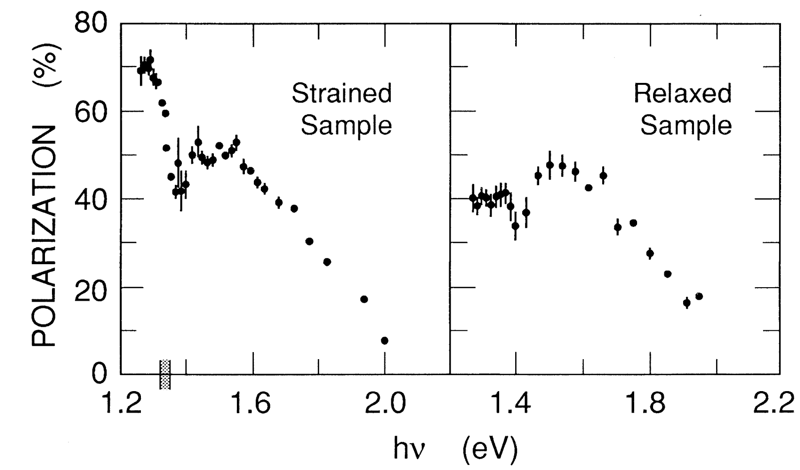
never exceeds 50 per cent because of spin degeneracy. One way to eliminate this intrinsic limit is to remove the degeneracy by a suitably arranged periodic potential in a superlattice structure. If the level splitting is made larger than the thermal noise level, selective pumping from a single state will be possible. Subsequently the pumped electrons need to be efficiently transported from superlayer to superlayer, with minimal depolarization in transit.

The important first step was an optimization study of GaAs-AlGaAs superlattice parameters such as layer thicknesses and Al content. The first photocathode resulting from this study was tested last year with a titanium/sapphire tunable laser, and 53 per cent polarization was quickly seen.

Careful examination of this result led to a second sample with thinner superlattice layers. First measurements gave 71 per cent polarization at a wavelength of 802nm. Greatly encouraged by this achievement, the collaboration is aiming for even better production polarized electron sources for JLC.

## Polarized electron sources

*These two articles, from the Stanford Linear Accelerator Center (SLAC) in California, and from the Japanese KEK Laboratory, highlight the world-wide effort underway to develop new techniques for the next generation of electron-positron linear accelerators.*




*Highly polarized electron sources at Stanford. Left, a thin (0.1 micron) indium gallium arsenide layer on a gallium arsenide substrate, when irradiated, shows increasing electron polarization, eventually attaining 71 per cent. At about 1.34 eV, the spectrum shows the onset of the selective pumping of electrons from a higher energy valence band to the conduction band (see text). Right, a 'thick' 1.14 micron layer with no crystal strain shows no similar effects.*

# STANFORD
## Producing highly polarized electrons (2)

Electron spin polarization above 70 per cent by photoemission from a specially prepared semiconductor has been achieved by T. Maruyama and E. Garwin of the Stanford Linear Accelerator Center (SLAC), R. Prepost and G. Zapalac of Wisconsin, and J. Walker and S. Smith of Berkeley.

Since the first use of a gallium arsenide photocathode at SLAC for the historic 1978 experiment which saw left-right asymmetry in electron scattering, semiconductor photoemitters have become standard for linear accelerators. These sources give high peak currents and short pulses, for example satisfying the 16 ampere/2.5 nanosecond pulse requirement for Stanford's SLC linear collider.

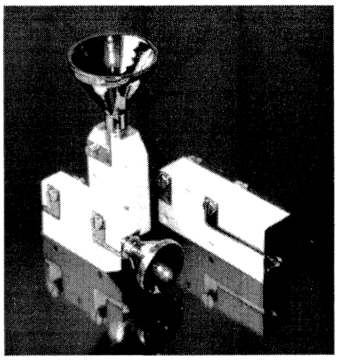
The conventional cathode material, gallium arsenide, has a theoretical maximum polarization of 50 per cent due to its crystal structure. In practice, polarization levels of about 40 per cent are achieved with bulk gallium arsenide, while thin epitaxial layers can approach the theoretical 50 per cent limit.

For over a decade much effort has gone into investigating other semiconductors to avoid this inherent limit due to valence band degeneracy. This degeneracy can be broken by deforming the crystal structure or by engineering suitable quantum wells or superlattice structures, opening up the possibility of 100 per cent polarizations by selective pumping of the higher energy valence band.

