

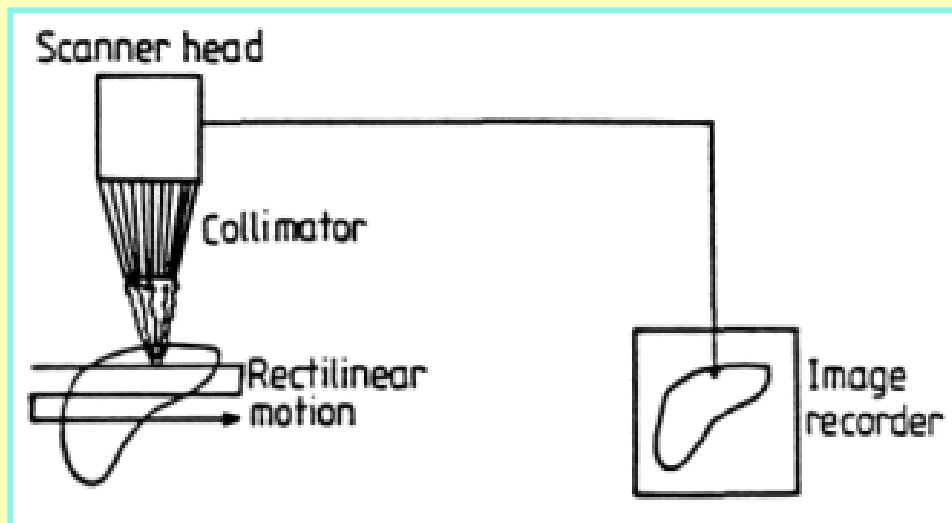
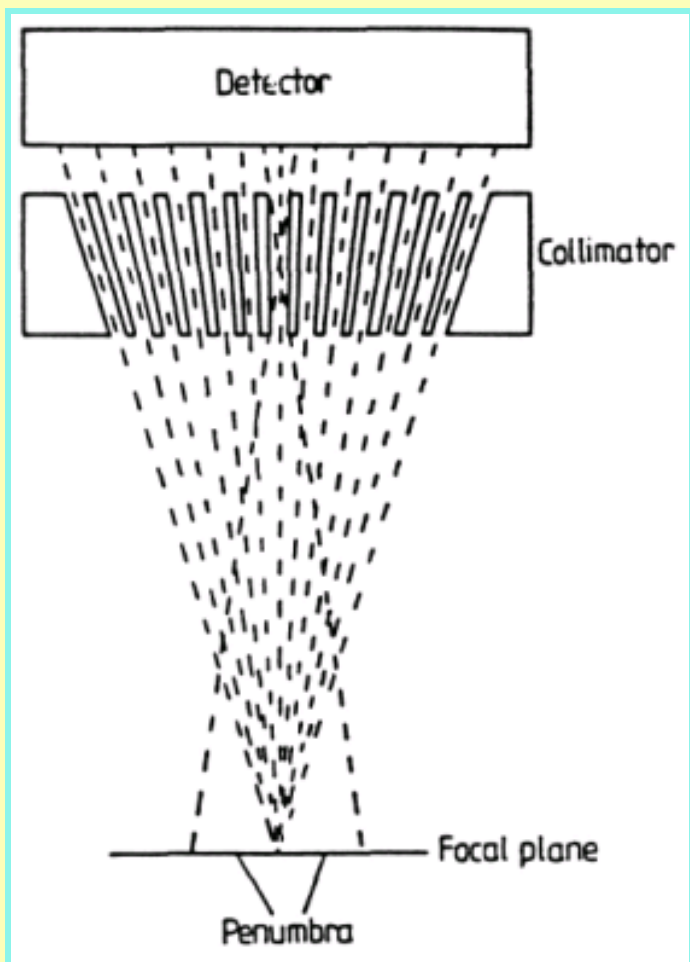
**NUCLEAR MEDICINE**

**ANGER CAMERA**

**SINGLE PHOTON EMISSION COMPUTED TOMOGRAPHY**  
**SPECT**

## $\gamma$ – *Ray Imaging*

- ◆ **Inject a pharmaceutical labelled with a radioactive nuclide**
- ◆ **Detect where  $\gamma$ -rays are coming from**
- ◆ **Local concentration in patient indicates problems or otherwise**



# SCANNING



**The figure shows an image from a rectilinear scan showing cancer in the upper left lung using a  $^{67}\text{Ga}$  citrate.**

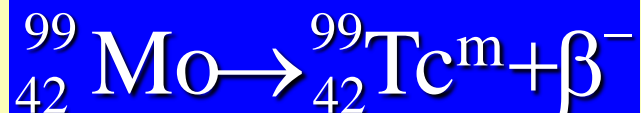
# ***Radiopharmaceutical***

- ◆ **Choice of isotope for labelling:**
  - **Half life a few hours**
  - **Produces  $\gamma$  photon of a few hundred keV**
  - **Easily attached to pharmaceuticals**
  - **Can be delivered to hospital in a form to last several days**

