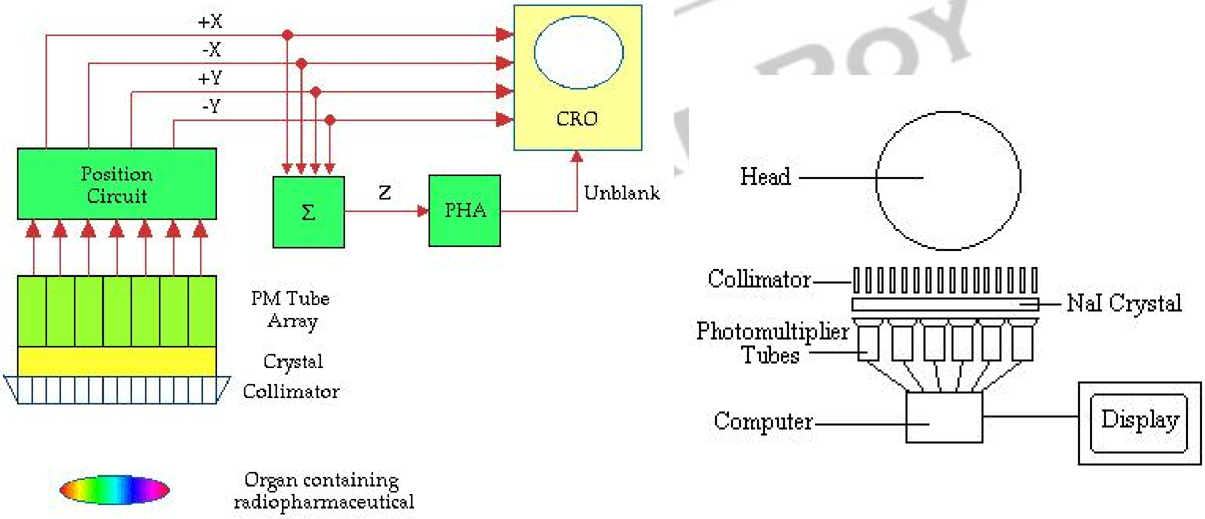
<u>**Gamma camera**</u>

This is an imaging device used in nuclear scanning. The basic design of the most common type of gamma camera used today was developed by an American physicist, Hal Anger and is therefore sometimes called the **Anger Camera.** It consists of a large diameter NaI(Tl) scintillation crystal which is viewed by a large number of photomultiplier tubes.

A **gamma camera**, also called a **scintillation camera** or **Anger camera**, is a device used to image gamma radiation emitting radioisotopes, a technique known as scintigraphy. The applications of scintigraphy include early drug development and nuclear medical imaging to view and analyse images of the human body or the distribution of medically injected, inhaled, or ingested radionuclides emitting gamma rays.

A block diagram of the basic components of a gamma camera is shown below:



Block diagram of a gamma camera

The crystal and PM Tubes are housed in a cylindrical shaped housing commonly called the **camera head.** The crystal can be between about 25 cm and 40 cm in diameter and about 1 cm thick. The diameter is dependent on the application of the device. For example a 25 cm diameter crystal might be used for a camera designed for cardiac applications while a larger 40 cm crystal would be used for producing images of the lungs. The thickness of the crystal is chosen so that it provides good detection for the 140 keV gamma-rays emitted from ^{99m}Tc - which is the most common radioisotope used today.
Scintillations produced in the crystal are detected by a large number of PM tubes which are arranged in a two-dimensional array. There is typically between 37 and 91 PM tubes in modern gamma cameras. The output voltages generated by these PM tubes are fed to a position circuit which produces four output signals called ±X and ±Y.This set-up yields relatively accurate positional information. The positional information is recorded onto film as an analogue image or onto a computer (coupled to the camera) in digital form.

