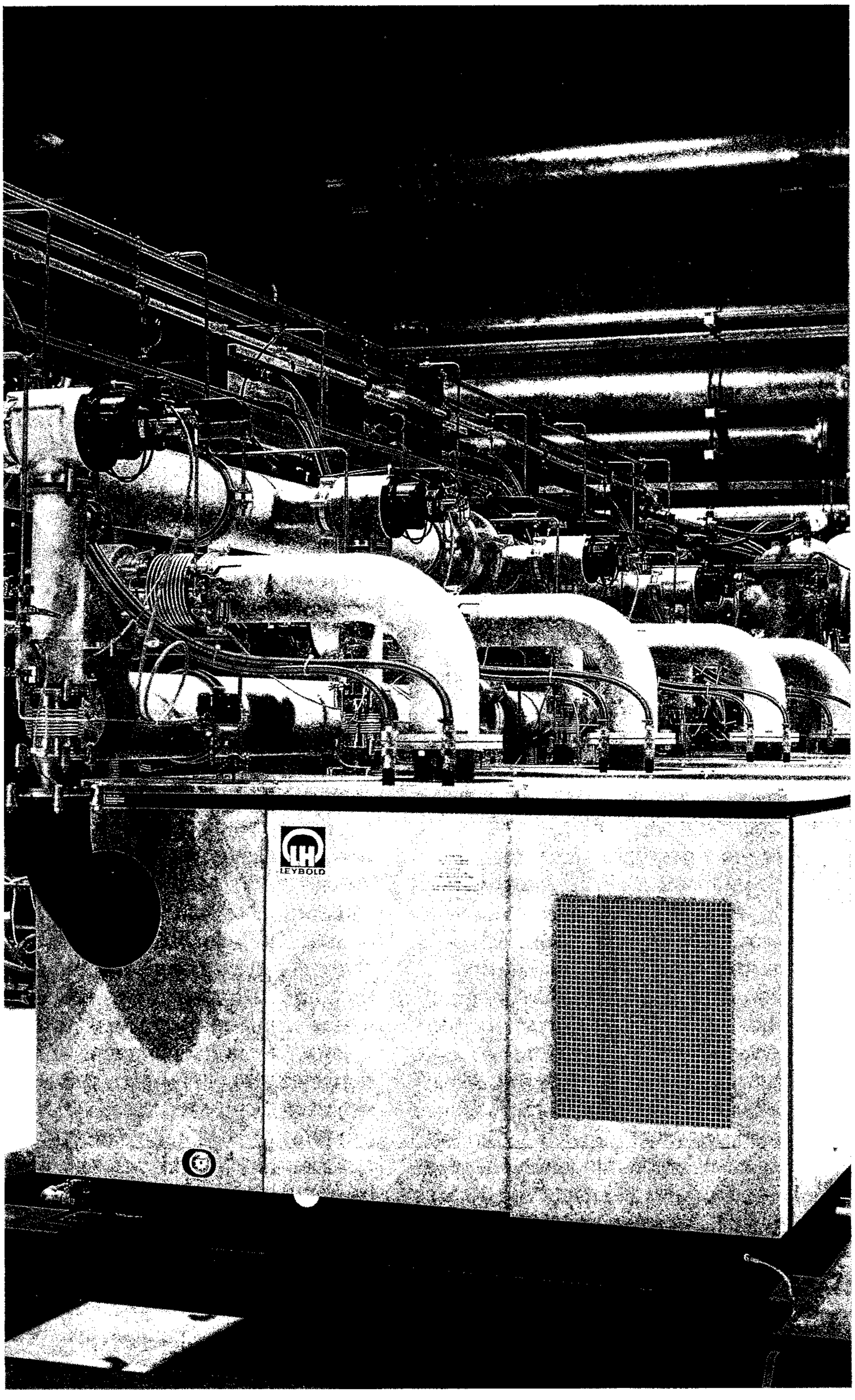
Now being prepared as a major experimental facility for the 87-kilometre Superconducting Supercollider (SSC) being built in Ellis County, Texas, is the GEM detector project. GEM thus becomes the companion to the Solenoidal Detector Collaboration (SDC), the first major SSC detector to emerge (March 1992, page 13). This is in keeping with the SSC Laboratory's aim of two major detectors with overlapping and complementary strengths.

GEM is designed to observe all SSC signatures, with emphasis on precise measurement of electrons, photons and muons. Hence the name GEM - "Gammas, Electrons and Muons." Design goals are clean signatures for leptons, jets, and missing transverse energy, maximum sensitivity to narrow resonances, and low backgrounds. Also important is maintaining significant capability at high luminosity (10^{34} $cm^{-2}s^{-1}$).

GEM has some distinctive features. A key concept is the exterior magnet, surrounding all detector elements. Inside the magnet are a muon tracking system, a precision calorimeter, and a compact central tracker. This allows the muon momentum to be measured the air of the radiation-shielded area outside the thick calorimeter, giving both high precision and robustness at high luminosity.

A large magnet gives a large lever arm (at least 4 m) for precise muon momentum measurement. Placing the magnet outside also minimizes the material between tracker and calorimeters, so that the calorimeters are limited only by their inherent resolutions.

Interpolating cathode strip chambers (CSCs) have been chosen for muon tracking. These are multiwire proportional chambers in which an ionizing particle's position is given by the charge induced on a segmented strip cathode, rather than by reading out the anode wires. CSCs offer the full functionality of the muon system - precise measurement of the bend coordinate, fast inputs to the momentum trigger, and timing to tag the beam bunch crossing - in a single device. The momentum of a 500-GeV/c muon will be measured to



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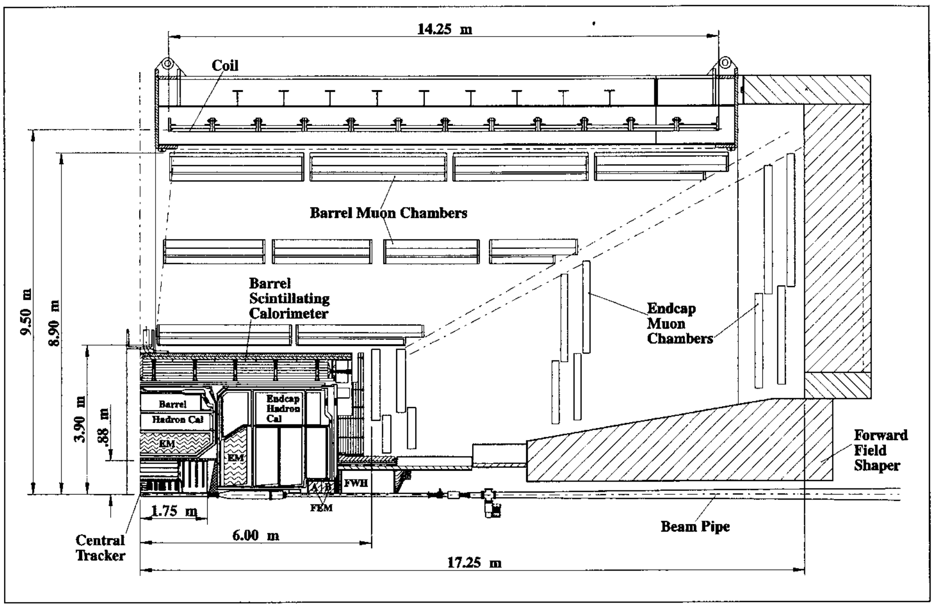
A quadrant of the GEM detector.



between 5 and 13%, depending on angle. This requires a track error below 55 microns, and the alignment of three superlayers of CSCs to 25 microns. An optical system will dynamically measure and correct deviations.

Because the system can measure muons without relying on the central tracker, high resolution muon measurements will be available even at maximum luminosities, providing one of GEM's "complementary" strengths.

Photons and electrons will be accurately measured by a state-of-the-art electromagnetic calorimeter using a noble liquid sampling calorimeter with an accordion plate structure. Using a thin (1 mm) lead absorber and a dense sampling medium (liquid krypton) in the barrel should achieve an energy resolution of $6\%/\sqrt{E} + 0.4\%$. Liquid argon will give $7.5\%/\sqrt{E} + 0.4\%$ in the endcaps, where the average energy of emitted particles is higher. For a high energy particle, the calorimeter will measure the shower energy to better than 1%, while determining its position to about 1 mm. Three-fold longitudinal segmentation allows good angular resolution of the shower direction, fixing the production vertex to about 5 mm. Measuring a photon's direction as well as its energy gives photon pair masses without an independent determination of the vertex. This is important for rejection of two-photon and neutral pion backgrounds and will make for robustness at high luminosities.

Precise photon measurement could find a Higgs particle between 80 to 140 GeV, where only its decay into two photons has reasonable signal to background ratio. With high resolution, GEM hopes to strongly suppress the large background of quark-produced photon pairs in the two-photon channel, as well as jets imitating single photons by fragmenting into neutral pions. This channel is considered to be one of the complementary strengths of the detector.

