transition from an insulating state to a conductive state. A variety of models has been proposed, but little experimental verification exists for any of them. —GBL

*References*

1. S. R. Ovshinsky, Phys. Rev. Letters **21**, 1450 (1968).
2. B. T. Kolomiets, E. A. Lebedev, Radiotechnika i elektronika **8**, 2097 (1963).
3. A. D. Pearson, W. R. Northover, J. F. Dewald, W. F. Peck Jr, *Advances in Glass Technology*, Plenum Press, New York (1962), p. 357. J. F. Dewald, A. D. Pearson, W. R. Northover, W. F. Peck Jr, J. Electrochem. Soc., Sept. 1962, p. 243 C.
4. D. L. Eaton, J. Am. Ceram. Soc. **47**, 554 (1964).

### *Is There A New Mechanism For Superconductivity?*

The model proposed for the large positive isotope effect that Robert D. Fowler and his collaborators found last year in superconducting alpha uranium (under 10–11 kilobars of pressure) (PHYSICS TODAY, December 1967, page 60) has been criticized by Herbert Capellmann and J. Robert Schrieffer of the University of Pennsylvania (*Phys. Rev. Letters* **21**, 1060, 1968).

The Fowler group at Los Alamos Scientific Laboratory had found that the superconducting transition temperature $T_c$ varied as $m^{2.0}$ for $U^{235}$ and $U^{238}$; for other known substances $T_c$ goes as $m^{\alpha}$ with $\alpha$ negative or zero. They suggested that the pairing interaction causing superconductivity in alpha uranium is due to an electronic-core polarization involving low lying f states; lighter atoms are more susceptible to lattice vibrations, which would reduce electronic-core polarization.

Capellmann and Schrieffer argue that the Fowler proposal would only account for an $\alpha$ of about $10^{-2}$. Assuming that the attractive interaction $V$ in alpha uranium is due to electronic-core polarization, they show that another source of mass dependence of $T_c$ is the dependence of $V$ on interatomic spacing. As $V = |M|^2/E$ where $M$ is the matrix element describing the scattering process and $E$ is the energy of the low lying f states with respect to the Fermi energy, the dependence can occur either through a shift of $E$ or a change in $M$ or both. Since the amplitude of zero-point atomic motions depends upon mass, $T_c$ would depend on mass. A rough calculation using the observed pressure dependence of $T_c$ yields $\alpha = 0.44$.

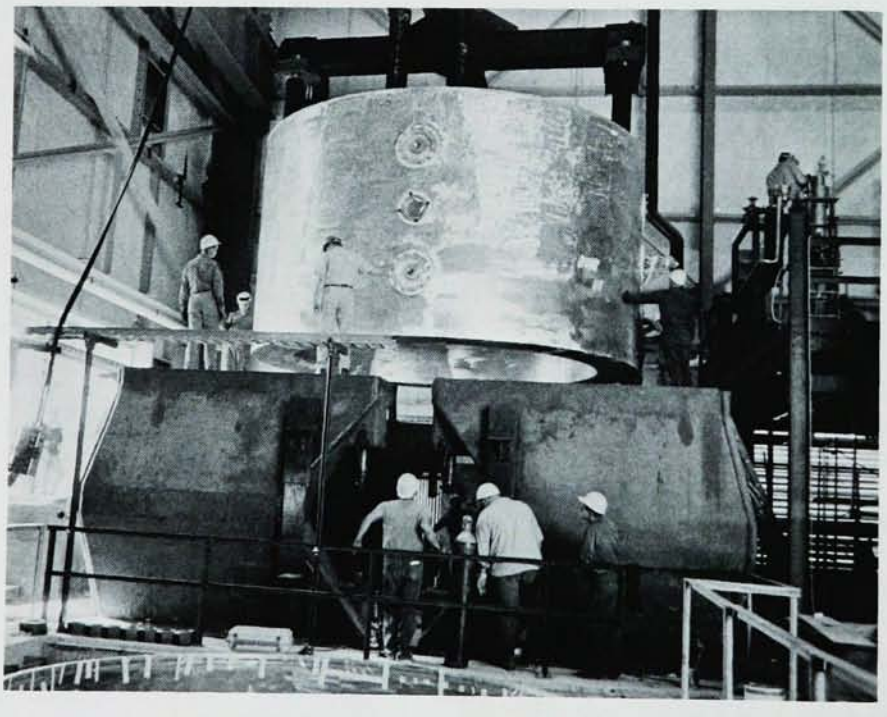
We asked Hunter Hill, one of Fowler's collaborators, to comment on Capellmann and Schrieffer's Letter. Hill was pleased that the Penn physicists had demonstrated that low lying f levels could produce a sizable positive isotope effect through electronic core polarization. He pointed out that $\alpha \approx 2$ is not excluded by their order-of-magnitude calculation.

