monitoring compliance and is being considered for adoption as the standard method.

Research closely associated with this work resulted in other important applications of resin bead technology. These include: measuring plutonium and uranium concentrations in the environment, quantifying accidental human exposure through urinalysis testing, characterizing radioactive discharges and effluents, and measuring radioactivity in reactor cooling water in the event of an accident.

Resin bead technology also provided a simple method for accurately determining the amount of fuel used up in a reactor. The method is also used at Oak Ridge National Laboratory to determine the proportions of transuranium elements—plutonium, americium, curium, californium, and einsteinium—produced in a special reactor there. These elements increasingly provide important services to the public.

While there are growing numbers of applications for resin bead technology, one of the most important remains its use in monitoring compliance with the Non-Proliferation Treaty. Its use is straightforward, economic, and reliable. As reprocessing activity expands throughout the world, resin bead technology will play an increasingly important role in detecting the unauthorized use of special nuclear materials, thus helping to deter the further spread of nuclear weapons.

POSITRON EMISSION TOMOGRAPHY

Nearly one person in three eventually suffers some disease or disorder of the central nervous system—usually the brain—in his or her lifetime. Unfortunately for the afflicted, the more rapid development of successful treatments is hampered by incomplete knowledge of neurological function, physiology, and biochemistry.

These barriers are beginning to yield, however, with the help of a powerful new diagnostic tool for medical research, called positron emission tomography, or PET. Its development, stemming from three fields of research, namely nuclear chemistry, mathematics, and high energy physics, was aided significantly by support from Basic Energy Sciences.

During most of the 20th century, the brain and its associated network of nerves remained shrouded in a fog of clouded x-rays. Although dissection, exploratory surgery, and enhanced methods of x-ray photography were able to define certain aspects of nervous system *structure*, some of the more insightful physiological details of *function* laid beyond the reach of all available probes.

With the advent of PET, medical researchers can now observe selectively specific biological functions important to understanding the causes and cures of brain disease and other organ disorders. Further, a growing number of major hospitals and medical centers now use PET daily in clinical applications to diagnose illnesses and guide the treatment of patients.

In a related technique, known as CATSCAN (for computerized axial tomographic scan), x-rays are used to produce cross-sectional views of the structural aspects of human anatomy. In PET, by contrast; faint emissions from specially prepared drugs are used to chart the chemical activities of the body's life processes.

With PET, for example, it is possible to focus on biochemical reactions that pinpoint which brain cells trigger a patient's epileptic seizure or locate which muscle cells were damaged in a heart attack. Schizophrenia, depression, Alzheimer's and Parkinson's diseases, heart disease, and tumors of the brain are also being explored by PET. The findings are helping doctors prepare better treatments, in many cases before external symptoms become apparent.

The natural elements involved in human metabolism are carbon (C), nitrogen (N), oxygen (O), and hydrogen (H). The genius of PET is that its technology makes use of relatively rare and short-lived species of these elements, called radioisotopes. These radioisotopes have atomic weights that are different from the atomic weights of the natural elements: the radioisotope of carbon, for example, has an atomic weight of 11 and ordinary carbon has an atomic weight of 12. Using atomic symbols and their unusual atomic weights, these radioisotopes are labeled ^{11}C, ^{13}N, ^{15}O, and, by substituting fluorine for hydrogen, ^{18}F.

These radioisotopes can be chemically combined with other elements to form small molecules which, in turn, can be attached or "tagged" to sugars, proteins, steroids, or other probes. Once