CLASS I & II

20 Jan 2017

Set of rules

- Questions in exam can be from any topic discussed in the class
- TA Marks: ((30% attendance+70% CT marks)/highest(30% attendance+70% CT marks))*20
- If your attendance is more then 75% then only I will consider your complaints
- Answers in exam should be in inc or dec order with **keywords**
- If correct answer is from some other source, then bring it to me
- You will not get even one mark without justification (in case you are not failing)
- You have got the placements because you were more disciplined for it

Components of Imaging System: Collimators

- The collimator of a scintillation camera **forms the projection image** by permitting x or gamma-ray photons approaching the camera from certain directions to reach the crystal **while absorbing most of the other photons**.

- made of **lead**, that only allows x- or gamma rays approaching from certain directions to reach the crystal.

- required to generate meaningful images

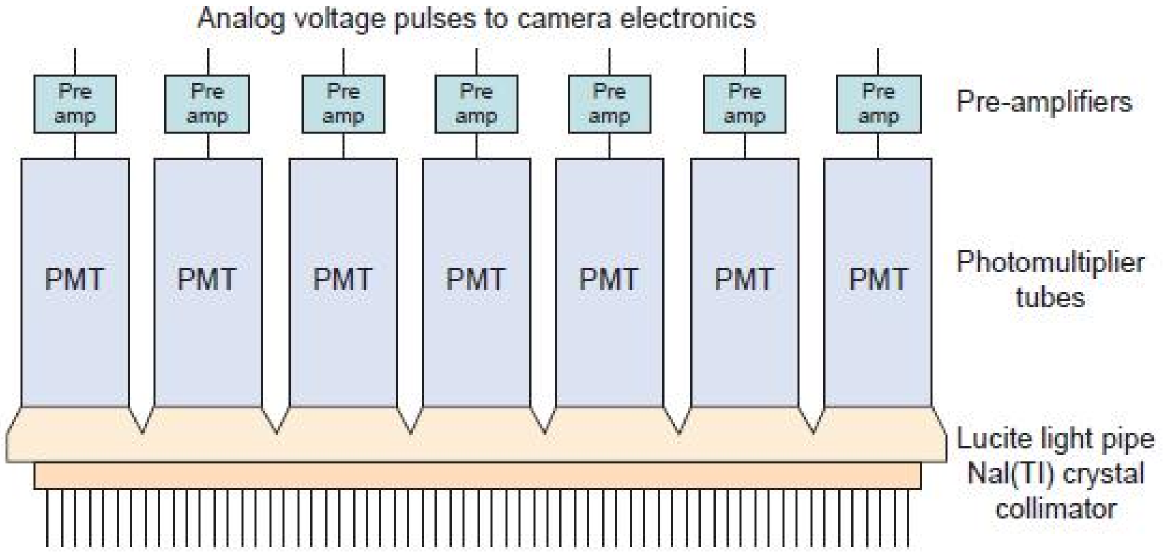


FIGURE 18-2 Scintillation camera detector.

- **Septa**: the lead walls, absorb most photons approaching the collimator from directions that are not aligned with the holes.

- Photons gets absorbed in thallium-activated sodium iodide [NaI(Tl)] crystal, causing the emission of visible light and ultraviolet (UV) radiation.

- The light and UV photons are converted into electrical signals and amplified by the PMTs

- made of high atomic number, high-density materials, usually lead
- *parallel-hole collimator*
- holes may be round, square, or triangular
- septa must be thick enough to absorb most of the photons incident upon them