The Penn physicists note work by James Garland and F.M. Mueller, who pointed out at the Washington APS meeting last spring that the uranium positive isotope effect could still be explained by the phonon mechanism provided it acted in a region of rapidly varying density of states, such as the f bands.

Hill finds it difficult to comment in detail on Schrieffer and Capellmann's belief that the electron-phonon mechanism can explain the positive isotope effect in alpha uranium, since the work of Garland and Mueller has not been published. He says, "It does seem unfortunate, however, that the authors are inclined to revert to this position after having come so close to providing valuable insight into the peculiar properties of alpha uranium."

Since the value of $\alpha$ depends sensitively upon the band structure of alpha uranium and thus cannot be calculated from first principles, Garland and Mueller are using the experimental value of $\alpha \approx 2$ in order to fix the energy of the bottom of the f band in alpha uranium. Garland says they are using the model to attempt to explain the peculiar normal state properties of alpha uranium.

Capellmann and Schrieffer emphasize that there is still no positive proof that a new superconductivity mechanism is required to explain the effect.



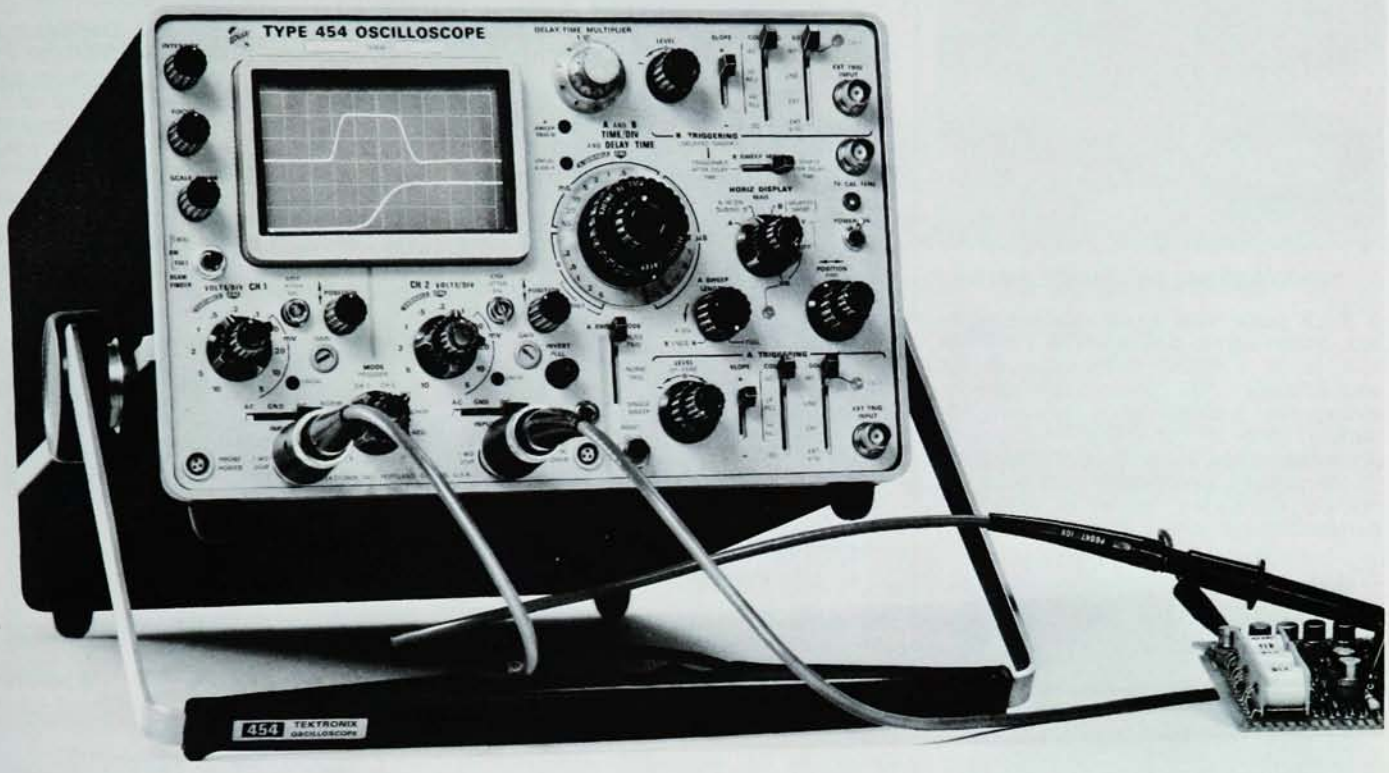
**WORLD'S LARGEST SUPERCONDUCTING MAGNET is lowered into its steel frame at Argonne National Laboratory. The 110-ton magnet will produce an 18-kG field for the laboratory's 3.7-meter bubble chamber, whose usable volume is 20 m³. The Mirabelle chamber nearing completion at Serpukhov is longer (4.5 m), but its usable volume is only 6 m³.**

