products mounts the Coulomb barrier of the second tungsten nucleus, making something in the actinide region, for example. Or a uranium contaminant in the beam stop could react with a spallation product, leading to a spontaneously fissioning species.

What next? Just about every available beam stop used at a high-energy accelerator has been spoken for. Brookhaven AGS targets, for example, have been sent to Oak Ridge, Argonne and Rutherford High-Energy Lab so that they can be searched for evidence of superheavies. In addition a group at Argonne is processing a uranium target from the ZGS for superheavies.

Marinov and his collaborators are doing a new experiment, using a thin source and sandwiching it between two surface-barrier detectors. They will try to measure the energy distribution of the fission fragments.

At Brookhaven several checks on the British work are in progress. In the chemistry department a group of investigators has put tungsten, uranium and gold targets into the AGS beam. They follow the target with a Mylar absorber and a fused-silica track detector and look for the cross section for production of very energetic, heavy fragments. Another experiment uses a thin target, followed by a stack of thin aluminum catcher foils, which are then processed chemically to look for very energetic spallation products. In a third experiment a uranium or lead target is irradiated and one uses track detectors to look for fission tracks from delayed fission. In the physics department a group is checking to see if the British group actually found a long-lived fissioning isomer of mercury. They bombarded a sample of normal hafnium with O^{16} or O^{18} ions and tungsten with C^{12} ions from the new tandem Van de Graaff. Solid-state detectors and plastic particle detectors are being used in a search for alpha emitters and fission events.

At Oak Ridge, Raymond Stoughton and his collaborators are using an AGS tungsten beam stop to look for neutrons being emitted. Because their background is very low, if the target contains element 112 they should be able to determine the number of neutrons emitted per fission by using a neutron multiplicity counter and looking for coincidences. The number is expected to be high (say 8 to 11 neutrons per fission), because element 112 is expected to be comparatively neutron rich.

At Argonne Paul Fields is using an AGS target to look for alpha particles and fissions from the actinide elements, as well as high-Z elements.

A CERN–Orsay collaboration involving René Bernas is trying to separate eka-lead and eka-mercury from a uranium target, rather than a tungsten target. Because of their skepticism regarding the mechanism invoked by Marinov, the group is following the suggestion by A. M. Poskanzer, Gilbert Butler and Earl Hyde (Berkeley) that high-energy neutron-rich fragments can by secondary reactions on uranium produce superheavies.

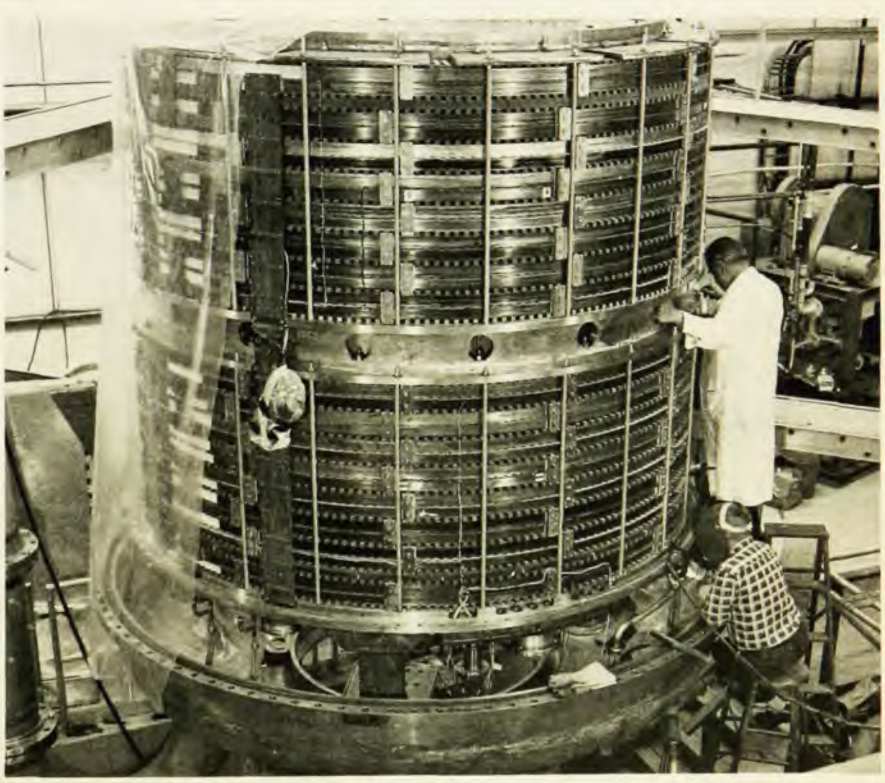
The experiments mentioned are only a few of the many now under way to check the validity of the British experiment. Although many doubts have been raised about the conclusions, many hopes have been raised, too. —GBL

