

Polarized beam experts Ernest Courant (Brookhaven/Michigan, left), Massimo Placidi (CERN, centre), and Igor Ternov (Moscow) discuss how to polarize more accelerators.

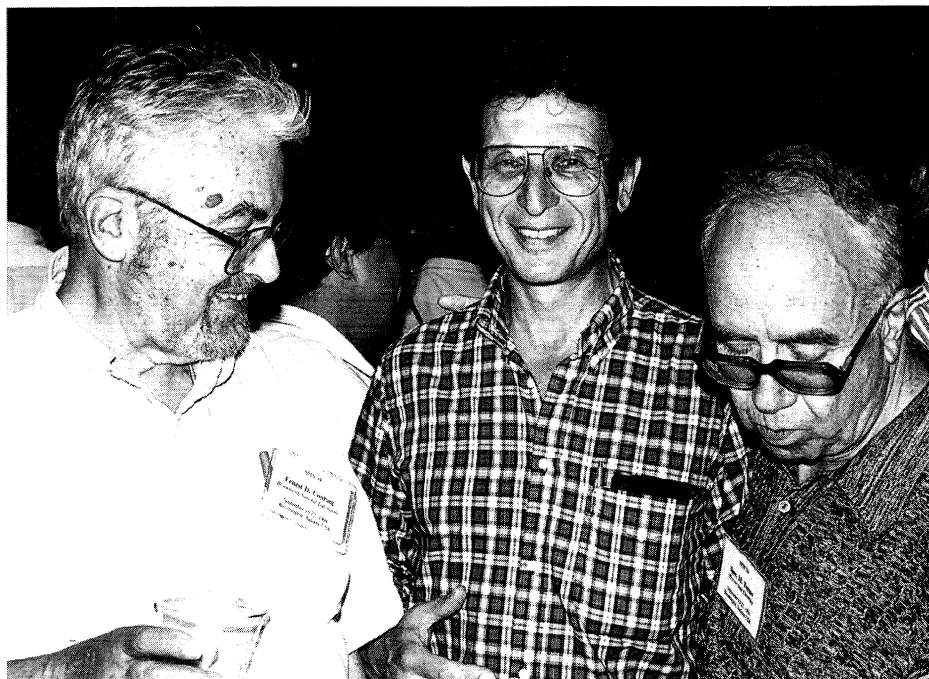
per second (60 petabecquerels).

Immediately transported to the Italian Gran Sasso underground Laboratory, it was installed in a special thimble in the core of the detector. Over more than three months, the source produced a relative abundance of neutrino interactions, ten times more than the Sun. The ratio between the number of germanium atoms produced by the artificial neutrino source and the number expected from its measured activity is 1.04 ± 0.12 , showing that the detector works perfectly well and confirming the original solar neutrino deficit observed by Gallex.

Because the Gallex, chlorine and Kamiokande experiments use different techniques, they have different sensitivities to the various sources of solar neutrinos. While Gallex sees an overall deficit, the current thinking is that the detector sees all the predicted neutrinos produced by the basic solar proton-proton fusion process, but not those from subsidiary fusions involving beryllium-7 and boron-8. The chlorine and Kamiokande experiments are only sensitive to these latter processes, and it is here that the deficit arises.

The leading contender explanation for the dearth of beryllium-7 and boron-8 particles is resonant neutrino oscillations inside the Sun (the so-called MSW effect). If the Sun produces electron-type neutrinos and the detectors are sensitive only to these, if some of them have been transformed en route into muon- or tau-types then the observed deficits can be accounted for.

To confirm this interpretation means waiting for the next generation of detectors (SNO in Canada, Superkamiokande in Japan and Borexino in Gran Sasso) and the neutrino experiments at CERN (Chorus and Nomad) which will look



hard for possible neutrino oscillations.

The Russian-American experiment SAGE, using a target containing 57 tons of metallic gallium in the Baksan Laboratory (Caucasus), is carrying out a similar check.

fact that most of the world's nuclear and high energy laboratories are now actively using or seriously considering spin-polarized beams and spin-polarized targets.

One major highlight was the recent blossoming of polarization at the world's large electron facilities: SLC (Stanford/SLAC), HERA (DESY) and LEP (CERN). Massimo Placidi (CERN) described the high transverse polarization obtained in LEP (January, page 6), which has allowed a very precise and important calibration of the Z mass.