### *Batavia Accelerator Staff Plans for Bubble Chambers*

Plans involving two bubble chambers for the National Accelerator Laboratory at Batavia, Ill. (née Weston) are going forward. NAL officials are exploring with Argonne National Laboratory and the Atomic Energy Commission the possibility of moving the 3.7-meter hydrogen bubble chamber (photo, left) now under construction at ANL. A decision will be made a year or two before the 200-GeV machine is turned on. At the same time NAL and Brookhaven groups will

product report
portables

# 150 MHz, 2.4 ns Portable Oscilloscope




## PERFORMANCE

The Tektronix Type 454 is an advanced design portable oscilloscope providing measurement of fast-rise pulses and high-frequency signals beyond the capability of most conventional real-time oscilloscopes. New miniature 10X probes permit specifying the 150-MHz bandwidth, 2.4-ns risetime performance at the probe tip—where you need it!

The Type 454 is a complete instrument package with dual-trace displays at 5 mV/div deflection factor, triggering to above 150 MHz internally or externally and 5 ns/div normal or delayed sweep. Full bandwidth measurements (150 MHz) are provided at 20 mV/div deflection factor. For low-level applications the Type 454 provides single channel 1 mV/div at 33-MHz bandwidth. Full-sensitivity X-Y operation (CH 1 drives the horizontal, CH 2 drives the vertical) is also provided with phase difference between X and Y not exceeding 3° from DC to 2 MHz. An illuminated, parallax-free graticule defines the 6 x 10 div display area and a bright P31 phosphor contributes to sharp, clear waveform displays even under marginal conditions.

For single-shot applications a photographic writing speed of 3200 div/$\mu$s ($>$2500 cm/$\mu$s) is provided by the Type 454 Oscilloscope, C-31 Camera and 10,000 ASA film . . . without employing film fogging techniques!

## PORTABILITY

The Type 454 is mechanically designed to be easily carried. It meets temperature, humidity, vibration and shock tests which simulate environments "portable" instruments may encounter. A dust-tight front cover protects the panel and serves as a convenient storage compartment for accessories. The handle may be rotated to several positions to serve as a tilt stand or adjusted for convenient carrying. All these features and more are packaged in a rugged 31-pound instrument.

## RELIABILITY

Advanced design concepts and the use of solid-state components insures long-term stable performance and permits operation within specifications over an ambient temperature range of $-15°$ to $+55°$.