1000 GeV with superconducting magnets at Batavia?

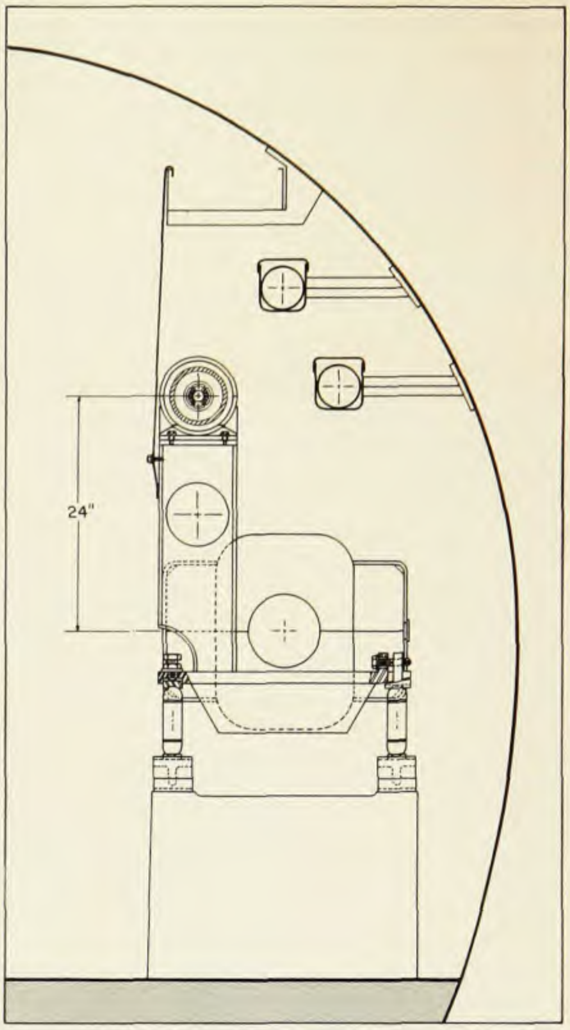
With a modest extension the Batavia accelerator may be able to produce 1000-GeV protons, double the expected 500-GeV maximum, according to National Accelerator Laboratory director Robert R. Wilson. On 9 March Wilson told the Joint Congressional Committee on Atomic Energy how a relatively inexpensive device ($10–20 million) consisting of small-bore superconducting magnets could act as an "energy doubler" that would pay for itself within the first few years of operation.

NAL construction has consistently been ahead of schedule and below estimated costs (see *physics today*, June 1970, page 29). The accelerator was originally designed to start operation with 200-GeV beams and have the capability of producing 500-GeV beams at some later date. It turned out, however, to have the capability for 500-GeV beams right from the start, and at a cost lower than that estimated for 200 GeV.

The energy-doubler concept would place very small-bore (3-cm) superconducting magnets just above the magnets in the one-and-a-quarter-mile diameter main ring, and would have the same configuration as the main-ring magnets—for example, focusing magnet above focusing magnet. After protons are accelerated in the main ring, they are transferred to the superconducting ring, whose magnetic field is maintained at the main-ring value. Then the field in the supercon-



SUPERCONDUCTING MAGNET for Brookhaven 7-foot bubble chamber. The 8-foot diameter, 8-foot high magnet, the largest and highest field air-core superconducting magnet ever built, has lived up to its designers' expectations; it achieved an operating field of 28.2 kG in a trial run. Other large bubble-chamber magnets have either iron cores (such as at the 12-foot Argonne bubble chamber) or water-cooled copper coils. The bubble chamber will be used to detect neutrino events produced in beams from the 33-GeV Alternating Gradient Synchrotron (AGS). Experiments are expected to begin in summer 1972 when modifications of the bubble chamber and construction of a new experimental area at the Brookhaven laboratories have been completed.