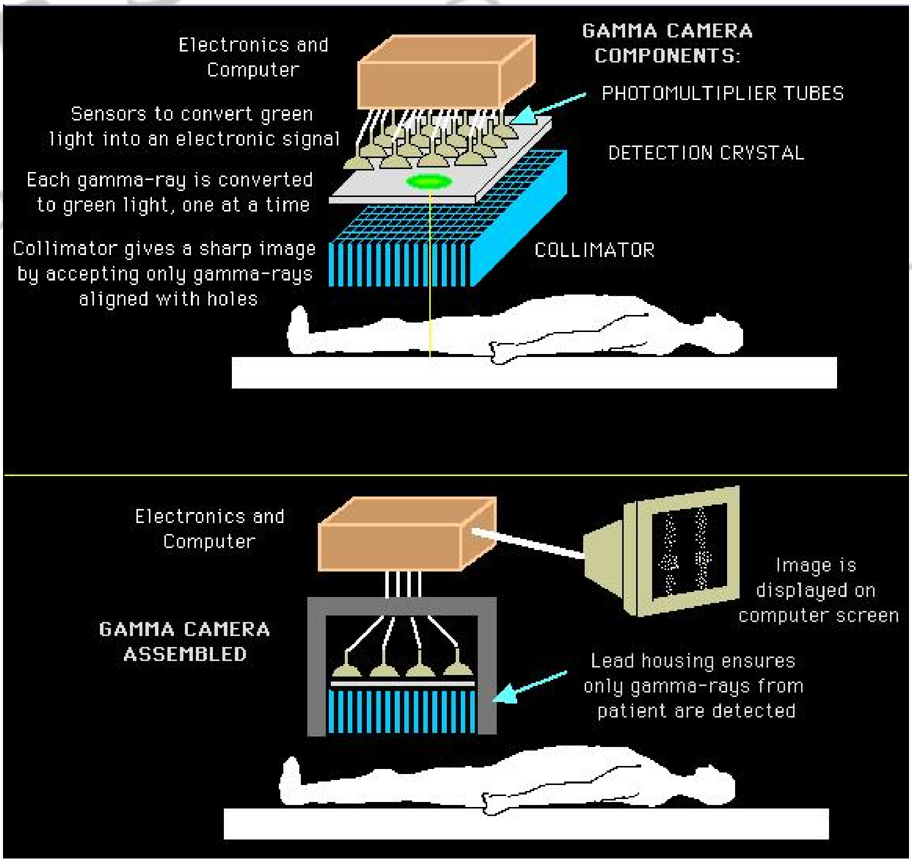
The crystal scintillates in response to incident gamma radiation. When a gamma photon leaves the patient (who has been injected with a radioactive pharmaceutical), it knocks an electron loose from an iodine atom in the crystal, and a faint flash of light is produced when the dislocated electron again finds a minimal energy state. The initial phenomenon of the excited electron is similar to the photoelectric effect and (particularly with gamma rays) the Compton effect. After the flash of light is produced, it is detected. Photomultiplier tubes

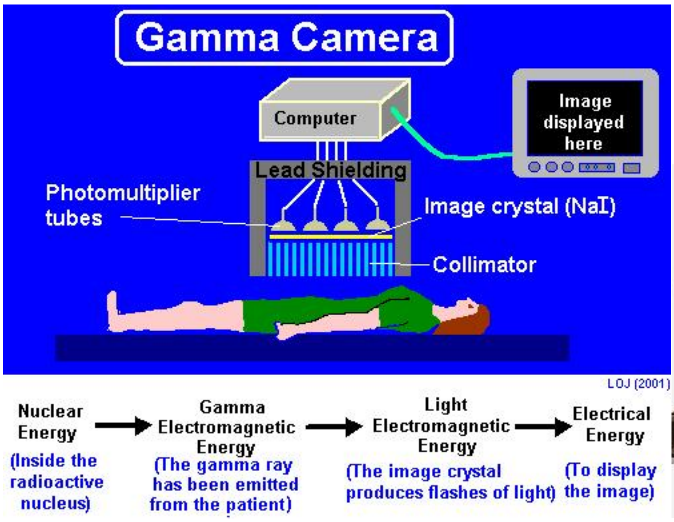
(PMTs) behind the crystal detect the fluorescent flashes (events) and a computer sums the counts. The computer reconstructs and displays a two dimensional image of the relative spatial count density on a monitor. This reconstructed image reflects the distribution and relative concentration of radioactive tracer elements present in the organs and tissues imaged.

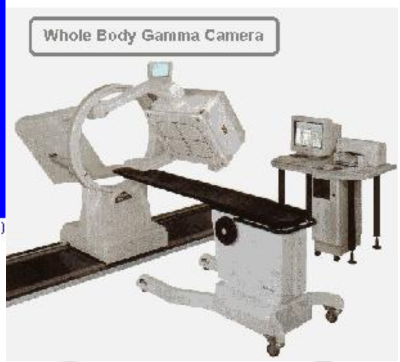
The gamma camera uses sets of vacuum tube photomultipliers (PMT). Generally each tube has an exposed face of about 7.6 cm in diameter and the tubes are arranged in hexagon configurations, behind the absorbing crystal. The electronic circuit connecting the photodetectors is wired so as to reflect the relative coincidence of light fluorescence as sensed by the members of the hexagon detector array. All the PMTs simultaneously detect the (presumed) same flash of light to varying degrees, depending on their position from the actual individual event. Thus the spatial location of each single flash of fluorescence is reflected as a pattern of voltages within the interconnecting circuit array.

The location of the interaction between the gamma ray and the crystal can be determined by processing the voltage signals from the photomultipliers; in simple terms, the location can be found by weighting the position of each photomultiplier tube by the strength of its signal, and then calculating a mean position from the weighted positions. The total sum of the voltages from each photomultiplier is proportional to the energy of the gamma ray interaction, thus allowing discrimination between different isotopes or between scattered and direct photons.

The following is a schematic diagram depicting the operation of a gamma camera.




Gamma Camera
Computer
Image displayed here
Lead Shielding
Photomultiplier tubes
Image crystal (NaI)
Collimator
LOJ (2001)
Nuclear Energy
(Inside the radioactive nucleus)
Gamma Electromagnetic Energy
(The gamma ray has been emitted from the patient)
Light Electromagnetic Energy
(The image crystal produces flashes of light)
Electrical Energy
(To display the image)


Whole Body Gamma Camera