With a Higgs between 140 GeV and 180 GeV, precise energy measurement of electrons will play a vital role in the search for its decay into four charged leptons, two leptons plus two jets, or two leptons plus missing energy. The background is more favourable in this case, but the rate is low. Precise electron energy measurement will also be useful in other particle searches.

Although GEM hadronic calorimetry is slightly downplayed because of the inherent limitations of jet definition, it is still important. The hadron calorimeter helps identify electrons and photons, and measure jets and missing energy.

The first part of the hadronic shower is measured in the liquid calorimeter, so that massive supports, services, and feedthroughs can be put out of the way. The remainder is measured in a relatively simple scintillator calorimeter in the barrel region, where ensuring an adequate lever arm for muon measurement calls for minimizing the calorimeter's outer radius. The scintillator calorimeter improves jet energy resolution and missing transverse energy measurements. Both hadronic sections also aid in identifying muons and measuring any muon energy loss in the absorber.

At forward angles, an extremely radiation-hard electromagnetic and hadronic calorimeter system extends the coverage for missing transverse energy measurements, detects and measures jets, and shields the muon system. The electromagnetic section uses a novel configuration in which a quartz fibre spirals around a copper cylinder inside a copper sleeve, with liquid argon in the gap. The geometry avoids the problem of positive ion buildup, even at high luminosities. The hadronic section uses liquid scintillator flowing through capillaries in a tungsten absorber. The heavy absorber is used to limit the lateral

SSC underground

By late April, 12 shafts for the SSC Superconducting Supercollider had been sunk to tunnel depth, with four more under construction. Completed shafts include two for magnet delivery, three utility shafts, three for personnel, and four for ventilation, all in the ring's north arc.

Approximately 21,000 ft (6.4 km or 4.0 miles) of tunnel had been bored. Best daily rate of tunneling was 384 ft. Approximately 70% of the 87-kilometre Collider tunnel is so far under contract, and favourable bids for remaining portions have been received.

extent of hadronic showers, because the energy flow direction, rather than the magnitude, is the limiting measurement.

Inside the electromagnetic calorimeter is a compact tracker, 1.8 m in diameter by 3.5 m long, to distinguish different "pileup" events in the same beam crossing by finding the primary vertex; to help identify electrons, gammas, muons, and hadrons; to help reject background; and to determine the electron sign up to 600 GeV/c. The inner section has silicon microstrip ladders and discs (3.5 million strips covering seven sq m). The outer part employs interpolating pad chambers (IPCs). The silicon is designed to operate for 10 years at a luminosity of 10^{33}; the IPCs, for 10 years at 10^{34}. The pad tracker provides space points to help tracking capability at very high collision rates. Relatively few tracks curl up inside the relatively small tracker, simplifying pattern recognition .

Muon momentum resolution requirements fixed the parameters of the superconducting magnet - an 0.8-tesla solenoid, 31 m long with a free bore of 18 m. Too large to install in one piece, the magnet will be assembled in situ from two halves, which can be moved apart for access to other components. Support structures, cables, and services go in a 1.5-m gap. On the axis, cone-shaped iron field shapers bend the field lines to improve forward muon momentum resolution. No flux return is provided; components operating in the fringe field will be shielded as necessary. The operating current, 50 kA, is less than a quarter of the critical current, and the temperature margin is 3.4K; thus quenches should be rare.

A magnet with iron only at the ends of the solenoid is relatively light, saving installation time and cost. Omitting a flux return also leaves a useful region outside the coil for future additional tracking.

Data acquisition uses a multi-level trigger with buffering between levels. The first level selects interesting events using simple requirements on calorimeter energy and muon chamber hits. During this 2-microsecond delay, data from each subsystem are stored in digital or analog pipelines. After an event is accepted, the data from all systems are digitized/processed for the second and third level trigger algorithms. Higher level trigger processing has access to all data from the detector, with full granularity, in a microprocessor "ranch" (this being Texas).

The collaboration includes 1010 physicists from 114 institutions in 17 countries. The technical design report was submitted on April 30, and will be reviewed in depth by the SSC Laboratory and the US Department of Energy. If approved, the detector will be located at the IR-5 site on the east side of the ring; site preparations are underway and the underground hall design is progressing rapidly. Because magnet installation paces the GEM schedule, the magnet design, cost, and schedule have received early review, and the prime contractor will soon be selected.

DUBNA Nuclotron

The Nuclotron, the first superconducting accelerator for high energy nuclei, now in operation at the High Energy Laboratory of the Joint Institute for Nuclear Research, Dubna, near Moscow, will provide beams of relativistic nuclei and heavy ions with energies up to 6 GeV per nucleon.

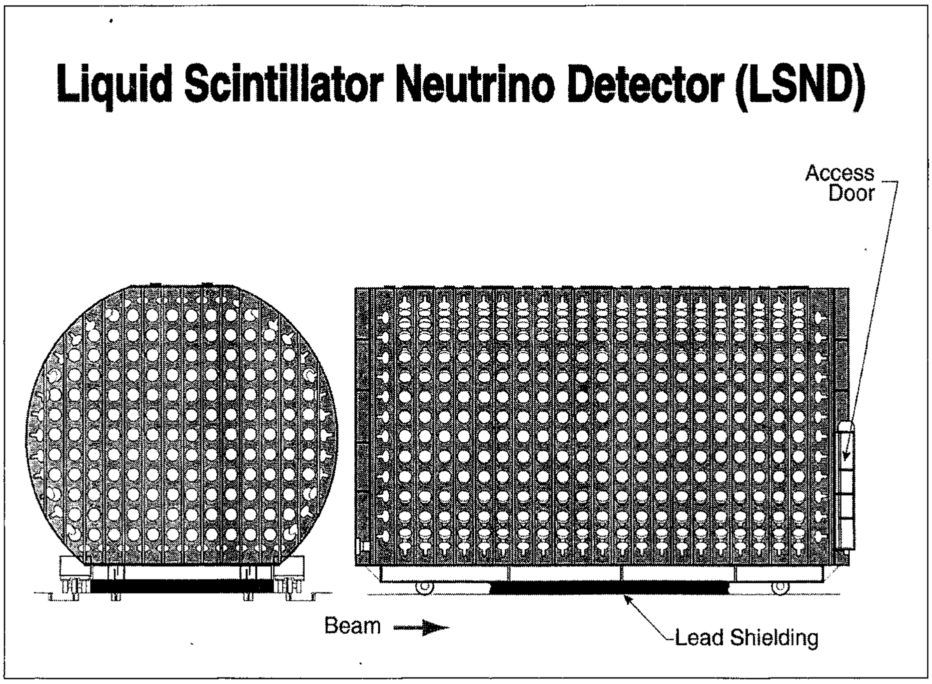
The planned wide research programme will have a major impact on the study of the features of atomic nuclei beyond the proton-neutron nuclear model and the development of the understanding of nuclear matter in terms of quarks and gluons. This work began back in 1971 when beams of relativistic deuterons were provided by the Dubna Synchrophasotron.

The 251-metre, 80-ton Nuclotron ring contains 96 dipoles and 64 quadrupoles cooled by two-phase helium. The cryogenic complex includes three KGU-1600/4,5 liquifiers producing 500 litres per hour. At the end of last year, the ring, assembled in the Synchrophasotron technological tunnel, passed vacuum tests. Cooling began on 17 March and took 100 hours to reach 4.5K in all elements, with vacuum in the beam pipe at 10^{-9}-10^{-10} torr. Cryogenic reliability was more than 98%, and it is hoped that cooling time will eventually be halved.

Magnets were fed by a 90A direct current. A 5 MeV/nucleon deuteron beam was injected and first full turns were achieved on 26 March. The high frequency accelerating system was tested for 12 hours under 8kV at 0.6 MHz.

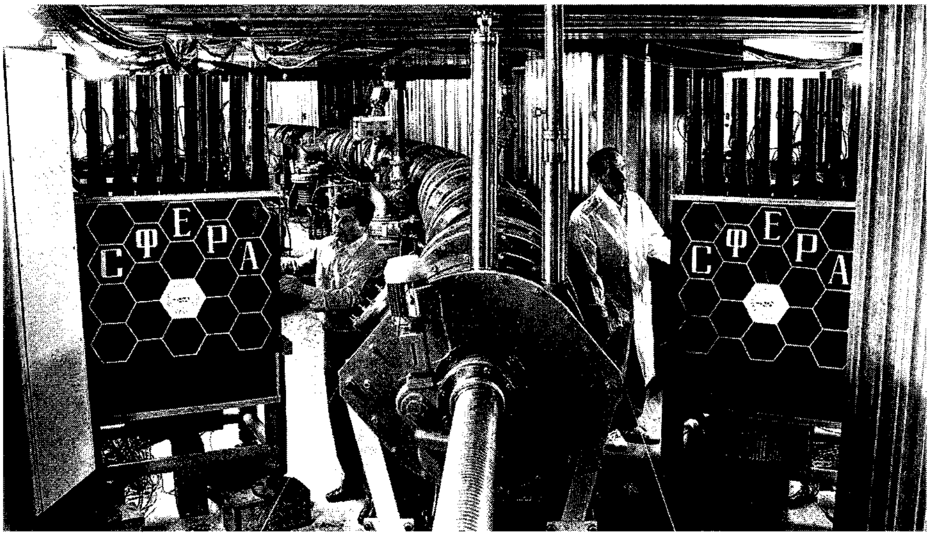
The next stage is a run at 1.5kA with limited beam acceleration and irradiation of internal targets. 2000 hours are scheduled this year for Nuclotron commissioning. Meanwhile slow extraction system assembly continues, en route to installation in the ring next year.