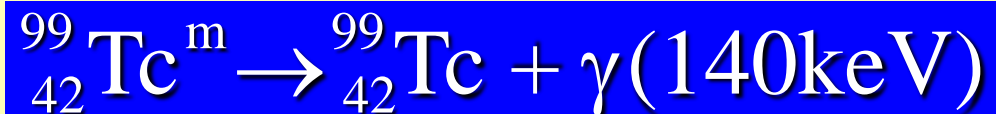
# ***Technetium 99***

## ◆ **Most commonly used isotope**

- **Decays from excited to ground state by  $\gamma$  ray**
- **Parent isotope is Molybdenum 99**
- **Half life about 6 hours**

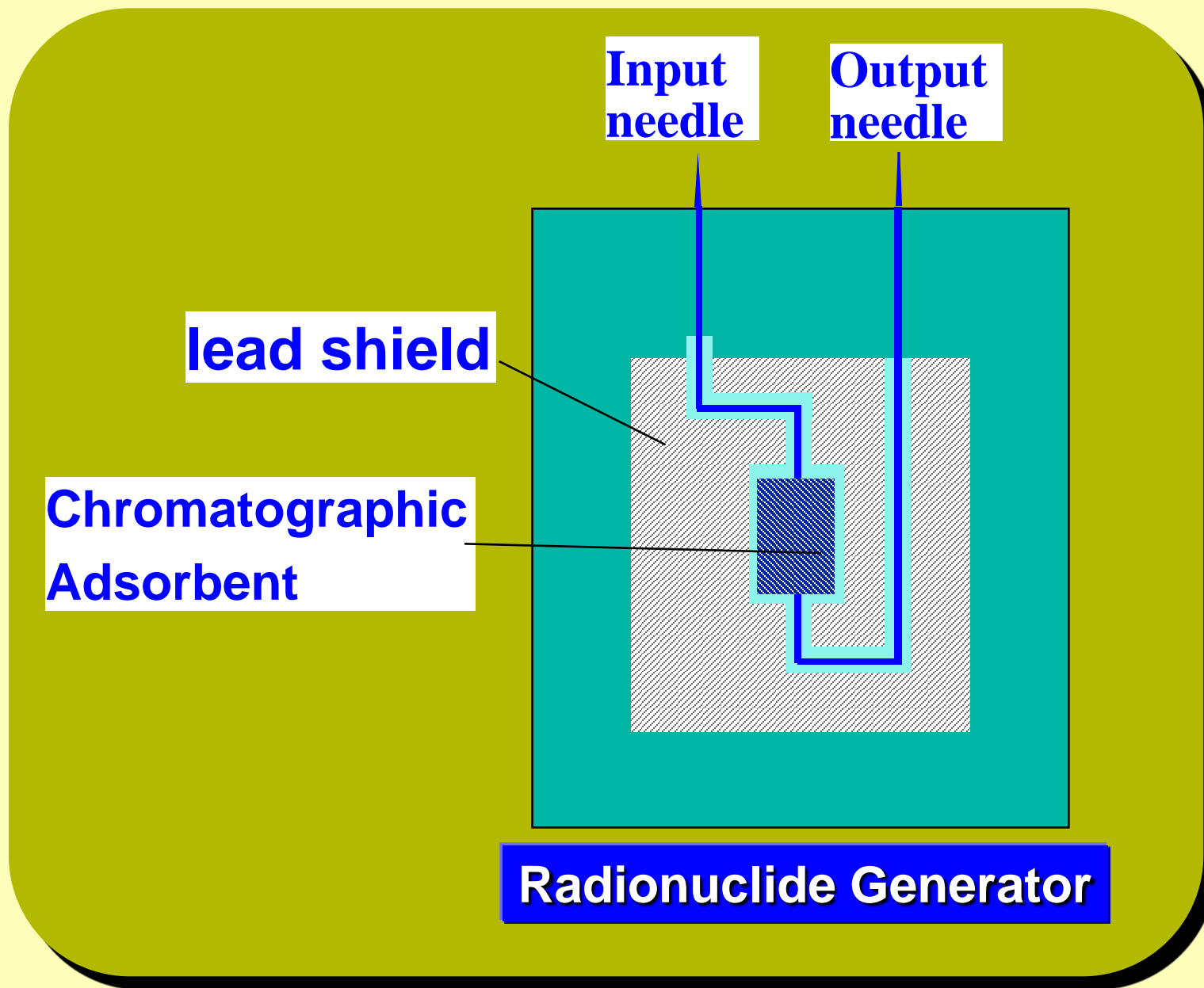