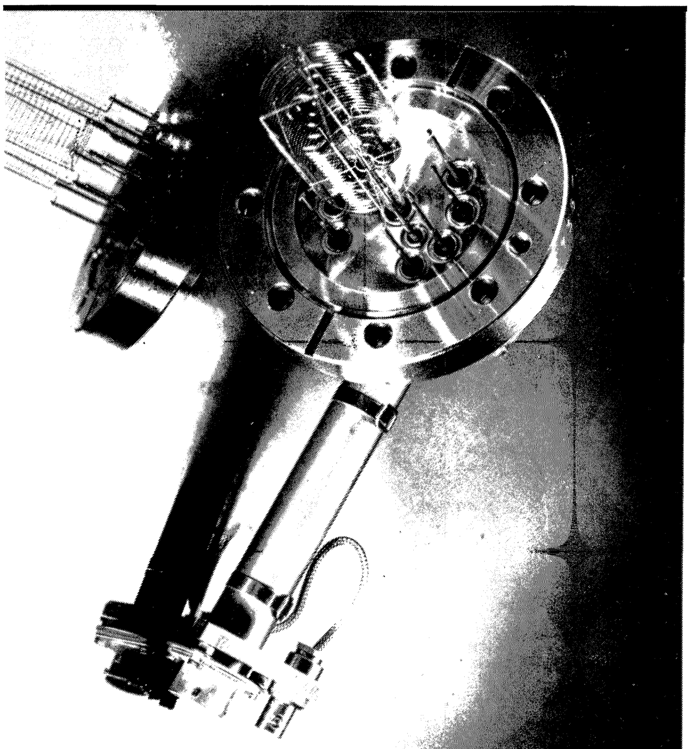
The SLAC/Wisconsin/Berkeley group has looked at indium gallium arsenide layers grown epitaxially on a gallium arsenide substrate, with the indium giving about a one per cent lattice mismatch. If this top layer is thin enough, the resulting crystal has a compression strain that splits the valence band degeneracy by some 50 meV.

Two samples were studied – an 0.1 micron indium gallium arsenide layer thin enough to give a high quality strained structure, while a 'thick' 1.14 micron layer without strain provided a control.

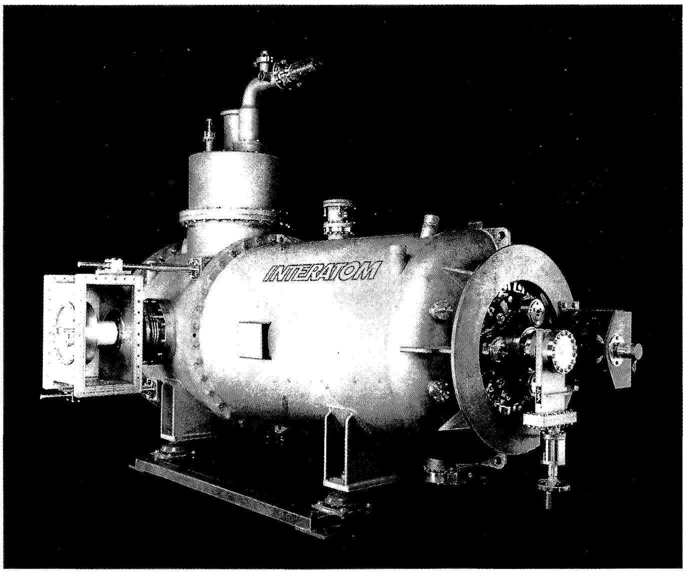
The thin strained sample showed a dramatic increase in el-












*500 MHz superconducting accelerator module INFN/Frascati*

***** A big new solar neutrino detector is also being constructed in the Baksan Laboratory in the Soviet Caucasus. A report will be included in our June issue.**

ectron polarization, eventually attaining 71 per cent at 1.26 eV. The thick sample showed no such enhancement.

A way is open for high polarization and high quantum efficiency photocathodes for linear accelerators.

# JAPAN Super-Kamiokande goes ahead

Now approved and funded is the Japanese Super-Kamiokande project for a greatly enlarged underground neutrino detector. Costing 8.7 billion yen ($62 million), construction is getting underway now and will continue until early 1996.

The detector will contain 50,000 tonnes of water, viewed by 11,200 50-cm diameter photomultiplier tubes to pick up Cherenkov radiation from traversing particles.

Underground physics began in the Kamiokande mine in the mid-80s, the existing detector using some 3,000 tonnes of water.