The commissioning of this pioneer machine is a major scientific and technological achievement for the Laboratory and carries an important message for the development of research capabilities in JINR countries.



(Above) Schematic of the LSND detector at LAMPF, Los Alamos, designed to search for neutrino oscillations with high sensitivity and to measure the strange quark contribution to the proton spin in neutrino-proton elastic scattering. The tank, approximately 6m in diameter and 9m long, is covered by 1220 8" phototubes and will be filled with 200 t of dilute liquid scintillator (see front cover).

(Below) At Dubna's superconducting Nuclotron heavy ion machine, the SPHERE electromagnetic calorimeter is prepared for studies on internal targets.



LOS ALAMOS New neutrino experiment

The Liquid Scintillator Neutrino Detector (LSND) experiment at Los Alamos' Meson Physics Facility (LAMPF) has been designed for a high sensitivity search for oscillations between muon- and electron-type neutrinos and, concurrently, between the corresponding antineutrinos. In addition, the experiment will measure neutrino-proton elastic scattering, thereby determining the strange quark contribution to the proton spin. At low momentum transfer, neutrino-proton elastic scattering is a direct probe of this contribution.

The detector tank, filled with 200 tons of dilute liquid scintillator, has 1220 8" Hamamatsu photomultiplier tubes mounted on the inside, cover-

ing 25% of the surface area. The dilute liquid scintillator is a mixture of mineral oil and 0.03 g/l of b-PBD, so that Cherenkov and scintillation light will be detected in an approximate ratio of 1 to 4. The attenuation length of the scintillator is greater than 30 m for wavelengths above 425 nm.

After two years of data collection for (anti)neutrino mixing, the upper limits on the square of the mass difference will be 1.7×10^{-2} ev^2 for maximal mixing for antineutrinos and 4.0×10^{-2} for neutrinos. Similarly, mixing strengths of 2.7×10^{-4} can be probed for each channel for all squared mass differences above 1eV^2.

This will provide the best terrestrial limits on oscillations between muon- and electron-type neutrinos. In addition, the neutrino-proton elastic-scattering reaction rate will be measured to an accuracy of 10, determining the strange quark contribution to the proton spin to within ±0.05.

Other physics goals include measurements of the charged current reactions where the neutrinos produce electrons or muons, the inelastic neutral current reaction where the neutrino stays a neutrino but excites the target, and a search for the 'rare' decays of a neutral pion and an eta into a neutrino-antineutrino pair.

The LSND collaboration includes groups from California at Riverside, Santa Barbara and San Diego, the University of California Intercampus Institute for Research at Particle Accelerators, Embry-Riddle Aeronautical University, Linfield College, Los Alamos, Louisiana State, Louisiana Tech, New Mexico, Pennsylvania, Southern, and Temple. Data collection begins this summer.

Schematic of the OPPIS optically pumped polarized proton source at the Canadian TRIUMF Laboratory, now delivering 80% polarization.

TRIUMF
Record polarized beams

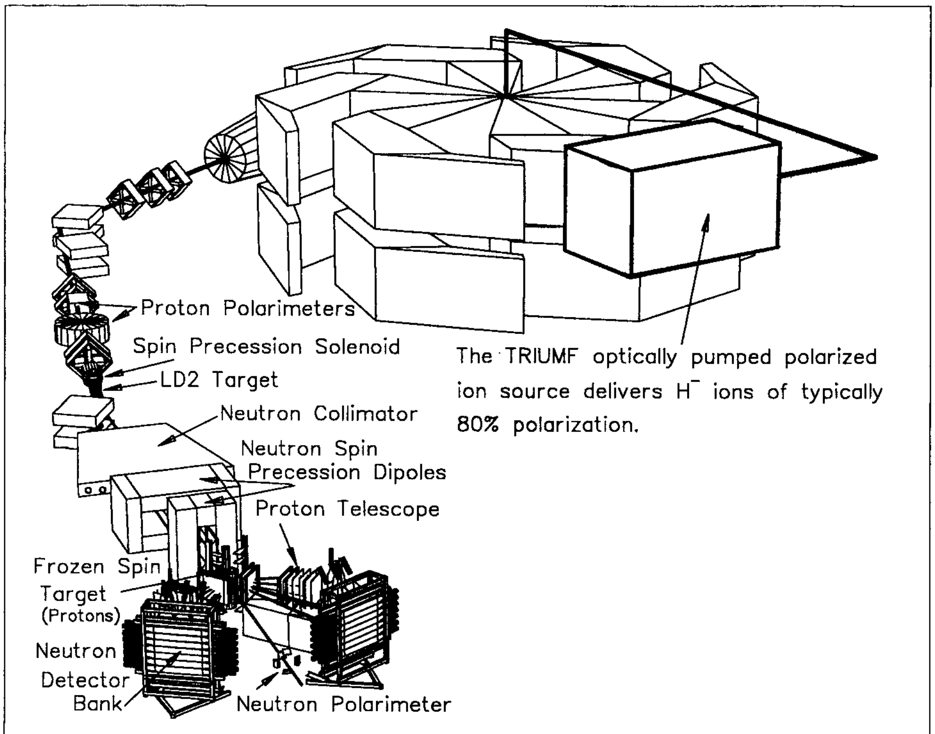
At the TRIUMF cyclotron Laboratory in Vancouver, the Optically Pumped Polarized negative hydrogen Ion Source (OPPIS - December 1991, page 10) is underlining the potential of these techniques for spin physics.

The source is performing well, producing a 20 microamp d.c. beam with a proton polarization above 80% and with good reliability. Spin reversal has also been speeded up and its effect on the beam intensity demonstrated to be negligible.

This substantially boosts TRIUMF's capabilities for polarization experiments. Data-taking has recently been completed for a second-generation experiment measuring charge-symmetry breaking in neutron-proton elastic scattering at 350 MeV. A 2.5 microamp polarized proton beam on a liquid deuterium target in a phase-restricted cyclotron mode reduced the time-spread of the incident proton beam to less then 0.8 ns.

The current was limited by the cooling capabilities of the liquid deuterium target cryostat. Polarized neutrons emerged via the D(p,n)2p reaction at an angle of 9°. Beam intensity at the experimental target (12.5 m from the liquid deuterium target) is uniform over an area 75 mm wide by 62 mm high, with a neutron flux of 0.9×10^5 microamps per sq cm per s and a polarization of 65-70%. At the same time, about 0.2 microamps of polarized beam are extracted from the cyclotron into a separate beamline for other experiments.

The new source is also being used to study parity violation in proton-



The TRIUMF optically pumped polarized ion source delivers H^- ions of typically 80% polarization.

proton scattering at 220 MeV. This requires fast spin reversals and imposes severe limitations on any current modulation coherent with spin-flip. The spin reversal time is limited by the laser frequency switching time, now reduced to less than 0.5 ms. Spin reversal can therefore be increased to 200 times per second (with less than 10% deadtime) and synchronous detection techniques used to cancel drifts of the polarized beam target and detector parameters. This should fix parity-violation to an accuracy of 2 $\times 10^{-8}$.

The spin-flip correlated current modulation of the polarized beam has been measured for the first time in an optically pumped polarized ion source. The modulation depends strongly on the density of the optically pumped rubidium vapour and the OPPIS primary proton beam energy. By optimizing the source parameters, the current modulation at 220 MeV was reduced to less then 2 $\times 10^{-5}$, measured in the transverse electric field ionization chamber of the parity violation detector system. This is close to the requirements of the parity violation experiment.

The recent results from optically pumped polarized ion sources are very promising for high-energy spin physics. Based on the performance of the TRIUMF d.c. OPPIS and of the INR (Moscow) pulsed OPPIS, optically pumped polarized ion sources look to be capable of producing at least 1 milliamp of pulsed negative hydrogen ion current with polarizations over 80%, ideal for use with high energy accelerators.