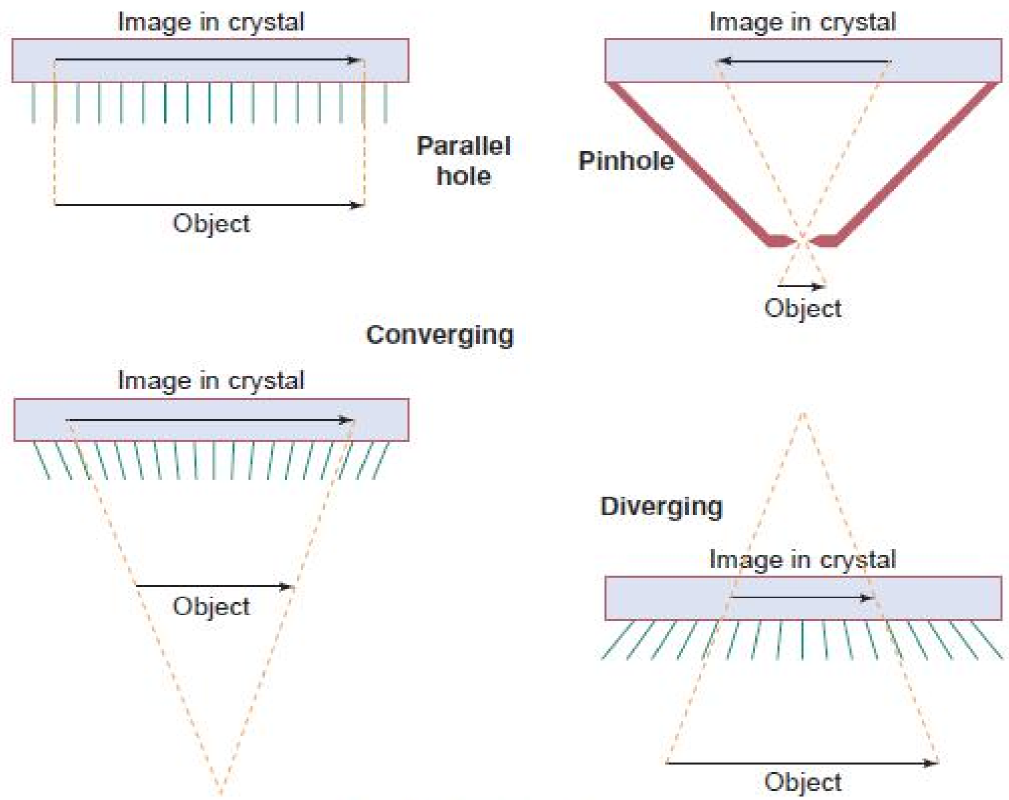


FIGURE 18-4 Collimators.

- radionuclides that emit higher energy photons have thicker septa.

- Trade off between resolution and efficiency (sensitivity) of collimators
  - Modifying a collimator to improve its spatial resolution (e.g., by reducing the size of the holes or lengthening the collimator) reduces its efficiency.
    - “low-energy, high-sensitivity”;
    - “low-energy, all-purpose” (LEAP);
    - “low-energy, high-resolution”;
    - “medium-energy” (suitable for Ga-67 and In-111),
    - “high-energy” (for I-131); and
    - “ultra–high-energy” (for F 18) collimators.

Parallel Hole Collimator

- The size of the image produced by a parallel-hole collimator is not affected by the distance of the object from the collimator.
- **Spatial resolution degrades rapidly** with increasing collimator-to-object distance.
- field-of-view (FOV) of a parallel-hole collimator does not change with distance from the collimator.

- Pinhole Collimator:
  - commonly used for magnified views of small objects
  - pinhole collimator produces a magnified image whose orientation is reversed
  - magnification of the pinhole collimator decreases as an object is moved away from the pinhole

- Converging Collimator:
  - has many holes, all aimed at a **focal point in front of the camera**
  - magnifies the image
  - magnification increases as the object is moved away from the collimator.
  - FOV decreases with distance from the collimator.