HERA has recently made great progress with its polarized electron beam. Gus Voss and Desmond Barber (DESY) reported a transverse electron polarization of about 70%; HERA also successfully used spin rotators to produce the first longitudinally polarized electron beam with about 55% polarization (September 1994, page 24). This exceeded the 50% "Soergel limit" and thus led to the approval of the HERMES experi-

Spin jamboree

About 340 spin enthusiasts gathered in Bloomington, Indiana, this Fall for the "trial partial merger" of the 11th International Symposium on High Energy Spin Physics and the 8th International Symposium on Polarization Phenomena in Nuclear Physics. Although there were five separate organizing committees, the Spin '94 Meeting was a great success, reflecting the

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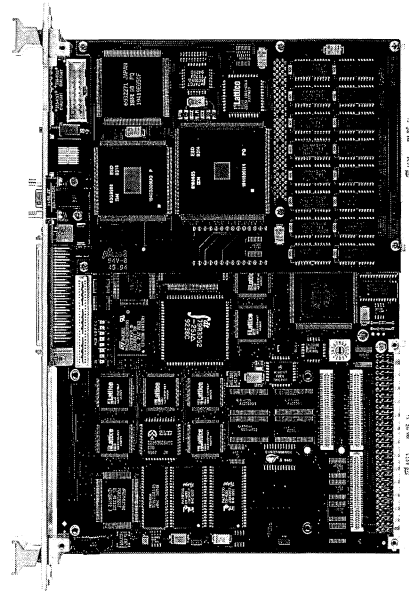
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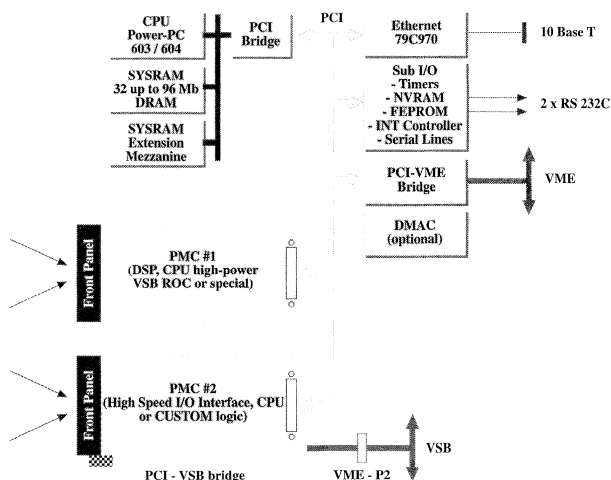


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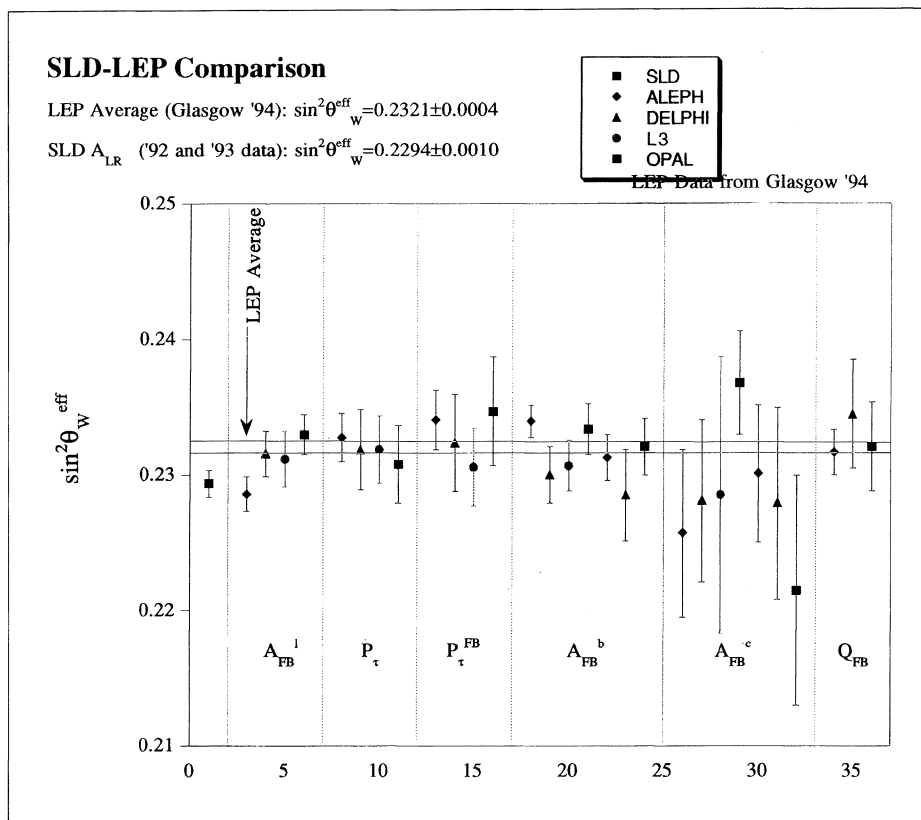
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The comparison of the electroweak mixing (Weinberg) angle measured at the SLC electron-positron collider at Stanford (SLAC), using the left-right polarization asymmetry, and at LEP at CERN using various asymmetries and the tau polarization.



ment. Hal Jackson (Argonne) discussed the clever HERMES "storage cell" internal polarized proton target which should soon allow precise measurements of the nucleon form factors' spin structure.

