Al-Mustaqbal University Colleg
Medical Physics Department

Medical Imaging

Lecture 10

Gamma Camera

Second Stage

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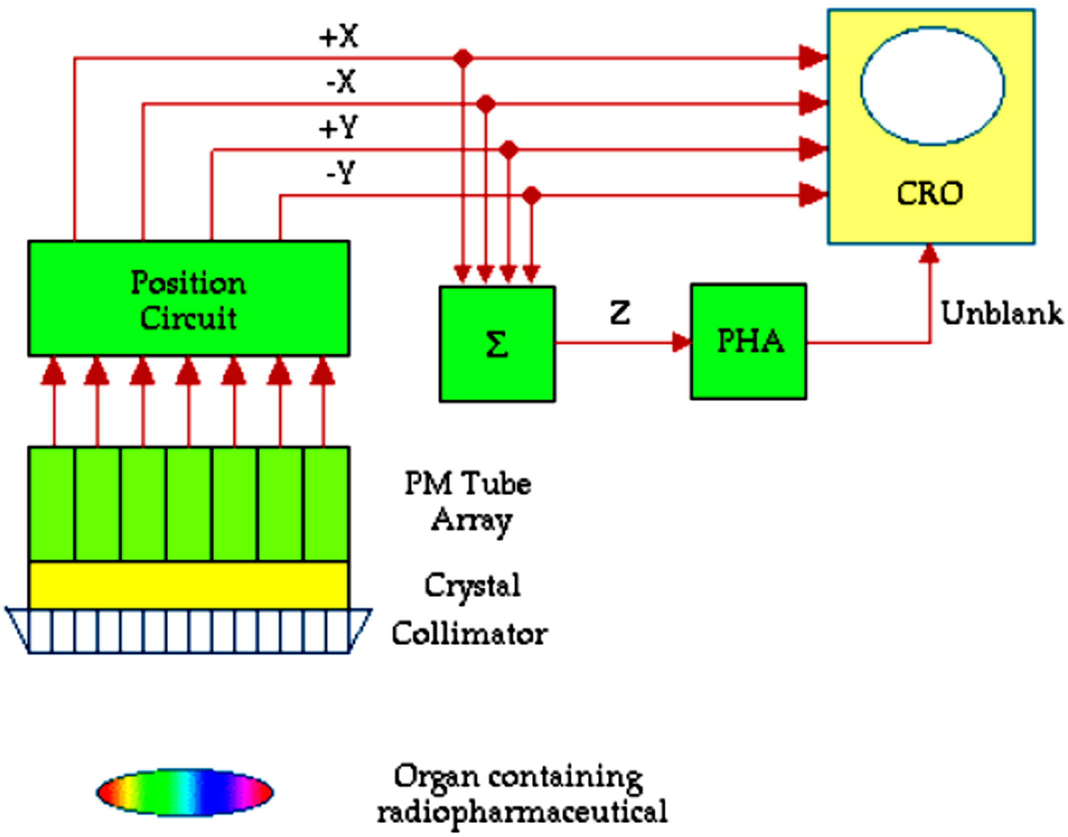
The basic design of the most common type of gamma camera used today was developed by an American physicist, Hal Anger and is therefore sometimes called the Anger Camera. It consists of a large diameter NaI(Tl) scintillation crystal which is viewed by a large number of photomultiplier tubes.

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



The crystal and PM Tubes are housed in a cylindrical shaped housing commonly called the camera head and a cross-sectional view of this is shown in the figure. 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 99mTc - 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.

These position signals contain information about where the scintillations were produced within the crystal. In the most basic gamma camera design they are fed to a cathode ray oscilloscope (CRO). Before we do so we should note that the position signals also contain information about the intensity of each scintillation.

This intensity information can be derived from the position signals by feeding them to a summation circuit (marked ∑ in the figure) which adds up the four position signals to generate a voltage pulse which represents the intensity of a scintillation. This voltage pulse is commonly called the Z-pulse (or zee-pulse in American English!) which following pulse height analysis (PHA) is fed as the un-blank pulse to the CRO.

A radiopharmaceutical is administered to the patient and it accumulates in the organ of interest. Gamma-rays are emitted in all directions from the organ and those heading in the direction of the gamma camera enter the crystal and produce scintillations. The scintillations are detected by an array of PM tubes whose outputs are fed to a position circuit which generates four voltage pulses related to the position of a scintillation within the crystal. These voltage pulses are fed to the deflection circuitry of the CRO. They are also fed to a summation circuit whose ouput (the Z-pulse) is fed to the PHA and the output of the PHA is used to switch on (that is, unblank) the electron beam of the CRO. A flash of light appears on the screen of the CRO at a point related to where the scintillation occurred within the NaI(Tl) crystal.

An image of the distribution of the radiopharmaceutical within the organ is therefore formed on the screen of the CRO when the gamma-rays emitted from the organ are detected by the crystal.

Some photographs of gamma cameras and related devices are shown below:


A single-headed gamma camera.


Another single-headed gamma camera.


The NaI crystal of a gamma camera.


The cathode ray oscilloscope (CRO) of a gamma camera.


The image processing system of a gamma camera.


A dual-headed gamma camera.


Another view of a dual-headed gamma camera.


The image acquisition and processing console of a dual-headed gamma camera.