Your Tektronix field engineer will demonstrate the Type 454 performance capabilities in your application, at your convenience. Please call him or write Tektronix, Inc., P.O. Box 500, Beaverton, Oregon 97005.

| | |
|---|---|
| Type 454 (Complete with probes and accessories) . . | $2600 |
| Type R454 (Rackmount) . . . . . | $2685 |

U.S. Sales Price FOB Beaverton, Oregon

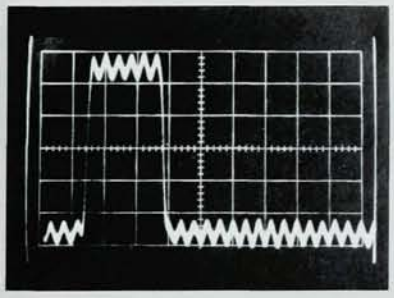
*please turn page for additional information*

# Making the Measurement . . . with the Tektronix Type 454 Portable Oscilloscope


***The total value an instrument provides its user is related to its ease of application in making practical measurements. Compatible accessory items such as voltage and current probes, special purpose probes, cameras, Scope-Mobile® Carts, etc. contribute significantly to a total measurement capability and are essential if the user is to utilize instrument performance to full advantage.***

### DIFFERENTIAL MEASUREMENTS

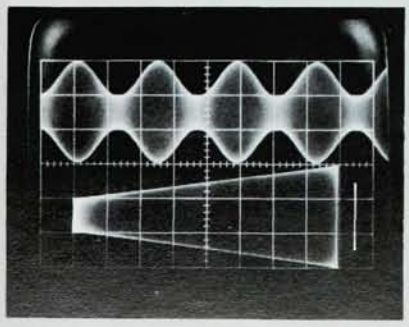
A 5-mV pulse with 1-volt, 50-MHz common mode signal displayed on the Type 454 using a P6046 Differential Probe and Amplifier. The photograph demonstrates the ≥1000:1 common-mode rejection ratio of the P6046 Probe and Amplifier. This same Probe/Amplifier/Oscilloscope combination provides 1-mV/div deflection factor at ≈70 MHz bandwidth!



Vertical - 1 mV/div; Horizontal - 50 ns/div

### X-Y

The Type 454 converts to a calibrated X-Y Oscilloscope with a flick of two front panel switches. Phase difference between X and Y is less than 3° from DC to 2 MHz. The upper display is a 150-MHz signal that is 50% modulated by a 2-kHz signal. The lower display is an X-Y trapezoidal modulation pattern showing the 150-MHz AM signal vertically (Y) and the 2-kHz modulation signal horizontally (X). The straight vertical line to the right of the photo represents the unmodulated carrier amplitude. Multiple exposure.

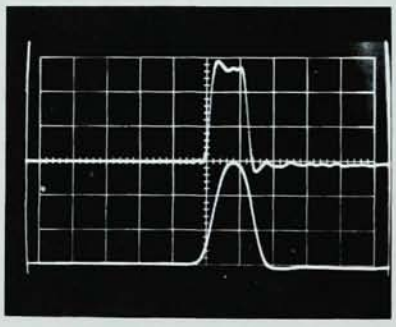


### MEASURING CURRENT

The new P6042 Current Probe provides measurements from DC to 50 MHz with sensitivity to 1 mA/div. Other Tektronix AC current probes are available and provide measurements from 8 Hz to 200 MHz.

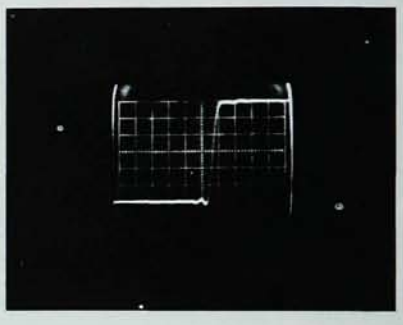

### PULSE FIDELITY

The same pulse displayed by the Type 454, upper trace, and by a 7-ns, 50-MHz Oscilloscope, lower trace (double exposure). Note the difference in detail of the pulse characteristics displayed by the Type 454 with its 2.4-ns risetime performance. Full bandwidth/risetime performance is preserved by the miniature P6047 10X Probes supplied with the Type 454. The optional P6048 10X Probe offers additional high-frequency measurement performance with 1-pF input capacitance.