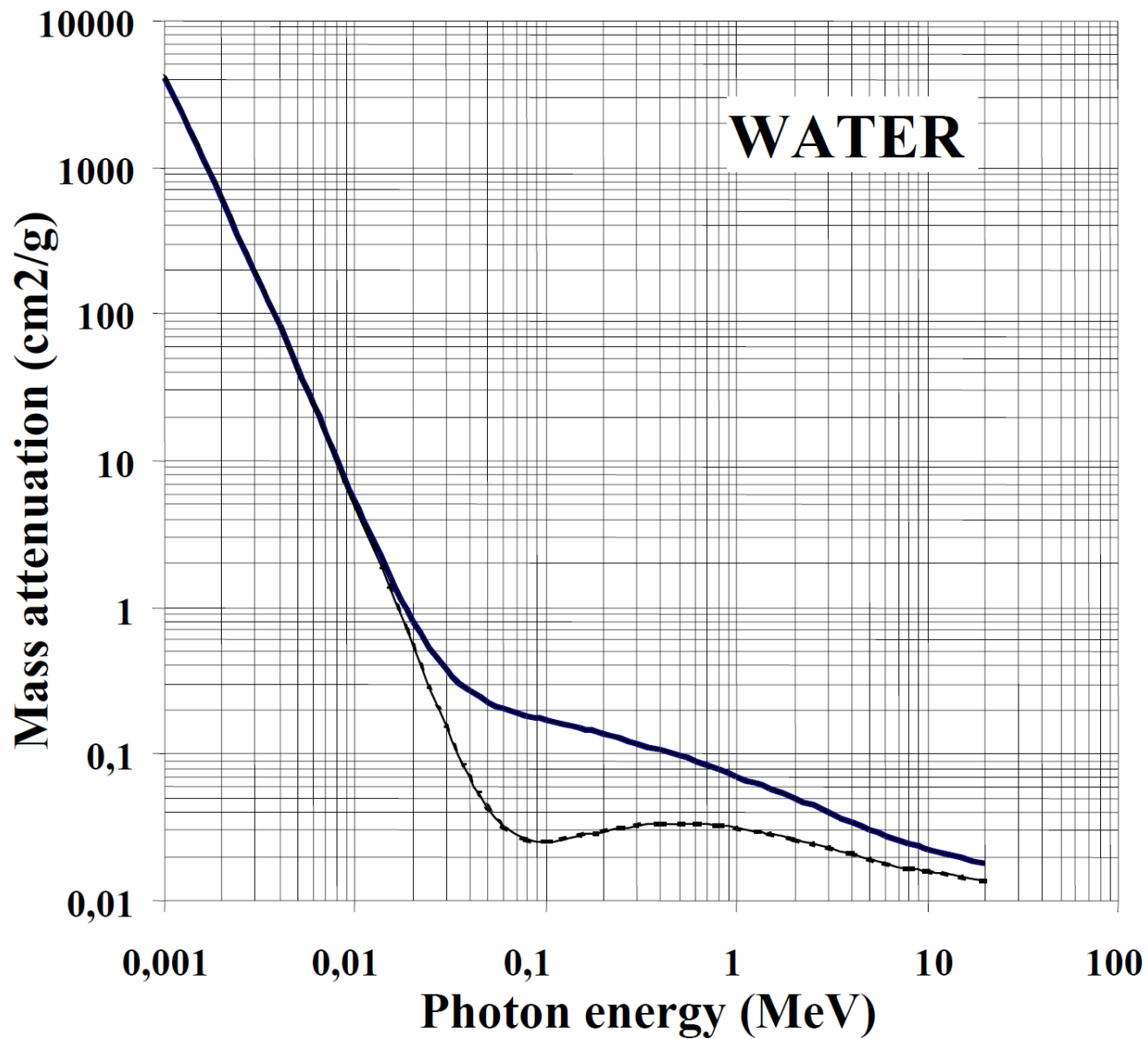
**Half life 2.7 days**



**Half life 6.01 hours**

# The Cow





Att coef 0.16 1/cm

cm	Undisturbed (%)
1	85.2
5	44.9
10	20.2
15	9.1
20	4.1

# ***Gamma Camera***

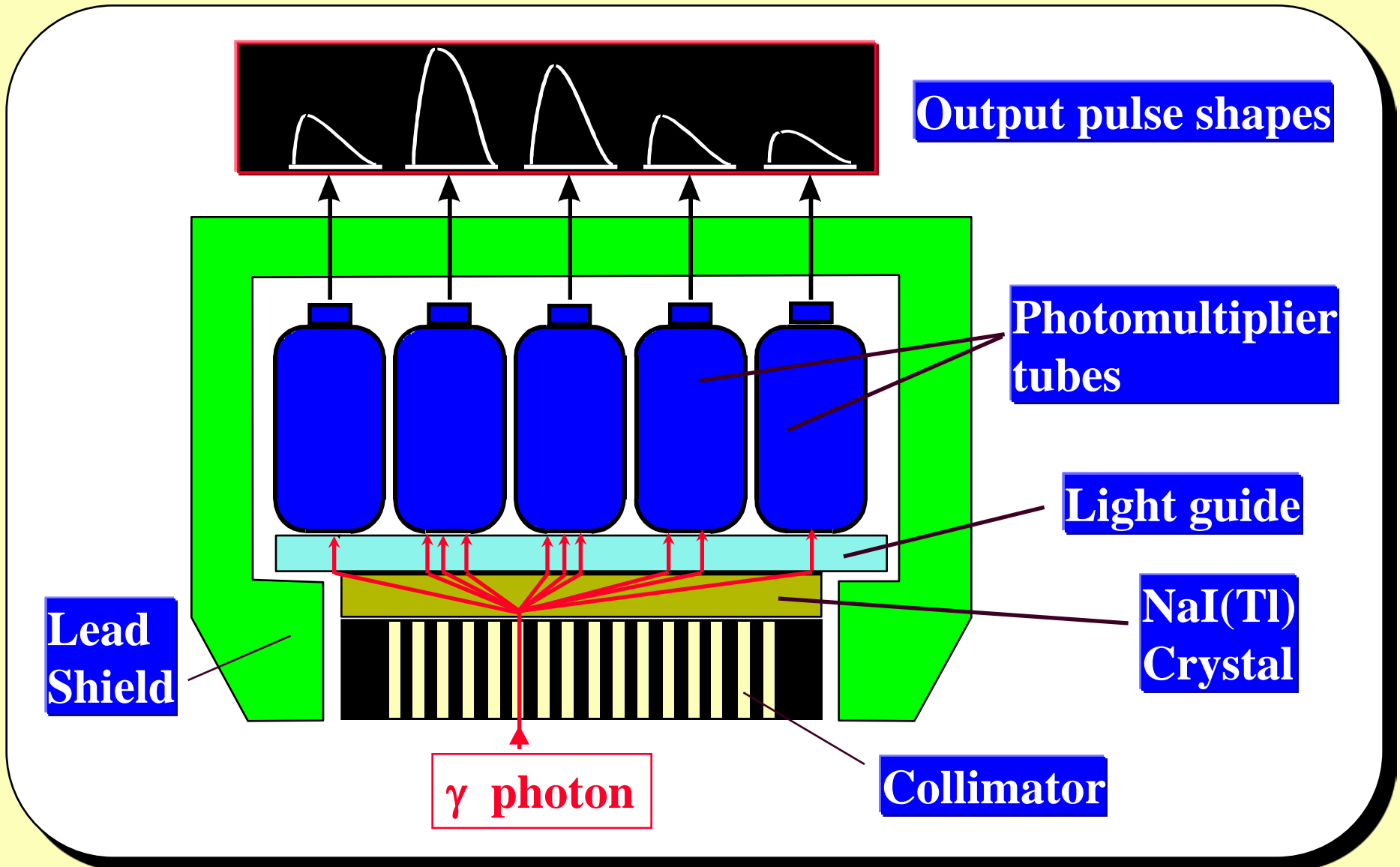
