different size. Then a photocell picks up the light, flickering at twice the speed of the spinning wheel. After phase-sensitive detection the 123 cycle/sec components of the photocurrent send two signal voltages to a servo system that automatically orients the main mirror and centers the solar image on the occulting disk.

To find the vertical and diagonal components of the solar image, the sine and cosine terms of the second harmonic signal are analyzed by phase-sensitive detection equipment and then the amplitude is determined.

Voltages are averaged over one-minute intervals; then the whole system below the secondary mirror is turned 90 deg about a vertical axis to cancel errors connected with these components. The primary and secondary mirrors are also periodically turned 90 deg to eliminate astigmatism errors.

Since a systematic brightening of the sun could cause a systematic error in measuring oblateness, the experimenters made measurements for three different amounts of exposed limb. The sun was found to be remarkably uniform in brightness—there was a temperature variation between pole and equator of at most 3°.

An elliptical sun. Dicke and Goldenberg find that the fractional difference between equatorial and polar radii is $(5.0 \pm 0.7) \times 10^{-5}$, which indicates that 8% of the Mercury perihelion precession may be due to a solar quadrupole moment. They note that this implies an 8% discrepancy in the Einstein value and lends support to a scalar-tensor theory.

Dicke, at the Texas Symposium, remarked, "It wouldn't surprise me if general relativity is just plain wrong." Many relativists in the crowded Statler Hilton ballroom did seem surprised; in the heated question period that followed, Dicke was barraged with objections. He appeared to have thought of all of them, however. Dicke remains convinced that if oblateness and perihelion measurements are accurate, general relativity is in trouble. —GBL

Superconductor Acts as Phonon Generator and Detector

If you excite quasi-particles in a superconductor, you can generate and detect phonons. Aly Dayem and Wolfgang Eisenmenger, who reported their work in the 23 Jan. issue of *Phys. Rev. Letters*, have built such a quantum generator and detector of phonons at 300 GHz. The same technique can be used over a large frequency range where conventional generators and detectors become prohibitively difficult. Until now phonons have been generated only piezoelectrically and at much lower frequencies.

In the experiment, done at Bell Telephone Laboratories, Dayem and Eisenmenger put two identical superconducting tunnel diodes at opposite ends of a sapphire rod. In the first diode, quasi-particles are injected by tunneling; they then relax, recombine and generate phonons, which are detected by the second diode.

The tin-tin-oxide-tin tunnel diodes are built as crossed stripes of tin; the first stripe, 100 nanometers thick, is evaporated onto the oxide layer that forms on the first stripe. The diode-crystal combination is immersed directly in a liquid helium bath.

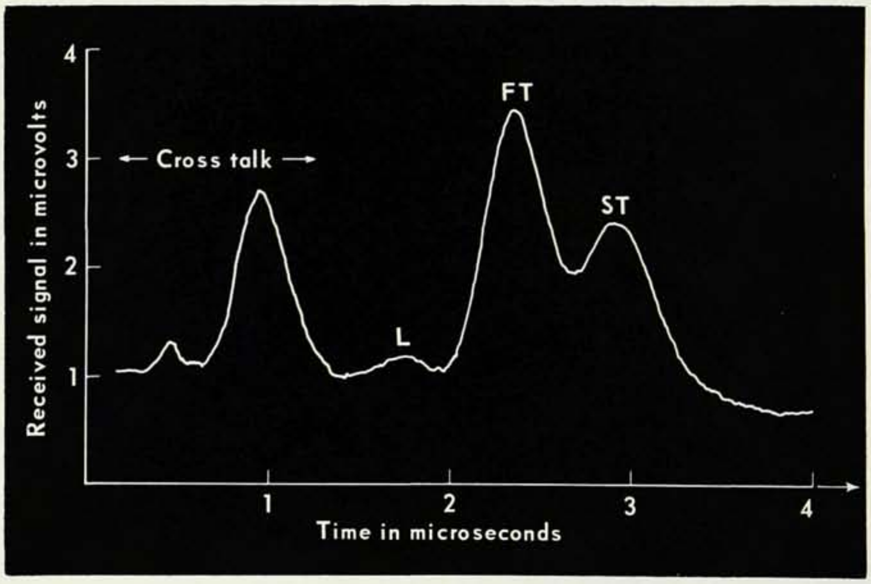
Eisenmenger and Dayem bias the generating diode at a voltage at least as big as the energy gap, 2Δ; they keep the receiver biased at less than 2Δ.

In their paper, Eisenmenger and Dayem draw the following conclusions: (a) An excited quasi-particle of energy E (measured from the Fermi level) relaxes first to the top of the energy gap, emitting a phonon of energy $E - \Delta$. Then pairs of quasi-particles of opposite spin and momentum recombine, emitting phonons of energy 2Δ. (b) Phonons incident on the receiving diode produce a change in the tunneling current, which depends on both the frequency and number of the phonons. The detector is sensitive only to phonons with energy greater than or equal to 2Δ. Thus, as Dayem told PHYSICS TODAY, the tunnel junction can be used as a quantum counter.

To excite the quasi-particles, the experimenters apply dc pulses 2.5 microsec long, at a rate of 10kHz. At the receiving diode they keep a constant dc bias of 0.8 mV.

The figure shows receiver signal as a function of time. At the left, one can see the electrical signal. Then there are three peaks due to acoustical signals; these correspond to longitudinal, fast and slow transverse modes of propagation in the sapphire.

