

of elements 99 and 100. A twenty-day activity emitting alpha particles of 6.6-MeV energy was identified as an isotope of element 99 (with the mass number 253), and a 7.1 MeV alpha activity with a half-life of 22 hours was identified as an isotope of element 100 (with the mass number 255).

The path of successive neutron captures by  $^{238}_{92}\text{U}$  and subsequent  $\beta^-$  decay of the capture products is shown in Figure 12. The  $\beta^-$  decay chains for each A value end in the first  $\beta$  stable nuclide. Thus the first isotopes of elements 99 and 100 produced in such a device are those with  $A = 253$  and  $255$ , respectively.

The large group of scientists who contributed to the discovery of elements 99 and 100 included A. Ghiorso, S. G. Thompson, G. H. Higgins, and me from the Radiation Laboratory and Department of Chemistry of the University of California; M. H. Studier, P. R. Fields, S. M. Fried, H. Diamond, J. F. Mech, G. L. Pyle, J. R. Huizenga, A. Hirsch, and W. M. Manning of the Argonne National Laboratory; and C. I. Browne, H. L. Smith, and R. W. Spence of the Los Alamos Scientific Laboratory (16) (Figure 13). These researchers suggested the name einsteinium (symbol E) for element 99 in honor of the great physicist Albert Einstein; and for element 100, the name fermium (symbol Fm) in honor of the father of the atomic age, Enrico Fermi, making these the first in a series of elements named after eminent scientists. The chemical symbols Es and Fm were adopted subsequently for these elements. The choice of name of fermium for element 100 has proven to be prescient since it is the last element to be synthesized using neutron capture reactions (which were extensively studied by Fermi).

Before removal of the "secret" label from this information and the subsequent announcement of the original discovery experiments could be accomplished, isotopes of elements 99 and 100 were produced by other, more conventional methods. Chief among these was that of successive neutron capture as the result of intense neutron irradiation of plutonium in the high-flux Materials Testing Reactor (MTR) at the National Reactor Testing Station in Idaho (Figure 14). The difference between this method of production and that of the "Mike" thermonuclear explosion is one of time as well as of starting material. In a reactor, it is necessary to bombard gram quantities of plutonium for two or three years; thus, the short-lived, intermediate isotopes of the various elements have an opportunity to decay. The path of element production proceeds up the valley of  $\beta^-$  stability. In the thermonuclear device larger amounts of uranium were subjected to an extremely high neutron flux for a period of nanoseconds; the subsequent beta decay of the ultraheavy isotopes of uranium led to the nuclides found in the debris.