## ◆ **Consists of:**

- Light Guide**
- Collimator**
- Scintillator**
- Array of photomultipliers**
- Computer**

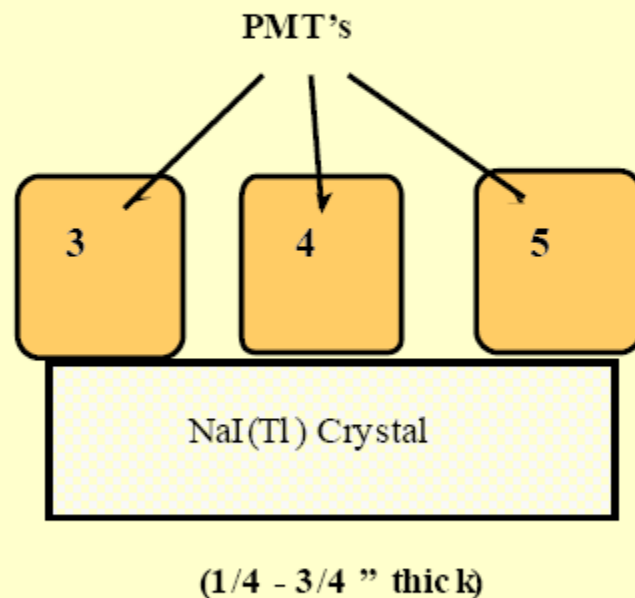
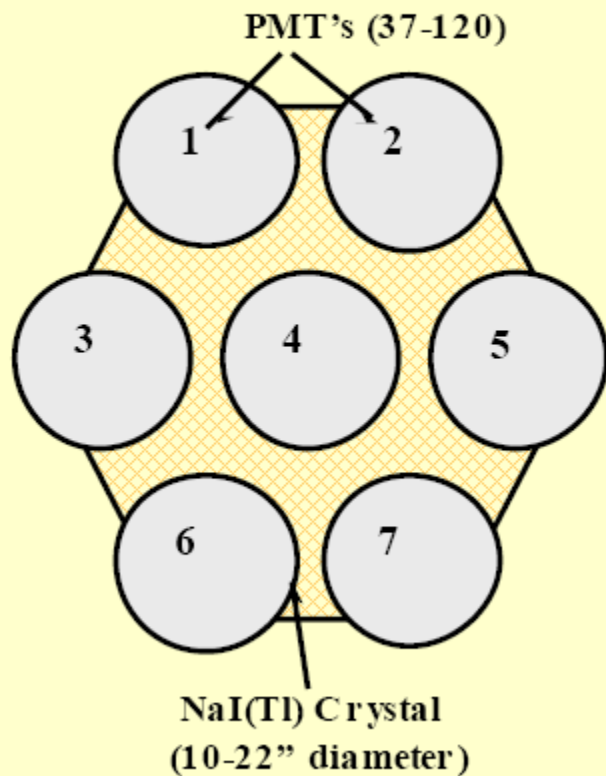
◆ **Position of scintillations can be found**