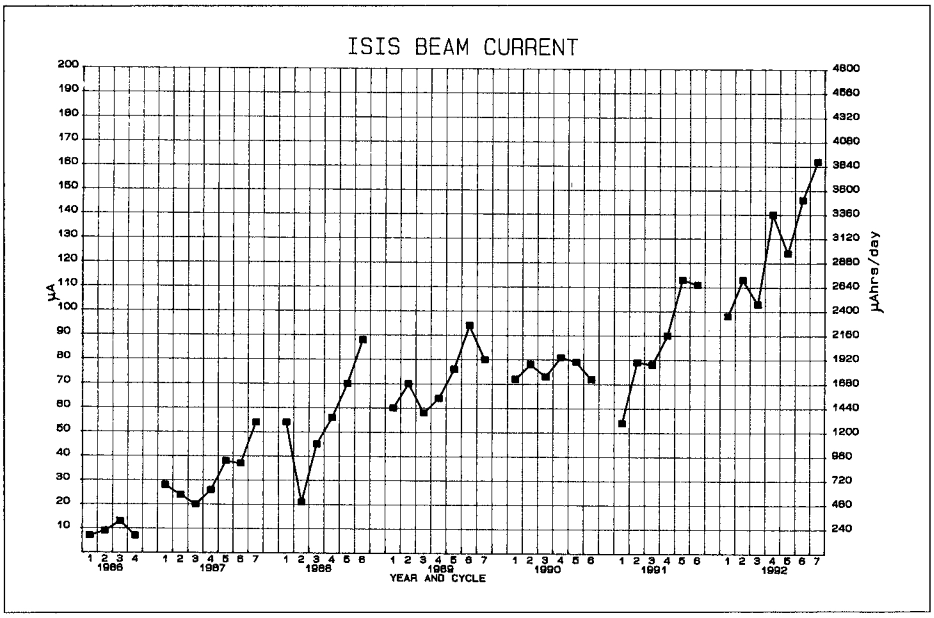
Testifying to the importance of this work, L.W. Anderson (Wisconsin, Madison) and Y. Mori (KEK) have been awarded the 1993 IEEE Particle Accelerator Conference Technology Award for their invention and development of the optically pumped polarized negative hydrogen ion source.

RUTHERFORD/ APPLETON ISIS intensity record

The Rutherford Appleton Laboratory in the UK is home to the world's most intense pulsed neutron source. The heart of ISIS is a 50 Hz proton synchrotron accelerating two bunches of protons from 70 to 800 MeV. After extraction the protons, occupying a total pulse length of less than 0.5 microseconds, strike a heavy metal target: the neutrons generated are moderated and directed through channels in the shielding to any of 14 instruments for condensed matter studies. As neutrinos and muons are copious by-products, major investments have also been made for investigations in these fields.

Efficient charge exchange injection into the synchrotron at 70 MeV is achieved using negative hydrogen ions and an aluminium oxide stripping foil. Some particles are lost during trapping and the early acceleration period, but they are captured by graphite-covered beam collectors to reduce machine activation. Later acceleration and fast-extraction are virtually without loss.

As the beam intensity increased over the years, the main task was to compensate correctly for the voltages induced in the six radiofrequency accelerating cavities by the circulating beam. When this problem had been solved and the intensity approached 2 $\times 10^{13}$ protons per pulse,



The growth over the years of microampere-hours delivered per operating cycle to the target at the Rutherford Appleton Laboratory's ISIS pulsed neutron source.

space charge effects became very important and the tune of the machine early in the cycle had to be increased in both planes, using trim quadrupoles.

The closed orbits become very sensitive and these too have to be finely adjusted, not least so that lost beam falls on the collectors and not elsewhere in the ring. Finally on 5 February, the design intensity was reached when 2.52 x 10^{13} protons per pulse were taken to the target at 50 Hz; a mean current of 201 microamps, at an overall efficiency of 82.6%.

Reaching the 200 microamp level is highly satisfactory as early design changes reduced the expected maximum current from 200 to 167 microamps, due to the space charge forces. The peak intensity has been achieved without sextupoles and octupoles, which are now available for further experimental studies.

Operationally, the facility runs for over 4000 hours a year. ISIS has been running with an availability of about 90%, and the record average current over 24 hours is 181 microamps.

BOMBAY Instrumentation school

Promising students had a foretaste of the latest laboratory techniques at the ICFA 1993 India School on Instrumentation in High Energy Physics held from February 15 - 26 and hosted by the Tata Institute of Fundamental Research (TIFR), Bombay. The scientific programme was put together by the ICFA Panel for Future Instrumentation, Innovation and Development, chaired by Tord Ekelof (Uppsala).

The programme included lectures and topical seminars covering a wide range of detector subjects. In small groups, students got acquainted with modern detector technologies in the laboratory sessions, using experimental setups assembled in various institutes world-wide and shipped to Bombay for the School. The techniques covered included multiwire proportional chambers for detection of particles and photons, gaseous detectors for UV photons and X-ray imaging, the study of charge drift in silicon detectors, measurement of the muon lifetime using liquid scintillators, tracking using scintillating fibres, and electronics for sensitive detectors.

The India School was attended by around 80 students from 20 countries; 34 came from Indian universities. It was the fifth in this series, previous Schools having been at Trieste (1987, 1989 and 1991) organized by the ICFA Panel and hosted and sponsored by the International Centre for Theoretical Physics, and in 1990, organized at Rio de Janeiro in collaboration with the Centro Brasileiro de Pesquisas Fisicas.

The School was jointly directed by Suresh Tonwar (TIFR), Fabio Sauli (CERN) and Marleigh Sheaff (University of Wisconsin), and sponsored by TIFR and DAE (India), CERN (Switzerland), ICTP and INFN (Italy), British Council and RAL (UK), NSF and DOE (USA), KEK (Japan), IPP (Canada) and DESY (Germany).

Students around one of the experiments at the ICFA 1993 India School on Instrumentation in High Energy Physics from February 15 to 26 hosted by the Tata Institute of Fundamental Research (TIFR), Bombay.

Physics monitor

CERN/BEIJING Joint school

The CERN Accelerator School usually confines its activities to CERN's Member States, with the occasional exception of a joint school with its US counterpart. Recently a CAS team headed eastwards for a change, bound for Beijing's Institute of High Energy Physics (IHEP), for a school on particle physics and accelerator topics related to European plans for a Large Hadron Collider at CERN.

The School was CAS' first in an Asian country and in many ways was an experiment. While lectures were aimed at a basic level for the benefit of the many students having their first taste of the subject, there was still time to handle more detailed questions from specialists. All local arrangements were handled entirely by the local Organizing Committee with admirable efficiency.

In addition to H Lengeler, S. Myers, D. Treille, F. Pauss, W. Scandale and E. Wilson from CERN, the team included G. Horlitz (DESY), J. Perot (Saclay) and H.S. Chen, Z. Chuang and Z. Guo from IHEP.

Lecturers' initial misgivings about how much of this tough material would be absorbed were soon dispelled. Each lecture had a one-hour tutorial to iron out any problems, and these sessions became quite animated.

So successful was the experiment that CAS plans to bring other Asian countries, including Japan and India into its circle of friends when time permits.

Academia Sinica President Zhou Guang Zhao welcomes CERN Accelerator School Head Ted Wilson to Beijing's Institute of High Energy Physics (IHEP).

Dark matter, hot and cold

Cosmologists responded enthusiastically to the announcement at the Washington meeting of the American Physical Society in April 1992 that the Cosmic Background Explorer (COBE) had succeeded in detecting primordial anisotropies in the cosmic microwave background radiation (CMB - June 1992, page 1).

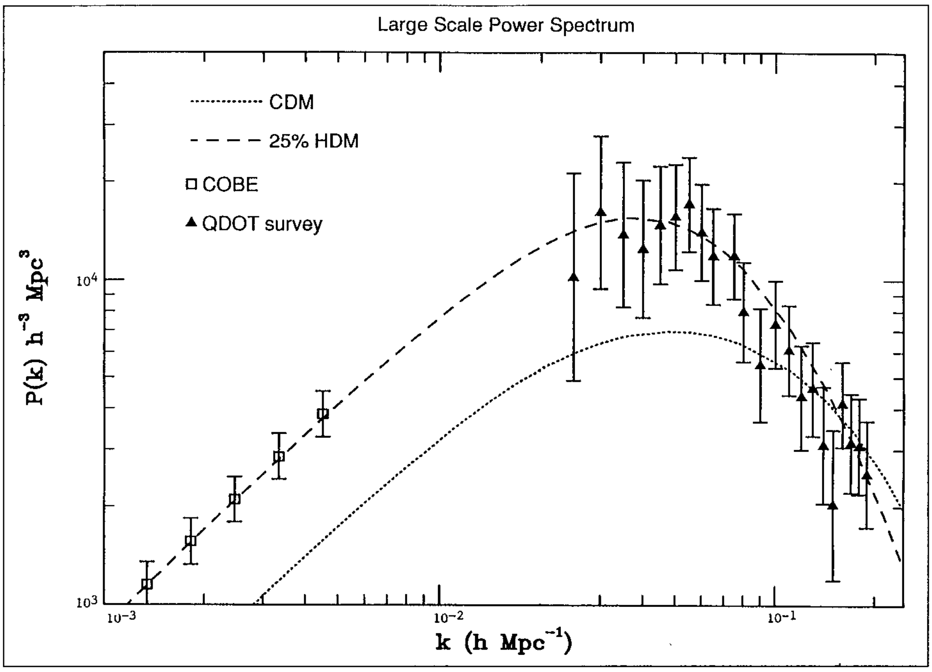
The COBE satellite was launched in November 1989 into an orbit approximately 900 km above the Earth, carrying instruments to make precise measurements of the spectrum and anisotropy of the CMB. Data from the Far-Infra Red Absolute Spectrophotometer (FIRAS) beautifully shows the CMB spectrum to be that of a black body at a temperature of 2.73 ± 0.06K.

