

permit Wu and her collaborators to accept only events showing simultaneous tracks from the same spot and displaying appropriate curvature in their 400-gauss field. The streamer chamber and magnet reduce background event rate due to external radiation by a factor of 6000 from what they would have obtained with only counters. The source was 10.6 grams of 97%-enriched  $\text{Ca}^{48}$  deposited as calcium fluoride and sandwiched between 3-mg/ $\text{cm}^2$  aluminum foils. A similar natural-calcium source served for background measurements.

After background has been subtracted, results from the counters show coincidence spectra and single-electron spectra that are consistent with current beta theory.

The group has definite evidence, however, that the  $\text{Ca}^{48}$  source is contaminated with a minute amount of radioactivity that produces beta-gamma cascades and causes false observations of double-beta coincidences. Because these false events are very similar to lepton-conserving double beta decays, they are not certain what fraction of their observed events actually are double beta decays. They are working on source purification in

the hope that some of this uncertainty will be removed.

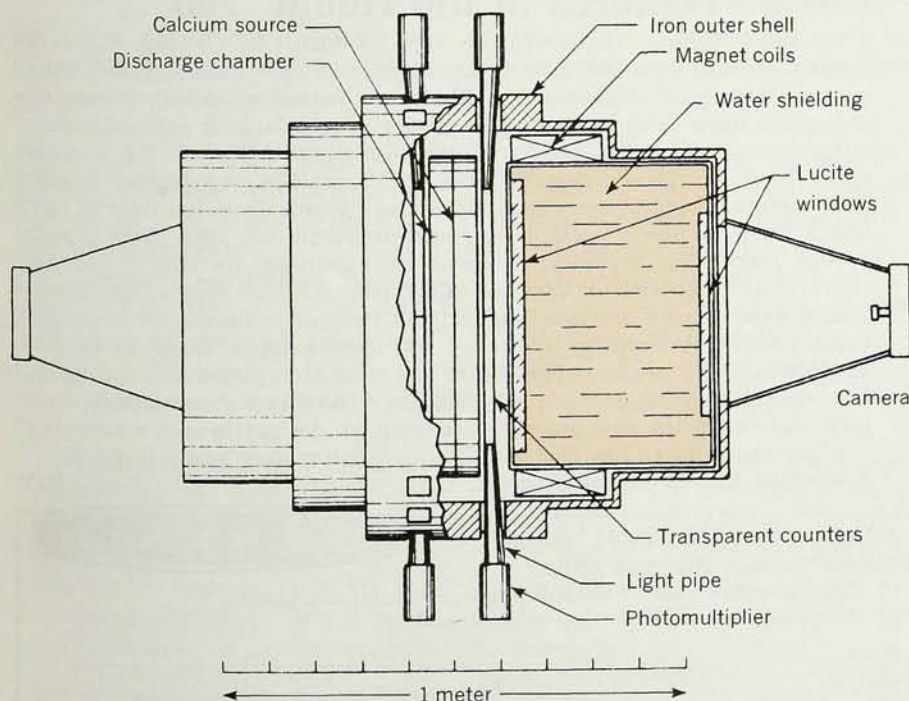
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### Wanted: Parent for High-Energy Muons

A new mechanism for muon production may be required to explain recent cosmic-ray observations. While measuring muon background with their neutrino detector a group at the University of Utah (Haven E. Bergeson, Jack W. Keuffel, Michael O. Larson, E. Ray Martin, Grant W. Mason) unexpectedly found that for muons with energies from 1000 to 10 000 GeV there was almost no variation in intensity with zenith angle.