◆ **Distribution of radioactivity imaged**

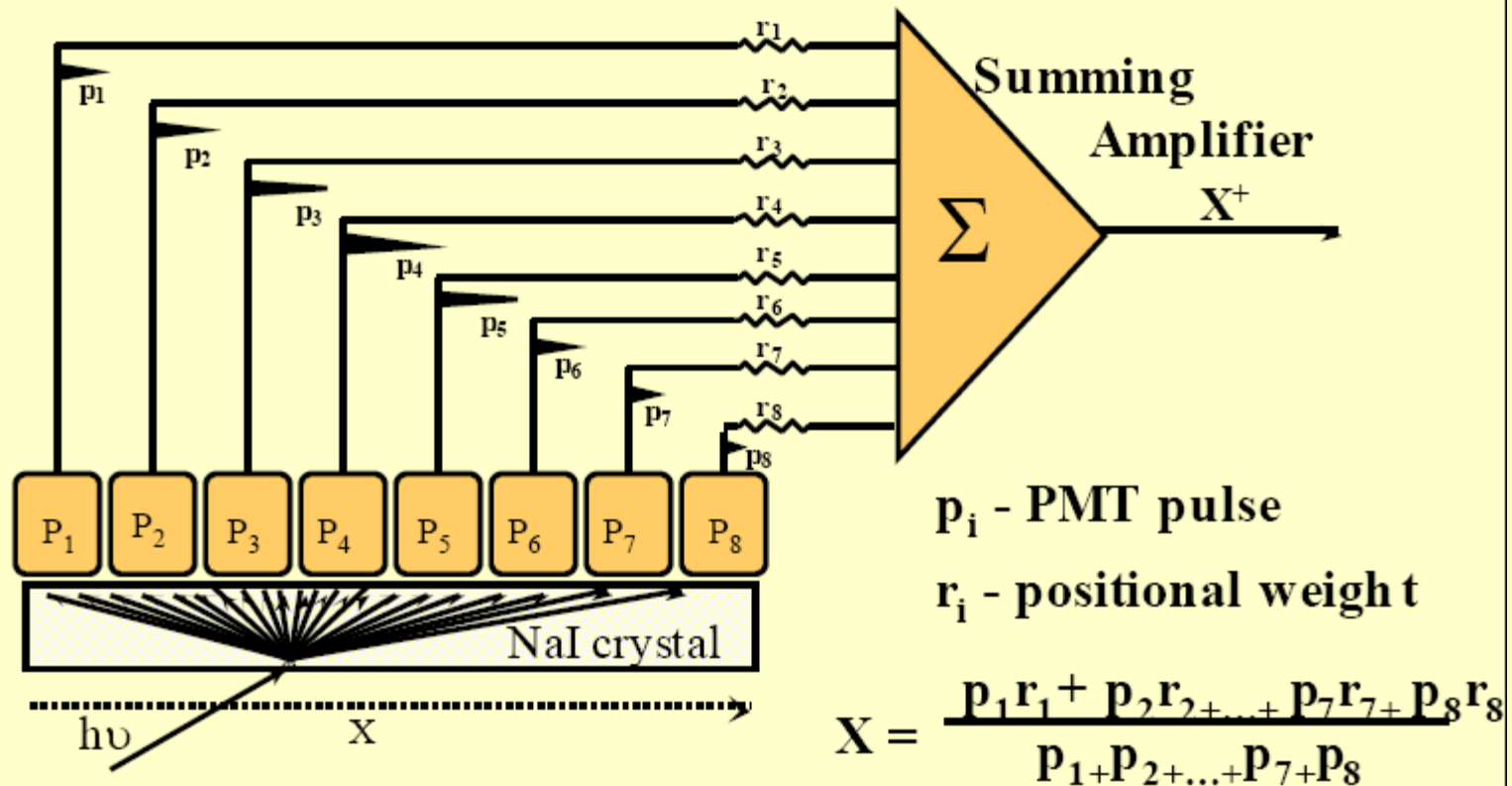
# Gamma Camera



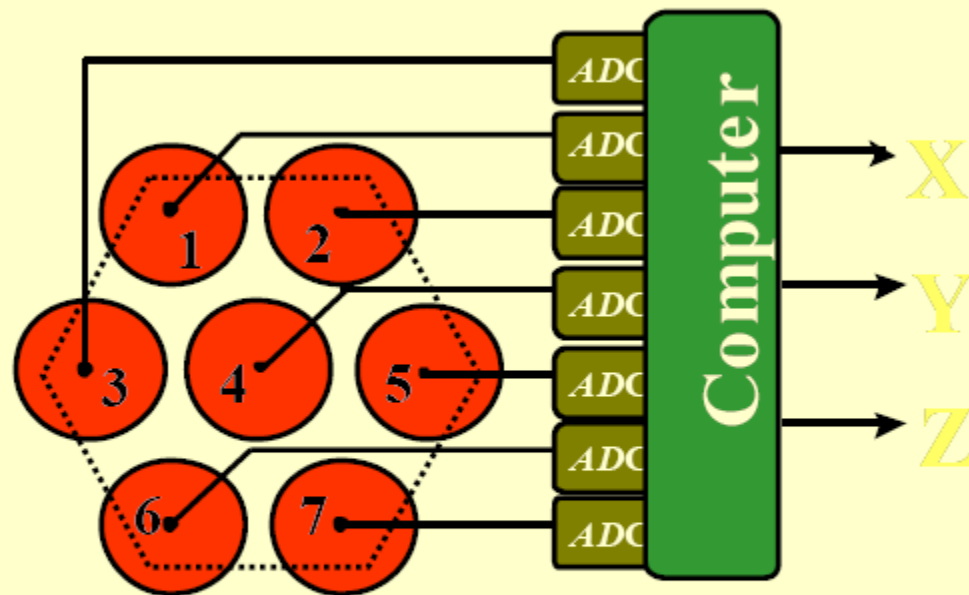
# “Anger-Type” Gamma Camera



# Localization - Position Weighted Sum



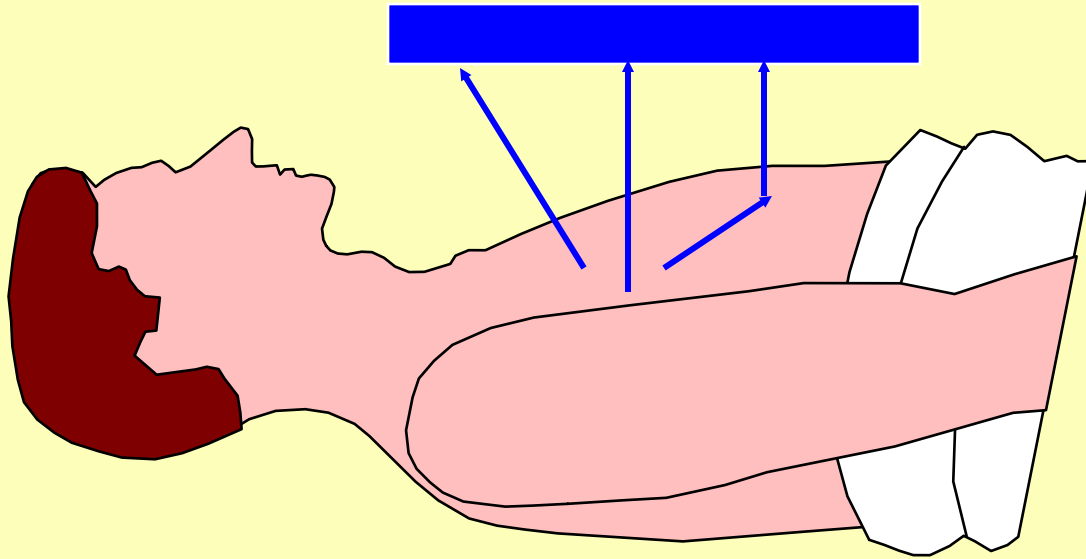