Igor Ternov (Moscow) gave a historical account of the 1963 calculations of the (Sokolov-Ternov) self-polarization effect. Because of their different synchrotron radiation rates, spin-up and spin-down electrons or positrons become polarized along an accelerator ring magnets' vertical direction. In 31 years, this clever theoretical abstraction has become the most important polarization tool at HERA and LEP.

In the 1990s, SLAC has become an almost "dedicated" polarized beam facility. The sterling work of their polarization team was described by Mike Woods (SLAC) and Herb Steiner (Berkeley). In 1994, their

gallium-arsenide source gave an electron beam polarization of 85% for SLAC fixed-target running and 80% for SLC collider running. This high polarization allowed electroweak measurements almost as precise as all the combined LEP data. The two measurements disagree by about 2.5 standard deviations; while this disagreement is not yet a "crisis", it certainly seems interesting.

The "Spin Crisis" (where does the proton spin come from? - July 1994, page 19) was extensively discussed by many theorists and experimenters from both the high energy and nuclear communities. Opening speaker Tony Thomas (Adelaide) suggested that perhaps, with the new data and some new theoretical understanding, the crisis has somewhat evaporated. Summarizer Alan Krisch (Michigan) suggested that physicists should use the word

"crisis" more sparingly; noting that the SSC's cancellation in 1993 gave direct experience with a real crisis.

The recent SMC data using a CERN polarized muon beam on a polarized proton target agrees rather well with the SLAC polarized electron data experiments. Moreover, the theoretical extrapolations to other kinematic regions and the validity of some sum rules have been reevaluated. With this latest theoretical input and the new polarized lepton-nucleon data, it now appears that perhaps one-third of the proton's spin is probably carried by the quarks and antiquarks.

At low energies, the weak interaction between nucleons was studied by searching for parity (left-right symmetry) violations at the level of one part in ten million. Using epithermal neutrons, these violations were found to be strongly enhanced by the mixing between different levels in compound nuclei. Early measurements at LANCE for thorium 232 showed effects as large as 10%; new LANCE results, reported by Yi-Fen Yen (Los Alamos), show even larger effects, with the expected mean of zero. These large parity violations should permit previously impossible studies of the weak interaction between nucleons.

Another highlight was the proliferation of 'Siberian snakes' to control spin-oriented beams. The Michigan-Indiana Siberian snake at the IUCF Cooler Ring (May 1993, page 21) has been joined by the Brookhaven AGS Siberian snake reported by Thomas Rose (Brookhaven). Both teams of "herpetologists" are enthusiastically testing the snakes' abilities to overcome all sorts of depolarization problems.

The Michigan-Indiana team and the AGS team both reported using a partial Siberian snake to accelerate

High energy spin symposium organizers Ken Heller (Minnesota, left) and Alan Krisch (Michigan) looking organized but tired.



through depolarizing resonances (September 1994, page 27). Rick Phelps (Michigan) also reported the first spin-flipping of a stored polarized proton beam by using an r.f.-solenoid-induced depolarizing resonance at IUCF; the polarization loss per flip was less than 0.05%. These technological innovations, together with the recent success of polarized experiments with pure internal targets and stored beams, have led to a plan for a Light Ion Spin Synchrotron (LISS) reported by Steve Vigdor (Indiana); LISS would exploit this technology to explore nucleon spin physics in the 1-20 GeV range.

Several other proton laboratories are now seriously considering installing Siberian snakes to accelerate polarized protons. Yusef Makdisi

(Brookhaven) described a plan to inject polarized protons from the AGS into the RHIC machine, now under construction. By installing two Siberian snakes in each RHIC ring, it would be possible to accelerate polarized protons to 200 GeV and then collide them. Spin rotators on either side of the STAR and PHENIX detectors would allow studying spin-spin effects in 400 GeV proton-proton collisions in either longitudinal or transverse spin states.