Unlike other detectors of neutrinos from cosmic rays and the sun, the installation is only 600 meters below ground; so high-energy muons can still penetrate. The apparatus consists of an array of water-filled Cerenkov counters and cylindrical spark



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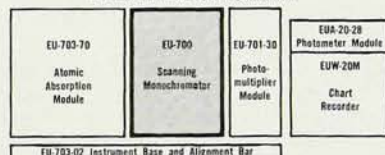


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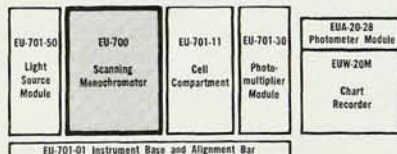
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counters  $6 \times 12 \times 10$  meters (PHYSICS TODAY, May 1966, page 88).

The only known ways to make large amounts of high-energy muons are from the decay of pions or kaons. Pions or kaons have relatively long lifetimes; accordingly, they need time (and consequently a long mean free path) to decay. Tangential pions and kaons stay longer in the rare portions of the atmosphere, so it was expected that the muon flux would be much greater tangential to the earth's atmosphere than perpendicular. Since the Utah experimenters see almost no variation, they conclude that the majority of cosmic-ray muons with energies greater than 1000 GeV are produced either directly or as the progeny of a parent that decays copiously into muons with a lifetime much shorter than that of the kaon.

The experiment has excited considerable interest. One intriguing candidate for parenthood is the long-sought intermediate boson (W particle), which might be the carrier of the weak interaction. Keuffel and his collaborators suggest that experimenters should now look in emulsions for high-energy muons and electrons, which would be expected if a W particle was being produced.

# IN BRIEF

On 7 Dec. the National Bureau of Standards Reactor (PHYSICS TODAY, November 1966, page 38) went critical. The heavy-water-moderated reactor, intended primarily for materials research, will be tested at low power until money to run it at 10 MW is available.

The Graphite Low Energy Experimental Pile (GLEEP) at Harwell celebrated its 20th anniversary in August, and is now the world's oldest operating reactor. The graphite reactor at Oak Ridge ran for 20 years, also, but was shut down on its birthday in 1963. GLEEP is currently being used for materials testing at a low operating power of 3 kW; it has been run at 80 kW.

A spacecraft should rendezvous with Halley's Comet on its next appearance (in 1985-86), according to Herman Michielson of Lockheed. He says it may even be possible to land on the comet's solid nucleus.

Meanwhile the Utah experimenters are adding additional muon detectors along the tunnel. By measuring the transverse momentum that muon pairs have with respect to each other, the group hopes to find out if the parent or parents are very heavy.

Results were reported in *Phys. Rev. Letters* 19, 1487 (1967).

## Deuteron D-State Helps Explain J Dependence in p,d Reaction

The type of spin dependence in direct nuclear reactions that was found in 1964 by Rubby Sherr, Ernest Rost and Martin Rieck appears to be explained well by some recent calculations of R. C. Johnson and Filipe D. Santos of the University of Surrey (reported at the Tokyo Nuclear Structure conference). The theorists, using the distorted-wave Born approximation, calculated cross section as a function of angle for p,d and d,p reactions. They found that, although the deuteron wave function is predominantly S-state, one must also include D-state contributions in the calculation to account for the forward-angle variation of deuteron angular distributions with the spin J of the final nucleus. Large-angle spin dependence, also discovered in 1964 by Linwood Lee Jr and John Schiffer, awaits explanation.

The midlatitude auroral red arc, a faintly glowing toroid that encloses the earth, will be studied by a new observatory being built at the University of Michigan.

Bunching of Van Allen electrons has been discovered by a Bell Labs experiment aboard ATS-1, a communications satellite in synchronous orbit. Irregular fluctuations in the solar wind apparently cause the bunches, which can be followed through several transits through the belt. Distortions of the belt by solar wind cause a day-to-night variation by factors of 10 to 100.

A nuclear-powered heart pacemaker expected to last ten years is being tested by AEC. Although the present model is electrically powered, eventually the device will use the heat from  $\text{Pu}^{239}$  decay to produce electricity.

Neptunium isotopes now number 13 with the discovery of  $\text{Np}^{229}$  and  $\text{Np}^{230}$  at Oak Ridge by R. L. Hahn, M. F. Roche and K. S. Toth. □

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