Energy doubler proposed by Batavia. Cross-sectional view shows ring of superconducting magnets mounted two feet above the existing main ring of conventional magnets.

ducting ring is doubled, and this doubling, along with rf acceleration, doubles the proton energy.

"In a sense," said Wilson, "the old main ring would become a booster accelerator for the new main ring, now made of superconductors." Many of the problems related to the use of superconductivity in pulsed accelerators would be reduced because the injection field of the new magnet would be very high. It would only be necessary to double the field, from about 22 kG to about 45 or 50 kG, rather than raise the field all the way from zero to 50 or 60 kG. The magnets would be small in aperture, so that the power supply would be a manageable size, and, of course, the small magnets would be cheaper than large ones. Wilson expects that operation above 200 GeV would be cheaper with the superconducting magnets than with the present copper and iron magnets, and that installation of the superconducting magnets might make additional water-cooling or electrical-load smoothing devices unnecessary. He stressed, however, that his projection was based "only on the most preliminary of studies."

Experimental work on superconducting synchrotron magnets is going on at Brookhaven, Lawrence Radiation Laboratory, Saclay, Karlsruhe and the Rutherford High-Energy Laboratory. At Brookhaven, a study has been done on the feasibility of converting the 33-GeV alternating-gradient synchrotron to a 120-GeV synchrotron with superconducting magnets.

The recently approved 300-GeV CERN accelerator (see page 63) may also use superconducting magnets. In the "missing-magnet" design, the accelerator ring would initially include only every other magnet, and would yield 200-GeV beams. The additional magnets would be added later, and so options could be kept open to see how superconducting-magnet technology progressed. Installation of superconducting magnets in the gaps would increase the maximum energy to 700 GeV, compared with 400 GeV for the conventional magnets, and might eventually provide 1000 GeV.

Summarizing progress at NAL, Wilson told the committee that construction of the booster synchrotron, which takes 200-MeV protons from the linac (finished last December) and raises their energy to 8 GeV, is now complete; the booster is now being tested and has already produced a 1-GeV beam. The four-mile long main-ring tunnel has been built, and about half of its 1000 magnets are in place. Beams of 1-GeV protons from the booster, in fact, have been injected into the main ring, and studies of their orbits are under way.

NAL has had a slower than expected funding rate. Wilson complained to the committee that they have so far received only $150 million of the projected $250 million for construction, and only $13 million of the $60 million for equipment. President Nixon's budget for fiscal year 1972 includes $48 million for construction, $11.9 million for operating funds and $8 million for equipment. "We have been responding to this low rate of funding by doing only the most urgent construction, by making sure that no contingencies arise, by keeping the number of employees to an absolute minimum, by exploring technical innovations—such as the energy doubler—to keep down operating costs, and by scrounging used and old-fashioned equipment to bolster our meager equipment funds. . . ." MSR

New coordination between universal and atomic time

Coordinated Universal Time (UTC), the time scale based on the Earth's rotation, will be changed on 1 January next year to ensure that the difference between UTC and International Atomic Time (IAT) will always be a whole number of seconds. The plans, approved by the International Radio Consultative Committee at its February meeting in Geneva, should simplify life for physicists who use precise frequency generators or other precise timing devices.

At present the time scale based on the earth's rotation and the atomic-based scale are coordinated by slowing the atomic scale and by adding or subtracting fractions of a second several times each year. On 1 January, UTC will be reset a few hundred millisec to differ exactly 10.000 sec from IAT. Thereafter, "leap seconds" will be added every 12 or 18 months to keep a difference of an integral number of seconds between the two scales.

Mauna Kea observatory has 88-inch telescope running

Atop the extinct volcano, Mauna Kea, 13 600 feet high, the University of Hawaii's new 88-inch reflector telescope is now operating. The instrument was manufactured by the Boller and Chivens division of Perkin-Elmer Corp. Two 24-inch telescopes are also located in the laboratory.

The Mauna Kea complex cost $6 million, $3 million of which came from NASA, $1 million from NSF; the state of Hawaii paid the rest. Its low latitude allows observation of more southerly stars than can be obtained from mainland observatories. □