For tin the experimenters find a phonon frequency of about 300 GHz. Dayem notes that if they use lead instead, they can generate 633 GHz; for



SIGNAL RECEIVED VS TIME. Phonons are both generated and detected by superconducting tunnel diodes evaporated on opposite ends of a sapphire rod. Peaks labeled L, FT and ST correspond to longitudinal, fast transverse and slow transverse modes of propagation in sapphire.

Nb_3Sn they can produce 800 GHz. Since the energy gaps in the quasi-particle spectrum of superconductors correspond to a frequency span of 1–1000 GHz, the new technique seems to have great potential.

If one wants to improve the efficiency of detection, Dayem says, one can simply increase the area of the tunnel diode and decrease the separation of the two diodes.

All you need to make superconductors act as phonon generators is to excite quasi-particles somehow, Dayem remarks. He is now preparing to do this optically, using a laser as the energy source. —GBL

1.5-GeV Electrons, Positrons To Circulate Soon at Adone

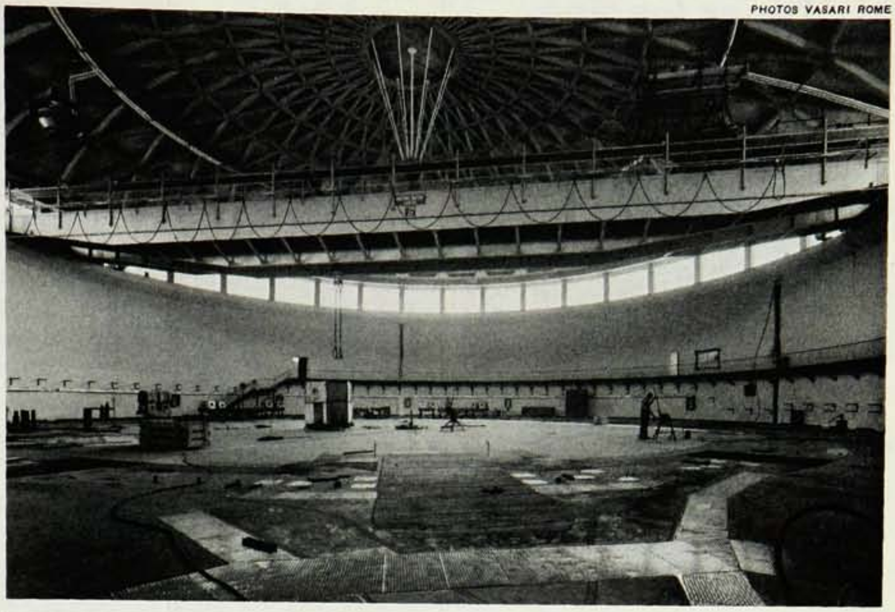
Beam testing in the 1.5-GeV Adone storage ring for positrons and electrons is expected to begin this year at Frascati Laboratories, run by the Italian Institute of Nuclear Physics (INFN). The ring, expected to store 2×10^{11} particles per beam, will be able to deliver a beam to any of four crossing regions that are free for setting up experiments. The ring has a mean radius of 16.7 meters, but the radii of the curved orbit sections (which alternate with straight sections around the circumference) is only 5 meters. Useful aperture will be 22 by 10 cm.

The ring will act as its own synchrotron. It is fitted with 12 bending magnets and 48 quadrupole magnets to produce strong focusing and two rf accelerating sections to compensate for energy radiated. The same rf accelerating sections will increase the energy of particles injected at 350–400 MeV to 1.5 GeV in about 1 sec.

The injector, an S-band linac built by Varian Associates, has been operating since last fall. It delivers electrons at 390 MeV (100 mA peak current), all of them within a 2% energy band, and about 60 mA within a 1% energy band. The average electron current is 80 microamp, equivalent to 5×10^{14} electrons per second. Power of the resulting beam is 31 kW.

Positrons are delivered at 360 MeV (1 mA peak current). About 0.6 mA are contained within a 2% energy band. Both positron and electron pulses last 3.2 microsec and occur at a frequency of 250 per second. Average positron current is about 0.8 microamp, equivalent to about 5×10^{12} positrons per second. The linac can supply beams directly to an experimental hall as well as feed the storage ring.

PHOTOS VASARI ROME



1.5-GEV ELECTRON-POSITRON STORAGE RING at Frascati is nearly finished. Upper photo shows ring building last July. Lower photo shows ring building (left), power station and laboratories.

The storage ring will be fed by 2 or 3 pulses per second, and filling is expected to take less than half an hour.

The following were among the proposals discussed at a meeting on experiments with Adone, held at Frascati in February 1966:

ϕ-meson production (line shape and branching ratios),

single-neutral-boson production,

production of μ pairs,

production of π and K pairs,

wide-angle 2-γ annihilations and $\pi^0\,\gamma$ production,

proton form factors from proton-antiproton production,

magnetic devices for analysis of many-body annihilations.

The Adone electron-positron ring was promoted by INFN and was funded mainly by the Italian National Committee for Nuclear Energy; the Italian National Research Council paid for the linac. Total foreseen cost (excluding experimentation) is about \$9 million, of which \$2.5 million are for the linac. The Frascati laboratory is located at the town of the same name 30 km southeast of Rome.

When the electron and positron