## Digital Anger Camera



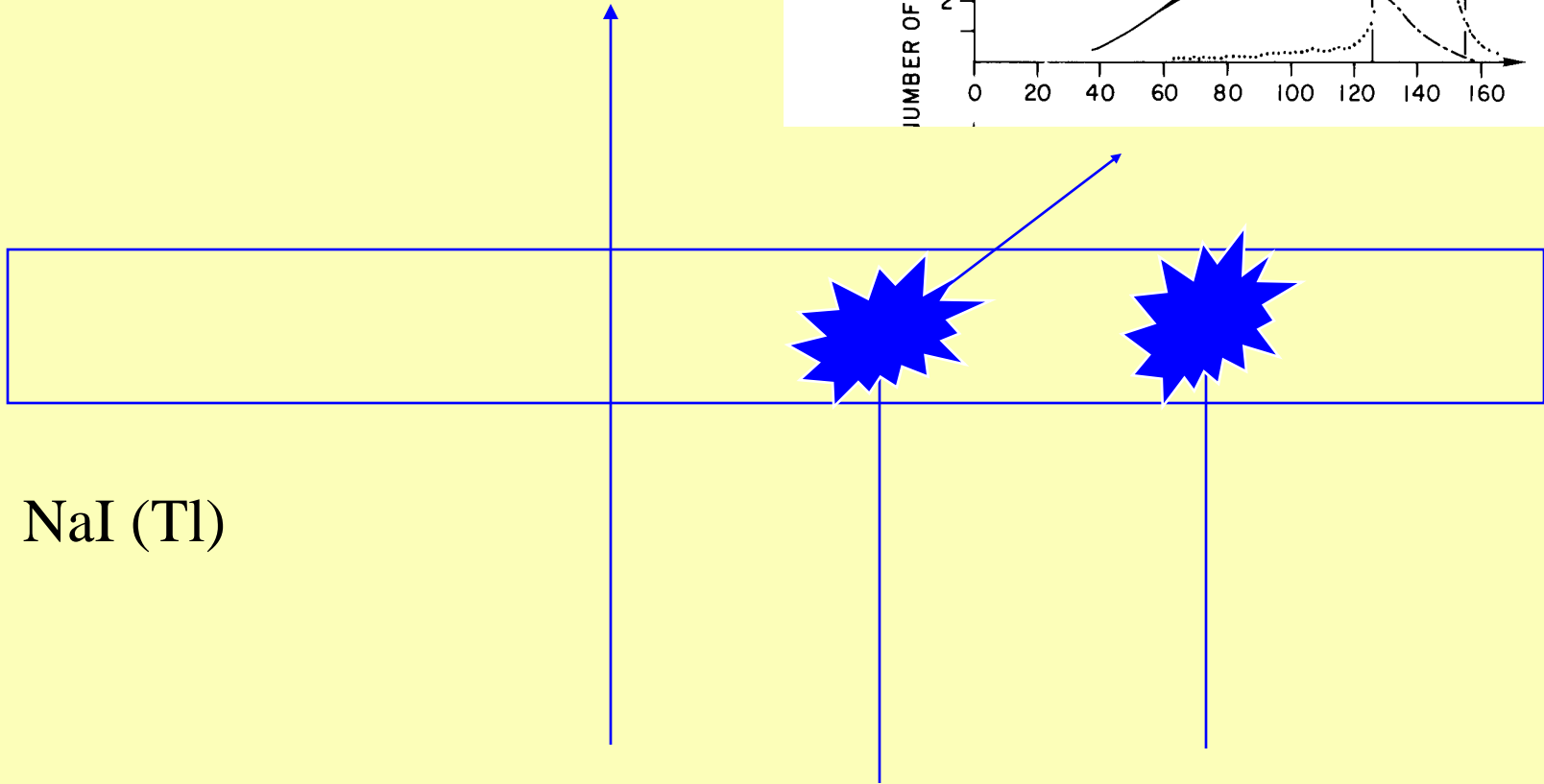
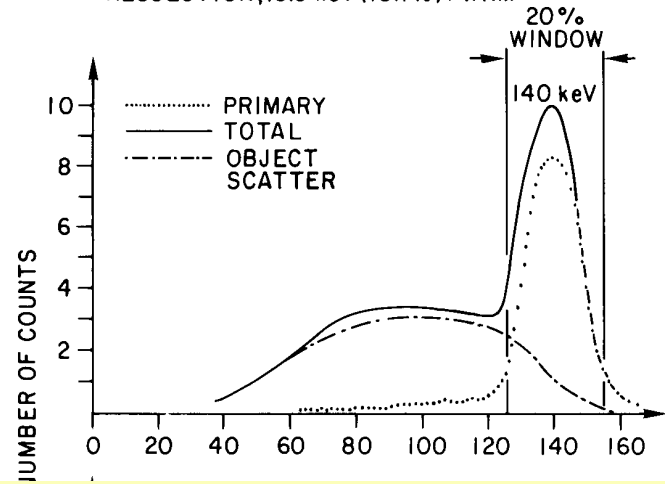
**Signals from each PMT is digitized and X, Y, and Z are determined by computer software.**

# *Analysis*

- ◆ **Pulse are passed through a pulse height analyser**