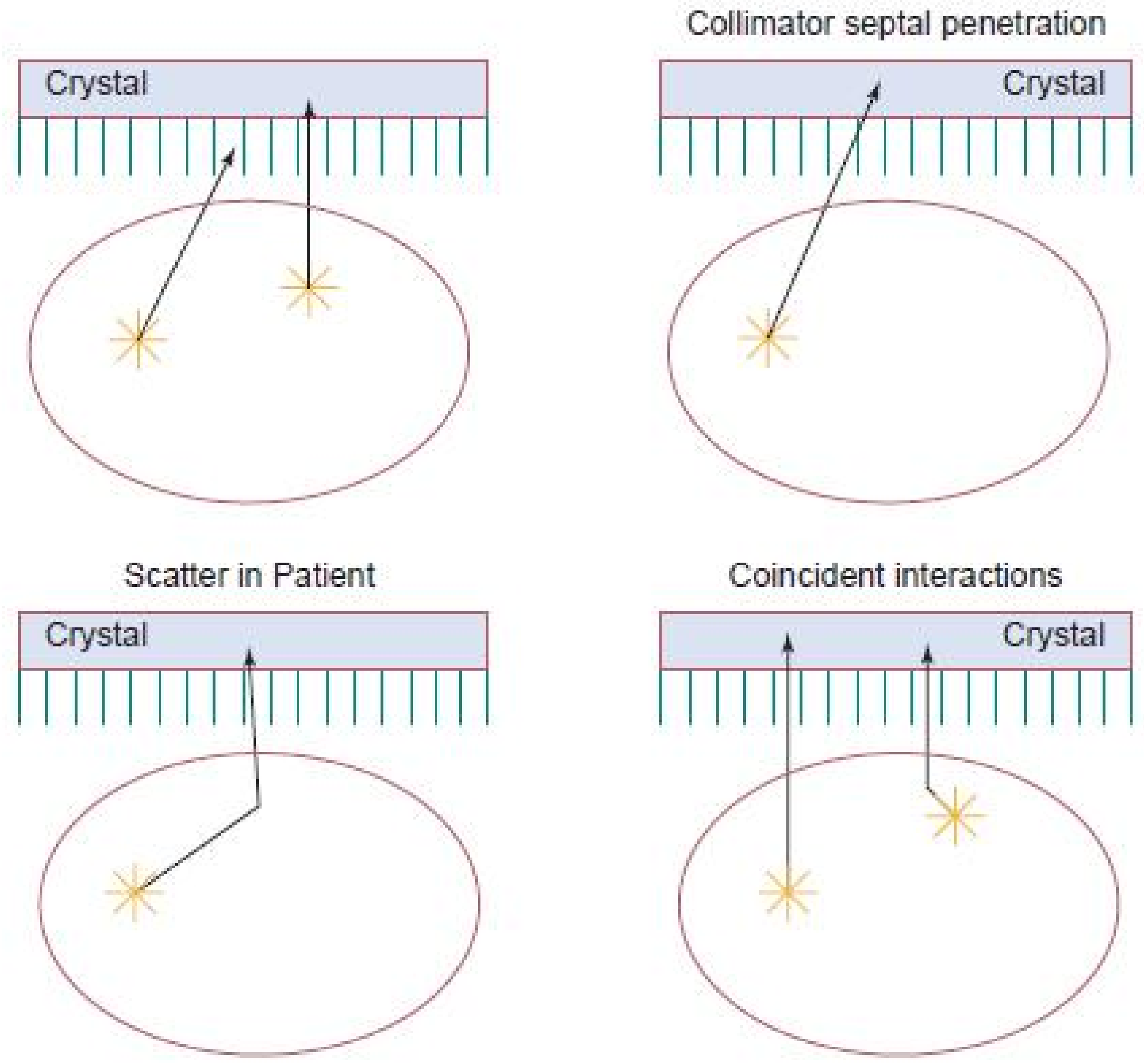
- Divergent Collimator
  - has many holes aimed at a **focal point behind the camera.**
  - produces a minified image in which the amount of minification increases as the object is moved away from the camera.

- If a diverging collimator is reversed on a camera, it becomes a converging collimator.

- a hybrid of the parallel-hole and converging collimator, called a fan-beam collimator, may be used in single photon emission computed tomography (SPECT) to take advantage of the favorable imaging properties of the converging collimator

- only a tiny fraction of the emitted photons (about 1 to 2 in 10,000 for typical low-energy parallel-hole collimators) has trajectories permitting passage through the collimator holes; thus, well over 99.9% of the photons emitted during imaging are wasted.

other than the ones depicted in the upper left, cause a loss of contrast and spatial resolution and add statistical noise.



- XRays vs Nuclear Imaging
  - point source vs scattered source
  - scattered xrays can be distinguished from the primary xrays by direction of primary xrays, but that's not the case with nuclear imaging
  - The collimator removes about the same fraction of scattered photons as it does primary photons
  - Scattered photons in nuclear imaging can only be differentiated from primary photons by energy, because scattering reduces photon energy