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.

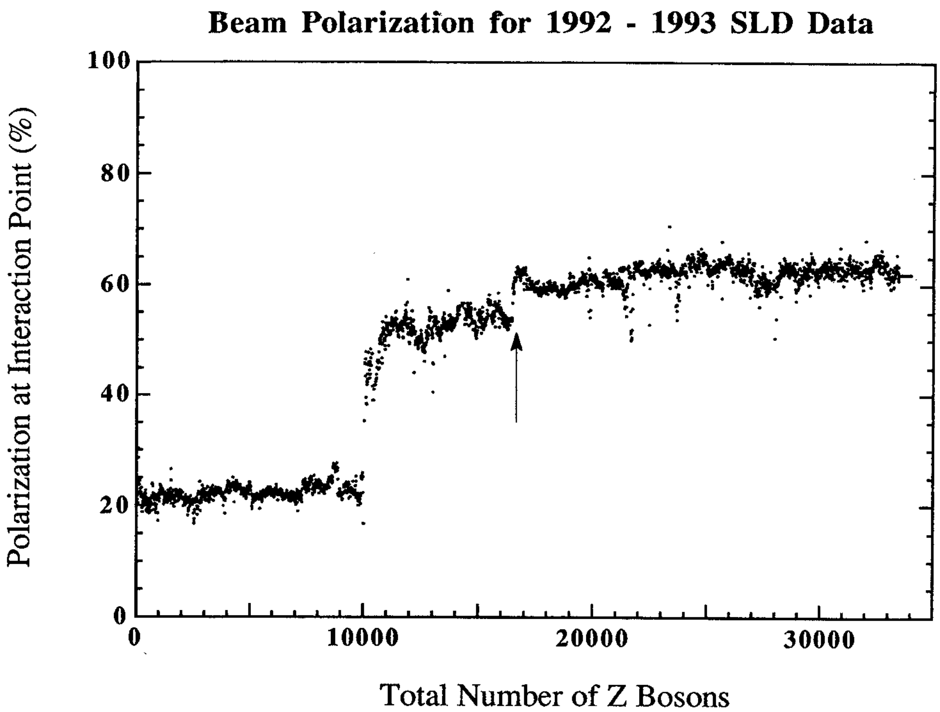
A full programme of ALICE detector component development work geared to the special requirements of heavy ion physics is underway.

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

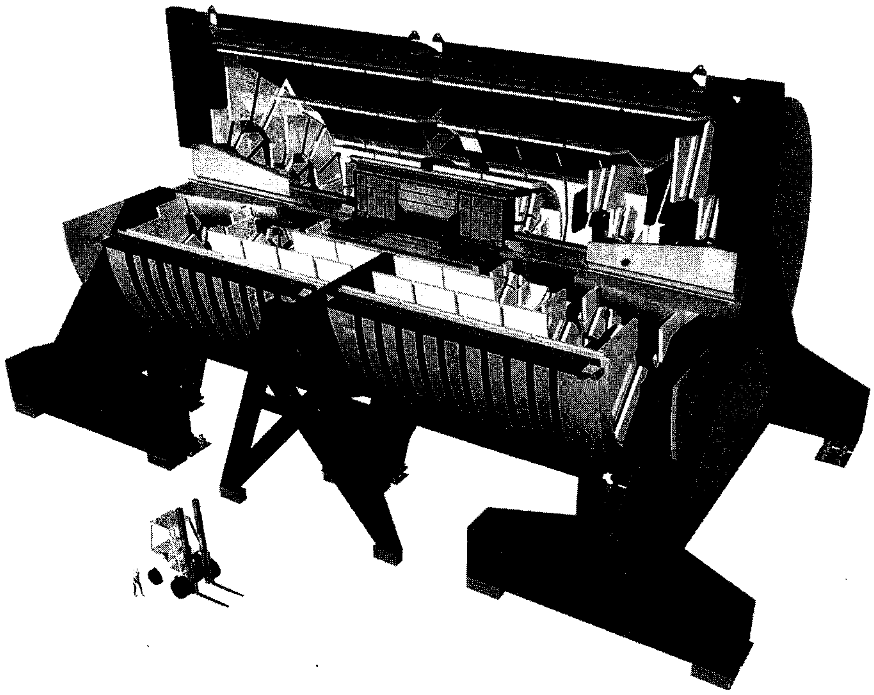
A conservative approach was called for, due to concerns about possible charge saturation effects. A relatively thick (0.3 micron) gallium arsenide layer was used for the photocathode in the SLC polarized electron source. With a titanium-sapphire laser operating at 865 nanometres shining on this photocathode, 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.

The GEM detector: jewel of the SSC.



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