Fermilab has commissioned the SPIN@Fermilab Collaboration (Michigan/Indiana/Fermilab/Protvino/Dubna/Moscow/INR/KEK/TRIUMF) to design polarized beam capability for the new 120-150 GeV Main Injector and the Tevatron Collider. Dave Caussyn (Michigan) noted that,

if the project were approved, there would be one Siberian snake in the 8 GeV Booster, two in the Main Injector, and six in the Tevatron.

Spin rotators near CDF and D0 would allow studies of one-spin antiproton-proton collisions at 2 TeV with either longitudinal or transverse polarization. There could also be proton-proton two-spin experiments near 1 TeV using a Tevatron polarized internal gas jet target. Moreover, the new Main Injector would allow simultaneous fixed-target two-spin experiments in the 120 GeV extracted polarized proton beam.

Summarizer Alan Krisch also described the plans for the NEPTUN and NEPTUN-A polarization experiments at UNK in IHEP-Protvino, near Moscow. When UNK-1 begins 400-600 GeV operation around 1997, it will be the world's largest circumference (21 km) proton accelerator until LHC starts up. Due to financial problems, the 3 TeV UNK-2 superconducting ring has been delayed to focus on the earliest possible operation of UNK-1. The first experiments planned for UNK-1 are NEPTUN and NEPTUN-A, which will both use the Michigan Ultra-cold polarized proton internal jet target. Thus, prior to UNK-2 operation, the huge UNK facility may be dedicated to these polarization experiments on the one-spin asymmetry in 400 GeV elastic and inelastic proton-proton collisions.

Since the 1992 Spin Symposium in Nagoya, spin has bloomed. The nuclear and high energy polarization community spun out of Bloomington wondering what dramatic advances would occur before the next major meeting in NIKHEF-Amsterdam in September 1996.

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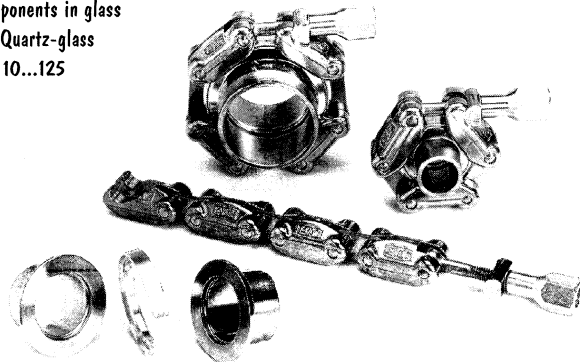


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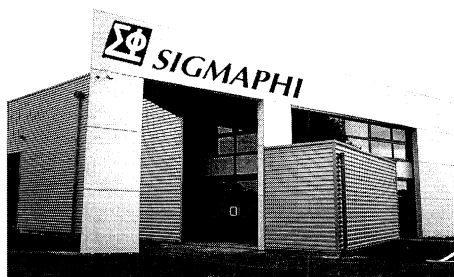
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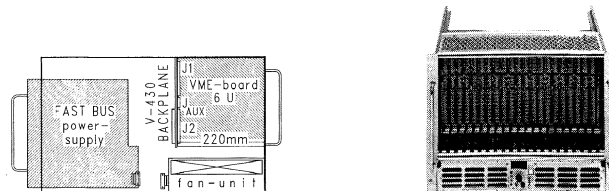
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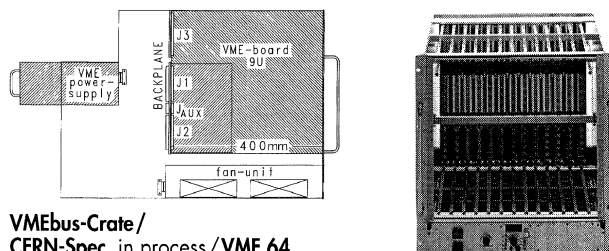
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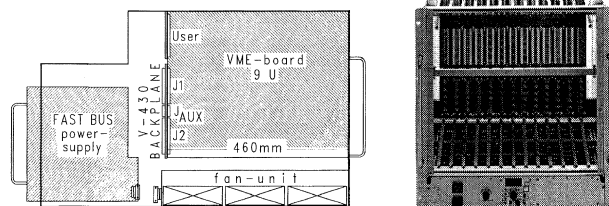


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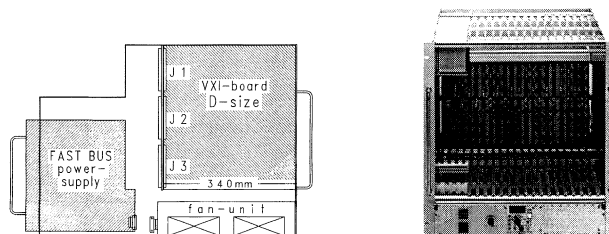
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