An even more important result, at least from the viewpoint of theories of large scale structure formation (LSS), comes from the Differential Microwave Radiometer (DMR) which provided the first evidence for CMB anisotropy. Some anisotropy on the angular slice probed by COBE is expected in any reasonable model of LSS.

COBE's measurement of the quadrupole anisotropy at six parts per million provides an important clue for developing a 'standard model' of LSS. The COBE numbers are in remarkably good agreement with the predictions of a particularly simple class of LSS models proposed almost a decade ago, with far reaching implications for dark matter searches.

Hot big bang cosmology predicts the existence of the CMB, discovered by Penzias and Wilson in 1965.

Models based on the simultaneous existence of cold and hot dark matter find it easier to explain large-scale structures in the Universe, providing a better fit to the COBE microwave background fluctuations as well as data from galaxy surveys. Not shown is data on smaller scales, where such models predict less formation, also in good agreement with observations.



However the high CMB isotropy posed a major problem. According to initial big bang thinking, patches of sky separated by more than about 2° should not be temperature-correlated. This and several other related conundrums were overcome in the inflationary scenario proposed by Guth in 1981.

Inflation says that the universe contains a critical density of matter. Arguments based on primordial nucleosynthesis strongly suggest that no more than 10% of the critical density can be in baryons. The rest has to be 'dark', although inflation does not specify what this dark matter should be. This invisible dark matter is usually assumed to be either fast-moving, or 'hot dark matter' (HDM - relic light neutrinos with cosmologically significant velocities), or cold (CDM - axions, lightest neutralino,...). Inflation also provides a source of random fluctuations that are scale invariant, at least in grand unified theories - often referred to as the Harrison-Zeldovich (HZ) form of the density fluctuations.

Since neutrinos exist and could well have some mass, the simplest scenario relies on HDM. However it has been known for some time (and COBE provides further confirmation) that the observed large scale structure cannot be explained with purely HDM and the HZ spectrum.

One of the main problems is that fluctuations on scales smaller than the size of superclusters are wiped out by the free streaming neutrinos. Smaller objects such as galaxies and quasars would have to arise from the breakup of supercluster-sized structures.

For the last decade or so, many cosmologists opted for a scenario in which CDM makes up the entire missing mass in the universe, with the density fluctuations having the HZ form. This leads to a hierarchical clustering (bottom-up) scenario - smaller structures appear first and merge to make larger ones. There is so much small scale power that it was found necessary to associate galaxies only with high (and therefore rarer) peaks in density ('galactic biasing').

The mass fluctuations in a biased CDM model are several times smaller than fluctuations in galactic number density evaluated on an appropriate scale. However with this level of bias, the CDM scenario does not possess enough large-scale power to explain cluster correlations, bulk flows of galaxies, and galactic concentrations observed in recent redshift surveys. Even more significantly, however, the biased CDM model predicts a quadrupole signal several times smaller than that estimated by COBE for the HZ spectrum.

About a decade ago, particle physics models based on grand unified theories hinted at the simultaneous existence of cold and hot dark matter (CPHDM). CPHDM gives more large-scale power and less small-scale power than a similarly normalized CDM model. It was stressed that neutrinos could help bring consistency between the inflationary prediction of critical density and several dynamical estimates which lead to subcritical densities on 'small' scales, becoming more critical at 'larger' scales.

Even before the COBE result, it was known that CPHDM with a HZ spectrum provided a good fit to a variety of LSS data. Moreover, the COBE-compatible quadrupole anisotropy gives a good fit to cluster number densities, cluster correlations, bulk flows of galaxies, and the Infrared Astronomy Satellite Survey power spectrum. As well as agreeing with the COBE measurement, the outcome is consistent with recent studies of structure formation with

CPHDM carried out at Bartol, Berkeley, NASA/Goddard, Queen Mary College, Rome, Santa Cruz and elsewhere. These studies all conclude that cold-hot dark matter (with some 70% cold and 25% hot) is a promising model of large scale structure formation.

Alternatives to CPHDM include retaining CDM but giving up the HZ density fluctuations. But the required deviation from HZ is so large that it probably cannot be realized in ordinary grand unified theories, perhaps not even in other 'realistic' models. Another scenario assumes that the matter density is low, and has a cosmological constant (antigravity). This model may already be in conflict with some recent observations which suggest significant matter concentrations.

The idea that both cold and hot dark matter play a role in structure formation has far-reaching implications for particle physics. The preferred cold dark matter candidates include the lightest supersymmetric particle (LSP) as well as axions. For HDM, the tau neutrino with a mass 2 - 10 eV is the obvious candidate.

While COBE's discovery of microwave anisotropy is extremely important, these results and other data, spanning a wide range of length scales, are perfectly consistent with a scenario of cold plus hot dark matter, with density fluctuations essentially having the scale invariant (HZ) form predicted by inflationary models based on grand unified theories.

Just as the 1970s witnessed the rise of the Standard Model of particle physics, perhaps the nineties will see the emergence of a 'standard model' of large scale structure formation.

By Qaisar Shafi

Congress in Washington

Over 1200 accelerator physicists and engineers gathered in Washington mid-May for the 15th in the series of biennial Particle Accelerator Conferences (PAC) - the major US forum for accelerator physics and technology. For the first time since their inception, actual attendance declined, however the number of contributed papers stayed around 1500.

CERN Director General designate Chris Llewellyn Smith spelled out the challenges with an opening talk underlining the deficiencies in today's Standard Model. From many directions comes the message that collision in the 1 TeV range must tell us something new - wherefore art thou SSC and LHC?

The secondary shock waves of last year's (fortunately overturned) bid to cancel the SSC Superconducting Supercollider project still ripple around the USA, while progress towards authorization of CERN's LHC Large Hadron Collider has been slower than initially hoped.

The new US administration has indicated a constant rate of SSC funding over the next four years; the figure is higher than the present budget but considerably below the originally proposed budget profile, implying that completion will be retarded by some three years beyond the end of the decade. The SSC Laboratory will clearly have problems to fight increased overall cost and sustain enthusiasm. CERN hopes for LHC blessing in time to allow machine completion by the year 2000.

Pride of place at Washington went to DESY's HERA electron-proton collider - the major new facility since the previous PAC. Commissioning has been impressive and physics is well underway, with luminosity climbing towards the design figure.

The varied user community of the ubiquitous synchrotron radiation facilities is now considerably larger than that of particle physics and has extensive industrial involvement. Three such machines have come into operation since the previous PAC - the 6 GeV European Synchrotron Radiation Facility at Grenoble, the 1.5 GeV Advanced Light Source at Berkeley, and the 1.3 GeV Synchrotron Radiation Research Centre in Taiwan.

Linear electron-positron colliders - the proposed route for collision energies beyond LEP at CERN - were moved out of 'advanced accelerator concepts'. They are now considered to be in the pipeline, with much work in progress and many test facilities built or being built, leaving techniques like plasma beat wave accelerators in the realm of exotic approaches.

Though the scale and complexity of today's big machine projects imply timescales long on a biennial progress report scale, this superficial impression hides a lot of achievement. Full report in the next issue.