Neutrino observations from the 1987 supernova showed that neutrino astronomy has now an important role to play, while the ongoing goal of solar neutrino studies is to establish a complete picture of neutrino emission from the Sun.

The motivation for many underground experiments came from Grand Unified Theories (page 1) and their prediction of an unstable proton. With no sign of this instability yet found, the big new detector will be able to probe longer decay times ($10^{33-34}$ years).

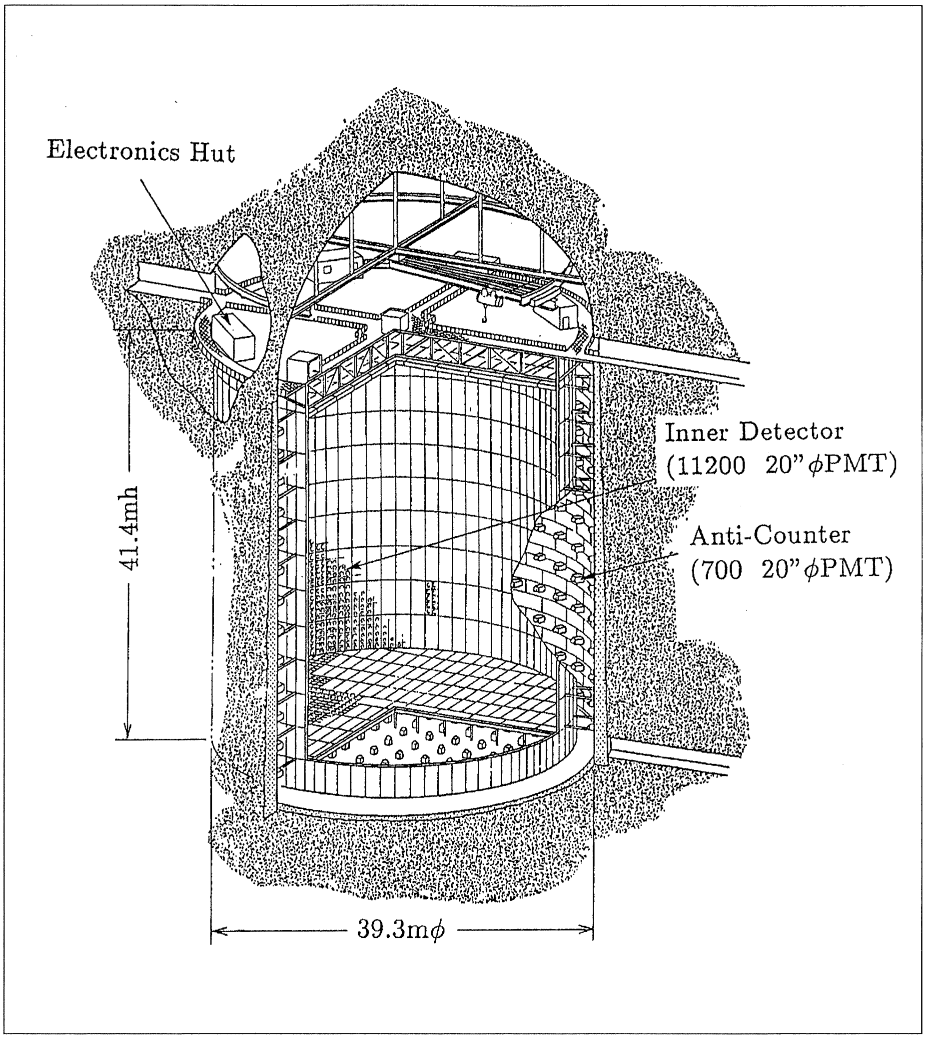
# SUPERCOLLIDER Preparing for experiments

Following an initial selection of two experiments from the letters of intent submitted last year (March, page 3), preparations for the research programme at the planned US Superconducting Supercollider (SSC) continue.

A two-detector scenario consisting of the SDC Solenoidal Detector Collaboration led by George Trilling and the L* collaboration led by Sam Ting has now been endorsed by the SSC Laboratory as providing opportunities for an outstanding initial scientific programme with significant complementarity, but which will need the full participation of the international community.

The next stage is submission of a technical proposal/design report from each of the two experiments by April next year, showing that its total cost will not exceed $500 million unless firm commitments from overseas expand the budget envelope.

This financial ceiling has serious implications in particular for the L*




*Sketch of the Japanese Super-Kamiokande underground neutrino detector, scheduled to come into operation in 1996.*