  - Allow only right energy pulses
  - Low energy pulses may come from other scattering processes
- ◆ **Position of each event calculated from relative energy at each photomultiplier**



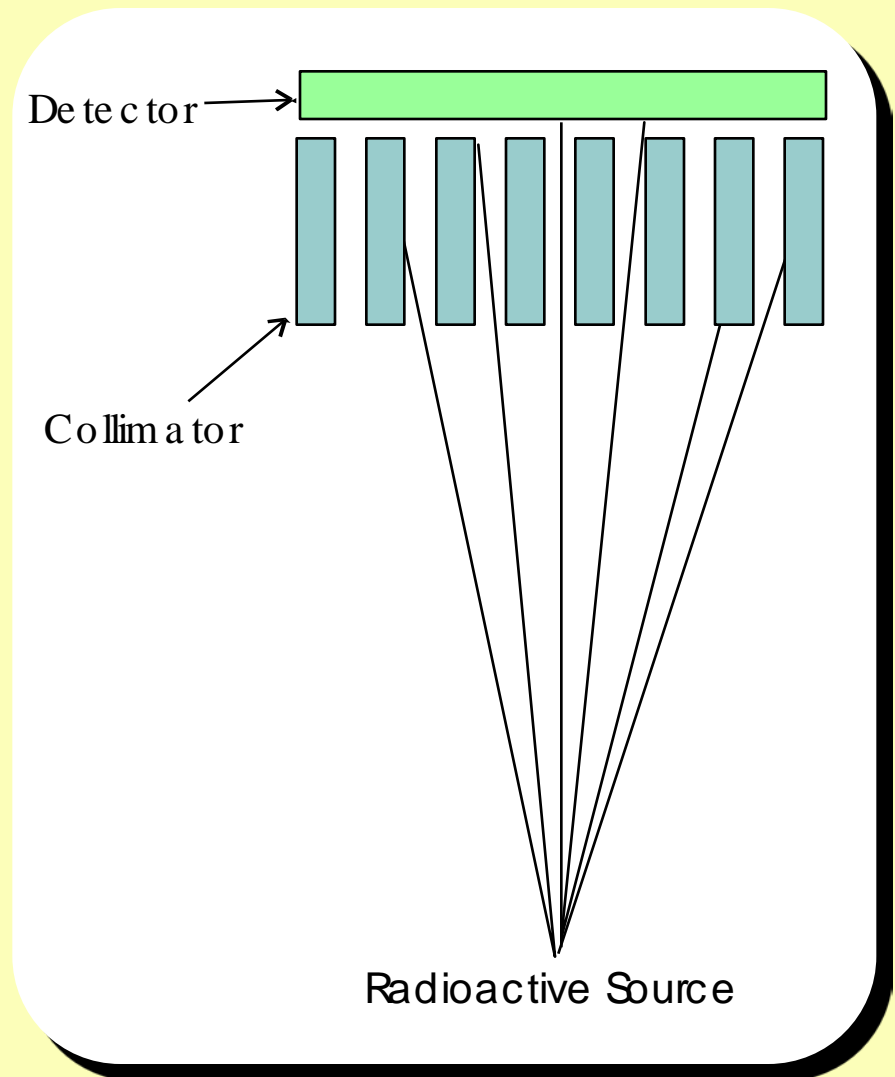
NaI (Tl) DETECTOR  
RESOLUTION, 18.3 keV (13.1%) FWHM