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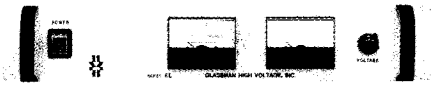

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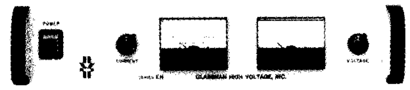

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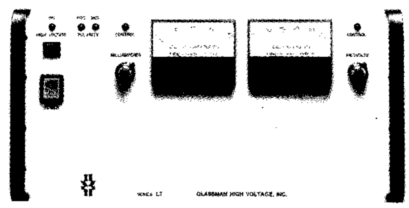

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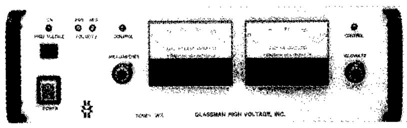

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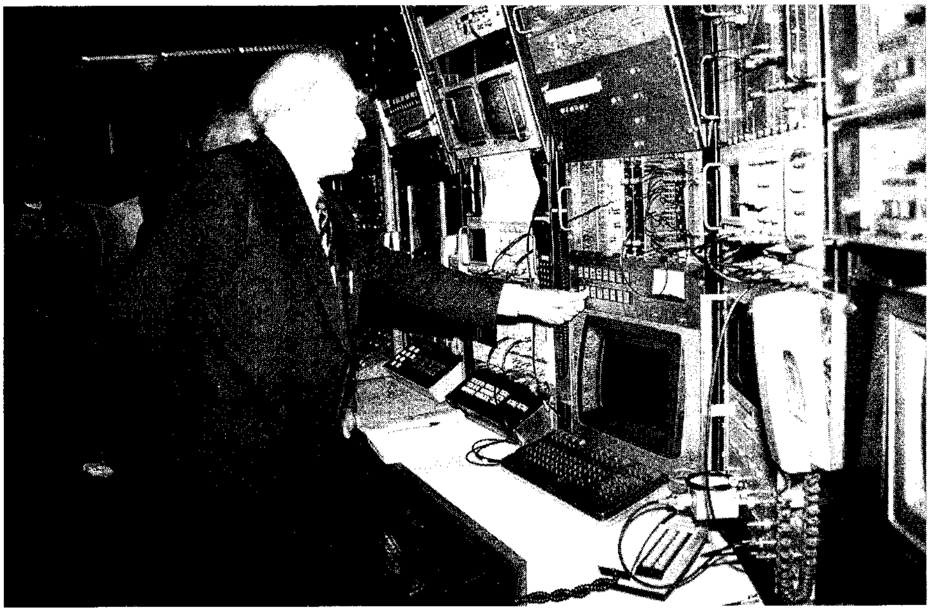
Glassman High Voltage

Adieu ADONE

Giorgio Salvini presses the button to kill the final beam in Frascati's ADONE electron-positron ring.



On April 26 the ADONE ring at Italy's Frascati National Laboratory was shut down for the last time. Giorgio Salvini, first Director of the Laboratory and presently President of the Lincei Academy, "killed" the last circulating beam in the machine. It was the end of a long and brilliant history, with an unusual interplay of technical skill, imagination and fruitful physics.

The first design of ADONE was presented at a Frascati workshop at the end of 1960, while the four-metre circumference ADA machine, the world's first electron-positron storage ring, was being assembled. ADONE boosted beam energies from the ADA level of 250 MeV to 1500 MeV, with luminosity foreseen as 10^{33} cm^{-2} h^{-1}.

Construction began in January 1963 and first beam-beam interactions were in the spring of 1969. In its characteristic operation mode, with three bunches per beam and 60+60 mA stored current, the maximum luminosity reached the design value in the collision energy range 2.0 - 2.4 GeV.

The first significant and unexpected result came immediately: a copious production of hadronic states at energies far from the so-called rho-tail. Hadrons were twice as copious than muon pairs, demonstrating dramatically the production of quark-antiquark pairs and the role played by quark colour.

Experiments continued in the search for higher recurrences of the already well-known vector mesons rho, omega and phi. However the first generation detectors, designed for a different scenario, did not have sufficient coverage nor magnetic field to analyse the final states. The next step came in 1973 with a second generation of experiments using more sophisticated detectors..

Also notable among the results of the first generation experiments were the study of the first photon-photon interactions and the production of proton-antiproton pairs.

In 1974, following the discovery of the J/psi resonance, ADONE's energy was pushed beyond its design limit to admire the new particle and a systematic search made for other narrow states. After this glimpse of "new physics", ADONE, was no longer able to compete with a new generation of machines. It was therefore modified, with some major modifications, to work with a single electron beam.

During its colliding beam lifetime, from 1969 to 1978, ADONE delivered to each of the four experiments working on the ring an integrated luminosity of 4.6 inverse picobarns. In its new configuration ADONE was dedicated to nuclear physics and synchrotron radiation research. During colliding beam operation, nuclear physics experiments had used the injector Linac beam: now a new range of experiments became feasible on the ring itself.

The first facility to come into operation in 1978 was LADON, the first beam of high energy (up to 80 MeV), high intensity, monochromatic and polarized photons in the world obtained by back-scattering a laser beam on electrons in a storage ring. It went on to be extensively used for photodisintegration and photofission experiments.

A second nuclear physics facility was the Jet Target. This sophisticated setup, using a condensed argon molecular beam injected in the machine at 90° to the beam, came into operation in 1990, delivering photon beams for photoabsorption and photofission, as well as electron diffusion on molecular targets.

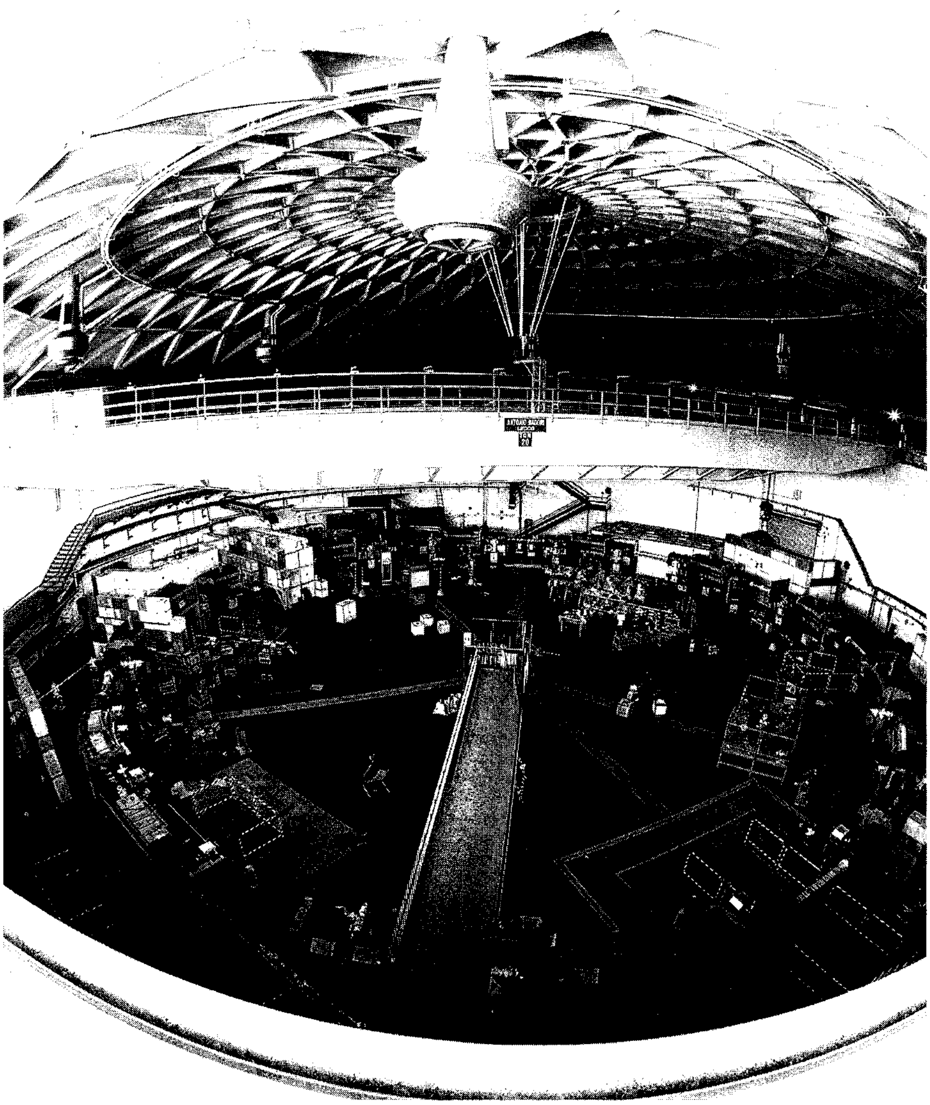
In 1981 an optical cavity was also installed for one of the first experiments (LELA) to establish the feasibility of a tunable laser in the visible wavelength range powered by the electrons of a storage ring.

Studies using synchrotron light have a long tradition at Frascati, the first experiments on the 1100 MeV electron synchrotron dating back to 1967. Exploitation of the synchrotron light from ADONE began with an X-ray beam for EXAFS spectroscopy, extracted from one of the bending magnets. The number of beamlines quickly increased, first to 3, then to 6.

To extend the wavelength range for synchrotron radiation research, in 1979 a 1.85 tesla wiggler magnet increased the critical wavelength of the light from 1.5 to almost 3 keV. Three beamlines were served by the wiggler in a new experimental hall (PWA). The most recent applications of ADONE synchrotron radiation were in lithographic exposures and some pioneering work on mammography as a possible tool for future biomedical investigations.

