History The scintillation camera was invented by Hal Anger in 1958 at the Donner Laboratory, an AEC-sponsored facility. A number of improved versions of the camera have been developed, building upon Anger's original invention. Paul Harper of the Franklin McLean Research Institute, developed in the 1960s the scanning camera concept that permitted the camera's field of view to be extended to make whole body scanning possible. A new version of the camera permits rotation around the long axis of a patient. Images acquired at a number of angles around the patient are used with a computer for highlighting three-dimensional characteristics of organs or structures of interest.

Benefits The nuclear cardiology procedures that use thallium-201 and technetium-99m are performed almost entirely with this camera. Thus, the numbers cited for patients diagnosed and the benefits associated with thallium-201 and technetium-99m apply to the Anger camera as well. About one in four patients in American hospitals has an examination with the scintillation camera as part of the process of medical diagnosis.

Anger cameras are now being interfaced with digital computers produced by specialized nuclear medicine manufacturers. By enhancing the images produced, such computers allow improved visual interpretation. More importantly, because the images are stored in the computer as a matrix of numbers, quantification is possible. Using mathematical models of physiological processes, the combination of Anger cameras and computers permits noninvasive measurements that were not previously possible.

In 1981, 6740 cameras were distributed among hospitals of all sizes in the United States.

Scanning Instruments—PET PET scanning is a technique used in nuclear medicine to provide virtually three dimensional images of body functions. The technique measures the direction and intensity of gamma rays from a positron emitting radiopharmaceutical in the body.

Computer Assisted Tomography (CAT) scanning, which has been called the most important advance in medical diagnosis in a decade, uses X-rays and sophisticated computer technology to provide views of the body's interior, revealing in striking detail the anatomy and structure of various organs. PET scanning carries tomography one step further, depicting the active functioning of body organs, such as blood flow and glucose metabolism in the brain. Thus, PET represents "new" nuclear medicine.

A person undergoing a PET scan breathes or is injected with a small amount of a radiopharmaceutical labeled with a short lived radioactive isotope of some element that occurs naturally in the body (such as oxygen, nitrogen, or carbon). The radioisotope, produced in a cyclotron, emits positrons while undergoing radioactive decay. (Positrons are particles that have the same mass as an electron, but a positive charge.) The positrons are attracted to electrons associated with the normal matter in the body, and when the particles meet (and annihilate each other), two gamma rays (each with 511 kiloelectron volt of energy) are emitted in opposite directions (180 degrees from each other).

The gamma rays are detected using a ring of radiation sensitive crystals placed around the patient's head or body. When two gamma rays are detected by opposing crystals at the same time ("in coincidence"), the site of annihilation is assumed to be along the imaginary line joining the two crystals. The set of such lines detected over time from different pairs of crystals is fed to a computer, which reconstructs an image representing the internal distribution of the radioisotope. The image of body function or structure of interest is then displayed on a video terminal or recorded on film.

History The first imaging device to exploit the unique geometrical properties of the positron-electron annihilation reaction using scintillation detectors was constructed with OHER funding in 1953 by Gordon Brownell at Massachusetts General Hospital. The first PET scanner (PETT) was built by Michel Ter-Pogossian and colleagues at Washington University in St. Louis in 1974, with support from the National Institutes of Health (NIH). Scanners subsequently designed and built with support from NIH, DOE, and industry include:

1. PETT III, IV, V, and VI at Washington University;
2. Donner 280 crystal tomograph at the University of California at Berkeley;
3. Emission Computed Axial Tomograph (ECAT);
4. Neuro ECAT at the University of California at Los Angeles (UCLA);
5. Neuro PET at NIH; and
6. Other new tomographs at Massachusetts General Hospital, the University of Texas, and the University of Pennsylvania.

Several manufacturers, including Positron Corporation (Houston, Texas), CIT, Inc. (Knoxville, Tennessee), and Scanditronix (Sweden), now market PET scanners. The average cost of a unit is around $1 million. Clinical applications of PET have included imaging of the cardiac blood pool and blood flow in the brain and heart by the Phelps (1976); imaging of the heart, lung, and brain by Ter Pogossian (1976) and Budinger (1979); and imaging of the cardiac blood pool and blood flow by Hoffman (1979).

Benefits Perhaps the most exciting use of the PET to date is to study brain metabolism quantitatively. In such studies, deoxyglucose, an analog of glucose that is taken up by metabolically active areas of the brain as glucose, is labeled with carbon-11 or fluorine-18 and then injected into a patient's blood stream. PET provides three-dimensional views of the brain that quantitatively reflect the rate