### PHOTOGRAPHIC WRITING SPEED

The Tektronix Type 454 Oscilloscope, C-31 Camera, 10,000 ASA film and P11 CRT phosphor provide a minimum photographic writing speed of 3200 div/μs (>2500 cm/μs) without employing film fogging techniques. This writing speed is in excess of that required to record a single-shot pulse at the risetime and screen height limits of the Type 454 . . . the important extra margin of performance a high-frequency oscilloscope should have.



5 ns/div


***Your Tektronix Field Engineer will demonstrate the Type 454 in your application at your convenience. Please call him, or write: Tektronix, Inc., P.O. Box 500, Beaverton, Oregon 97005.***

| | |
|---|---|
| Type 454 | $2600 |
| Type R454 (Rackmount) | $2685 |
| C-31 Camera | $ 550 |
| P6046 Differential Probe and Amplifier | $ 690 |
| P6042 Current Probe | $ 600 |
| P6048 DC-to-140 MHz 10X Voltage Probe | $ 50 |
| Type 200-1 Scope-Mobile Cart | $ 75 |

U.S. Sales Price FOB Beaverton, Oregon

**Tektronix, Inc.**

***committed to progress in waveform measurement***

design together a very large (100-m$^3$) hydrogen-deuterium chamber.

Because NAL's actual mailing address is Batavia and the name Weston is now associated with civil-rights problems, the lab decided to emphasize its Batavia location.

Mid-1972 is the target date for finishing the accelerator, and the end of 1973 for the entire laboratory.

### *Lamb-Effect Sources Make Better Polarized Ion Beams*

Spin dependence of nuclear forces is probably becoming more accessible to experiment as makers of polarized ion beams improve their sources. Two methods appear to be battling for the honor of producing the most intense and best polarized beams. The "conventional" one throws out ground-state atoms you don't want with inhomogeneous magnetic fields and keeps the ones you do want.

The other method starts by making metastable 2S atoms; then it quenches the unwanted ones by causing them to mix with the short-lived 2P state and drop through it into the ground state. With their own version of the quench method, which they call a "spin filter," Joseph L. McKibben and his colleagues at Los Alamos have been able to make 300 nanoamperes of 90%-polarized $H^-$ ions and 600 nA of 78%-polarized $D^-$.[1]

At Lake Forest College, Bailey Donnally has developed the quench method, basing his work on observations of Willis E. Lamb Jr, R. Curtis Retherford and E. K. Zavoiskii.[2] Hydrogen (or deuterium or tritium) atoms with their electrons in the metastable $2^2S_{1/2}$ state differ in energy from the short-lived $2^2P_{1/2}$ atoms by the Lamb shift. In a 575-gauss field 2S atoms with electron spin opposite to the field ($M_J = -1/2$) have the same energy as 2P atoms with $M_J = +1/2$. A small electric field mixes the states, and the $M_J = -1/2$ atoms fall into the ground state leaving undisturbed those 2S atoms with $M_J = +1/2$.

Thus the beam becomes electronically polarized, and when it passes adiabatically into a weak magnetic field, electrons couple with nuclei producing 50% nuclear polarization. Then you can add or subtract an electron to make ions that you can send through an accelerator.

**GROUNDBREAKING** task is shared by Robert R. Wilson, (left) director of the National Accelerator Laboratory, and AEC chairman Glenn Seaborg at the Batavia, Ill. site. First permanent building will house the 200-MeV linac injector. The 200-GeV proton synchrotron is scheduled for completion in 1972.

Leon Madansky and George E. Owen[3] had shown earlier that the method was possible, but the experimenters had had difficulty making enough metastable atoms and ionizing them selectively. Too many ground-state atoms became ionized in collisions and contaminated the beam. But Donnally and coworkers solved both problems. They made metastables by allowing protons to pick up electrons in the 2S state from cesium atoms. The charge transfer is nearly resonant, and they managed 5% efficiency.[4] Then they found that with 500-keV kinetic energy a metastable atom would pick up an additional electron from argon atoms 300 times as readily as would a ground-state atom.[5]

The resulting negative ion is appropriate for a tandem Van de Graaff, and Willi Haeberli and colleagues have in-