Before being shut down, ADONE still had one important contribution to make to high energy particle physics. After having resumed colliding beam operation at the beginning of 1990, neutron-antineutron production was measured at threshold using by means the FENICE detector. This measurement had been omitted during the first two generations of experiments due to its technical difficulty.

During its long history, ADONE delivered to experiments 5.3×10^4 hours of stored single beam and 2.2×10^4 hours of colliding beams, effectively nearly ten years of effective, excellent service on-line. Now its place will be taken by the DAFNE phi-factory (September 1990, page 43), which hopefully will inherit ADONE's successful tradition. As Giorgio Salvini said in his brief parting salute : "Le Roi est mort, vive le Roi !"



Commissioned in 1969, the ADONE ring at Frascati saw many physics and machine physics successes. Its place at Frascati will be taken by the DAFNE phi-factory.

THE UNIVERSITY OF BIRMINGHAM
SCHOOL OF SPACE RESEARCH

LECTURESHIP IN EXPERIMENTAL PARTICLE PHYSICS

Applications are invited for a Lectureship within the Particle Physics group. The current research programme is based on the OPAL experiment at LEP, the H1 experiment at HERA, and the OMEGA spectrometer, including the use of relativistic heavy ions. There is substantial involvement in R&D for LHC experiments : RD23 (optoelectronic readout), RD27 (triggering), RD28 (gas microstrips). The group is also part of the ATLAS and ALICE collaborations proposing LHC experiments.

The candidate appointed will be expected to contribute to the teaching of the School as well as to the current and future research programmes. The appointment will be made from 1st October 1993 with a starting salary in the Lecturer A range £ 13,400 – £ 18,576.

Application form (returnable by 16th July 1993) and further particulars from the Director of Staffing Services, The University of Birmingham, Edgbaston, Birmingham B15 2TT or telephone (021) 414 6483 (24 hours) quoting reference number S3692/93.

Further details about the post offered may be obtained from: Professor J.F. Dowell, School of Physics and Space Research, The University of Birmingham, Edgbaston, Birmingham B15 2TT. Tel. (021) 414 4658, fax (021) 414 6709, e-mail: JDD@UK.AC.BHAM.PH.I

Research positions experimental high energy physics Indiana University

The Department of Physics at Indiana University invites applicants for research positions to work with the high energy physics group on the OPAL experiment at CERN and/or development of the Solenoidal Detector Collaboration (SDC) outer tracking system for the SSC. Positions will be available beginning September 1993. Appointments can be made at either the research associate or research scientist level, depending upon qualifications.

In OPAL the Indiana University Group has been playing a leading role in heavy flavor physics and in the development of the silicon microvertex detectors. We also have developed and maintain the offline analysis facility, SHIFT, which uses RISC computers and a high-speed network to access the large amount of data that has been collected by the OPAL detector.

In SDC we are building the outer tracking system, which is composed of straw tube drift chamber modules. We are working on details of the module construction, measurements of the straw tube characteristics and performance in test beams, and computer simulation of the entire tracking system using GEANT-based software.

Applicants should have an interest and experience in one or more of the following: physics analysis, computing, computer simulation, tracking software, or tracking detectors. Candidates must have a Ph.D. degree. Applicants, including vitae, list of publications, and three reference letters, should be sent to:

High Energy Physics Secretary
Department of Physics
Swain West #117
Indiana University
Bloomington, IN 47405

by **August 31, 1993.** Indiana University is an Equal Opportunity/ Affirmative Action Employer.

Experimental high energy physics assistant research physicist university of California at Davis

The Department of Physics invites applications for an Assistant Research Physicist position in experimental high energy physics. The successful candidate will join the existing high energy group of four theoretical and six experimental faculty members. He or she will participate in the ongoing H1 research program at HERA and in detector development work at Davis. Extended visits to the DESY laboratory in Hamburg, Germany, will be required.

Candidates must have a Ph.D. in addition to experience in both detector technology and computer analysis for high energy physics. Review of applications will begin August 1, 1993 and will continue until the position is filled. The appointment can begin as early as October, 1993.

Applications should include vita, publication list, list of invited seminars and conferences attended, and a research statement. Send these materials and the names (including address, e-mail, Fax, and phone number) of three or more references to: Richard Lander, Chair, High Energy recruitment committee, Department of Physics, University of California, Davis, CA 95616. (FAX = (916) 752-2431; Email = Lander@UCDHEP.UCDAVIS.EDU)

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Carleton
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Centre for Research in Particle Physics Sudbury Neutrino Observatory

The Centre for Research in Particle Physics at Carleton University invites applications for two research positions to support its activities in the Sudbury Neutrino Observatory. The Centre's primary responsibility within this project is the production and monitoring of water with ultra-low radioactivity. The Centre will also be involved in the analysis of the experimental data.

RESEARCH SCIENTIST: A Research Scientist is required to assist with the development of the radioactivity monitoring techniques, commissioning of the systems at the Sudbury detector site, data analysis, and development of improvements to the neutrino detector. The Research Scientist would be based in Ottawa but would travel to Sudbury to assist with the detector operation. The position would be for three years in the first instance with the possibility of renewal. Applicants should have some post doctoral experience.

RESEARCH ASSOCIATE: A Research Associate is required to assist with the development of radioactivity monitoring techniques, to implement these techniques on site in Sudbury and to participate in the data analysis. The Research Associate would be based in Ottawa for one year and would then relocate to Sudbury for the remainder of the work. The position would be for two years in the first instance.

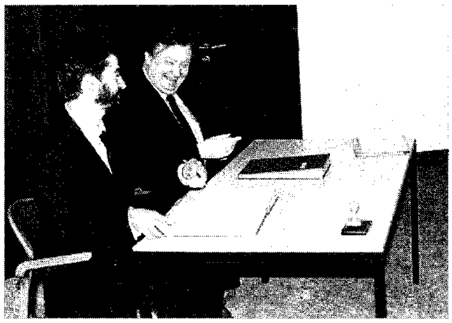
Please send resumé and arrange to have three letters of reference forwarded by August 1, 1993 to:

M. McGregor
Centre for Research in Particle Physics
Carleton University, 1125 Colonel By Dr.
Ottawa, Ontario, Canada K1S 5B6
Fax: (613) 786-7546
E-Mail: Marilyn@CRPP,Carleton.CA

In accordance with Canadian Immigration requirements, priority will be given to Canadian citizens and permanent residents. Carleton University is committed to equality of employment for women, aboriginal peoples, visible minorities and disabled persons. Interested persons from these groups are encouraged to apply.

People and things

On 17 May, a cooperation agreement between CERN and Colombia was signed by Clemente Forero (left), Director of Colombia's Institute for the Development of Science and Technology, and CERN Director General Carlo Rubbia.



External correspondents

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Successful LEP startup

Thanks to a major programme of magnet realignment, and improved orbit measurement systems, CERN's 27-kilometre LEP electron-positron collider began 1993 operations in fine form, with luminosities climbing fast and reliable physics conditions quickly achieved. This was despite several kilometres of the machine having been refitted in preparation for higher energy operation. The machine now uses a 90°/60° betatron phase combination, and an encouraging early achievement was 26% beam polarization.

VIP groundbreaking for Fermilab's Main Injector (June, page 10). Left to right - Fermilab Director John Peoples, Representative Denis Hastert, Senator Carol Mosely-Brown, Senator Paul Simon, and Director of the Department of Energy's Office of High Energy and Nuclear Physics Wilmot Hess

1993 American Physical Society awards

The 1993 American Physical Society awards, bestowed at several APS meetings, include several in particle physics.

Mary K. Gaillard of Berkeley receives the J.J. Sakurai Prize for Theoretical Particle Physics for her contributions to phenomenology and theory, in particular for her work with the late Ben Lee and others applying QCD to K meson mixing and decays and to the bound states of charmed quarks.

John Blewett receives the Robert R. Wilson Prize for Achievement in the Physics of Particle Accelerators for his many contributions, beginning in the 1930s, to accelerator physics and technology. These include the first indirect observation of synchrotron radiation, the first applications of alternating gradient focusing to linear accelerators, and to many developments in the design and construction of accelerators and storage rings.

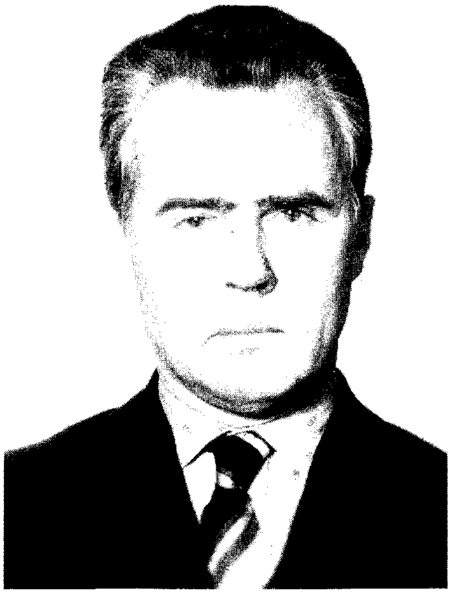
David N. Schramm receives the Julius Edgar Lilienfeld prize for his contributions to nuclear astrophysics and his communications skills (already published).

Robert Palmer, Nicholas Samios and Ralph Shutt receive the W.K.H Panofsky Prize for the leadership in the omega-minus discovery at Brookhaven in 1964 (already published).

In April, a 'Recent Advances in the Superworld' meeting at the Houston Advanced Research Center (HARC), sponsored by HARC in collaboration with the International Centre for Scientific Culture/World Laboratory, focused on the latest advances in Grand Unified Theories. HARC Astroparticle Physics Group Head Dimitri Nanopoulos (left) spoke on Density Matrix Mechanics ideas which extend the power of quantum mechanics, providing a link between quantum mechanics and gravity. ICSC/WL head Antonino Zichichi (right) gave the status of supersymmetric predictions in the context of coupling constant unification.

Alexander Alexandrovich Pomansky 1932-1993

Alexander Alexandrovich Pomansky 1932-1993



The prominent Russian physicist Alexander Alexandrovich Pomansky died on 9 April in the village of Neutrino in the Baksan valley, North Caucasus.

At the Lebedev Institutes and then at the Institute for Nuclear Research of the Russian Academy of Sciences, he made key contributions to cosmic ray and neutrino physics and to astrophysics. One of the pioneers of radiochemical gallium-germanium and lithium-beryllium methods of solar neutrino detection, he is also widely known for his work on double beta decay and other rare processes.

Pomansky devoted almost 30 years to the INR Baksan Neutrino Observatory, and was its head from its foundation in the mid-1960s till his death.

An active organizer of international neutrino meetings, his kindness, energy, openness and devotion to science won him many friends.

Meetings

An International Conference on Non-Accelerator Particle Physics (ICNAPP), organized by the Indian Institute of Astrophysics, Bangalore, from 2-9 January 1994 will focus on several exciting areas of this research and its significance for astronomy. Some proposed topics are : Physics Beyond the Standard Model, Neutrino Physics, UHE Gamma Rays and Cosmic Rays, Search for New Forces, Fundamental Quantum Mechanics, Dark Matter Searches and New Instrumentation for Astroparticle Physics . Convenor is Ramanath Cowsik, Indian Institute of Astrophysics, Bangalore 560 034, India. Fax : 91-812-533358, e-mail : icnapp@iiap.ernet.in or icnapp@tifrvax.bitnet

Dark matter

An "International School on Cosmological Dark Matter" will be held in Valencia from October 4-8,organized in collaboration with the Universities of Menendez y Pelayo, Valencia and IFIC/C.S.I.C. In addition to some pedagogical review lectures, the meeting will also include more specialized talks on frontline research topics.

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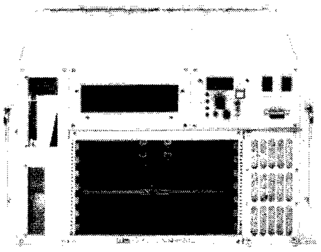

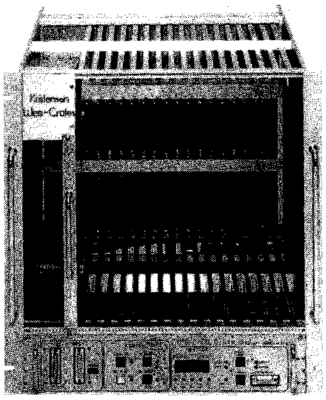

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The picture shows this crate for VMEbus FADC-Crate for DESY, H1.

VMEbus-Crates
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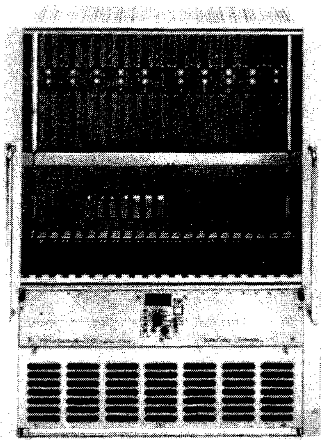

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Fermilab in Batavia, Illinois, is home to theTevatron colliding-beams accelerator and advanced research in particle physics at the highest energies.The DZero collider experiment seeks a Scientist with a PhD in High Energy Physics and at least 3 years post-doctoral research experience to take part in a broad experimental program.

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We provide our employees with opportunities for personal and professional growth, competitive salaries and an attractive benefits package. To apply, please send CV and 3 letters of recommendation to: **Dr. H.E. Fisk, Fermi National Accelerator Laboratory, P.O. Box 500, Batavia, IL USA 60510-0500.** Equal Opportunity Employer M/F/D.

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The Scientific Programme will consist of invited lectures and some selected seminars by participants together with discussion sessions on:1. The Standard Big Bang Cosmology and Inflation; 2. Observational Evidence for Dark Matter; 3. The Standard Electroweak Model; 4. Beyond the Standard Model; 5. Dark Matter and Particle Physics; 6. Neutrino Astrophysics and Cosmology; 7. Underground Experiments; 8. Dark Matter and Structure Formation; 9. Cosmological Phase Transitions; 10. Future Perspectives.

Spin 93

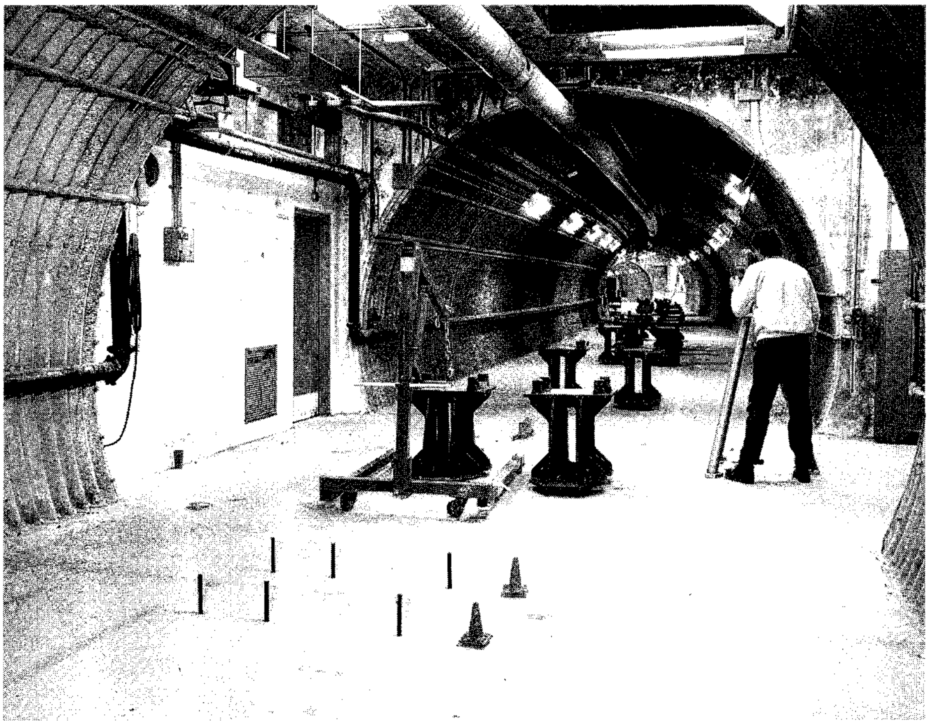
From 20-24 September, the International Spin-93 Workshop will be held under the sponsorship of the Institute for High Energy Physics (Protvino, near Moscow), and the International Committee for High Energy Spin Physics. Information from nurushev@ihep.su or mochalov@ihep.su or ufimtsev@ihep.su.

Newton revisited

Published by Cambridge University Press is Richard Westfall's 'The Life of Isaac Newton' (ISBN 0 521 43252 9), a abridgement of same author's 1980 classic 'Never at Rest'. With many mathematical details omitted, this fine story brings Newton's career to a wider audience, tracing the erratic progress of this enigmatic megamath.

Newton's introduction to the thrust and parry of scientific priority left him so disillusioned that he retired to his Cambridge bolt-hole.

Twenty years later, with comets in the sky, Edmond Halley suspected Newton might know a thing or two about celestial motion, but was amazed to find he knew everything. Equally amazed, Newton discovered the world wanted to know, and embarked on his Principia opus. Newtonian mechanics finally exorcized the ghost of geocentrism and Newton took his rightful place as an intellectual giant.



Getting ready for magnet installation in Brookhaven's RHIC heavy ion collider tunnel. First standard superconducting arc dipoles and quadrupoles manufactured by Grumman Aerospace are scheduled for delivery this year, with installation commencing mid-1994.