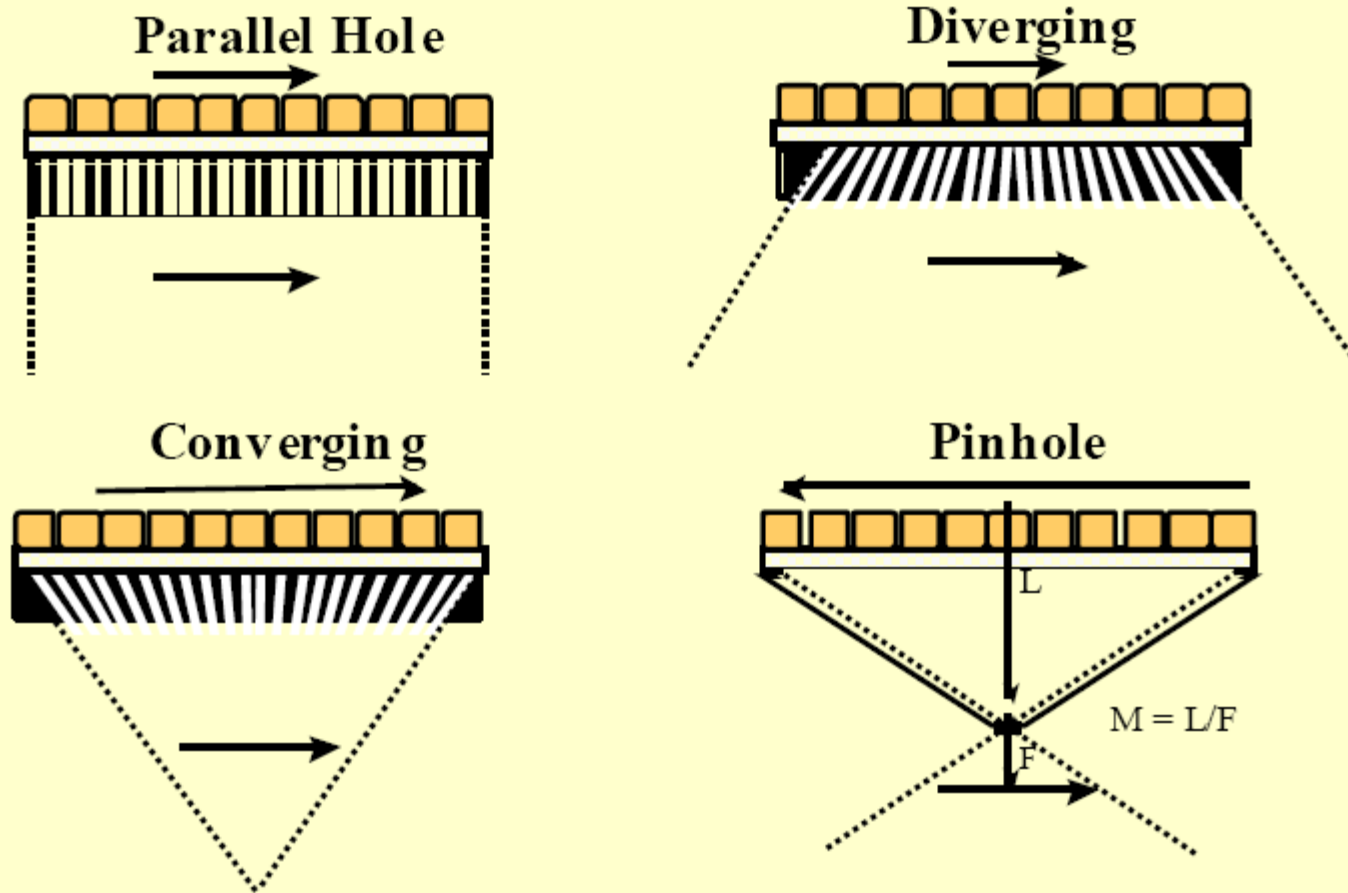
NaI (Tl)

# Collimator

- ◆ **Collimator restricts direction from which photons reach the camera.**
- ◆ **Made of lead with holes.**
- ◆ **Bigger, shorter holes means more photons, but more blurring**
- ◆ **Visa versa.**

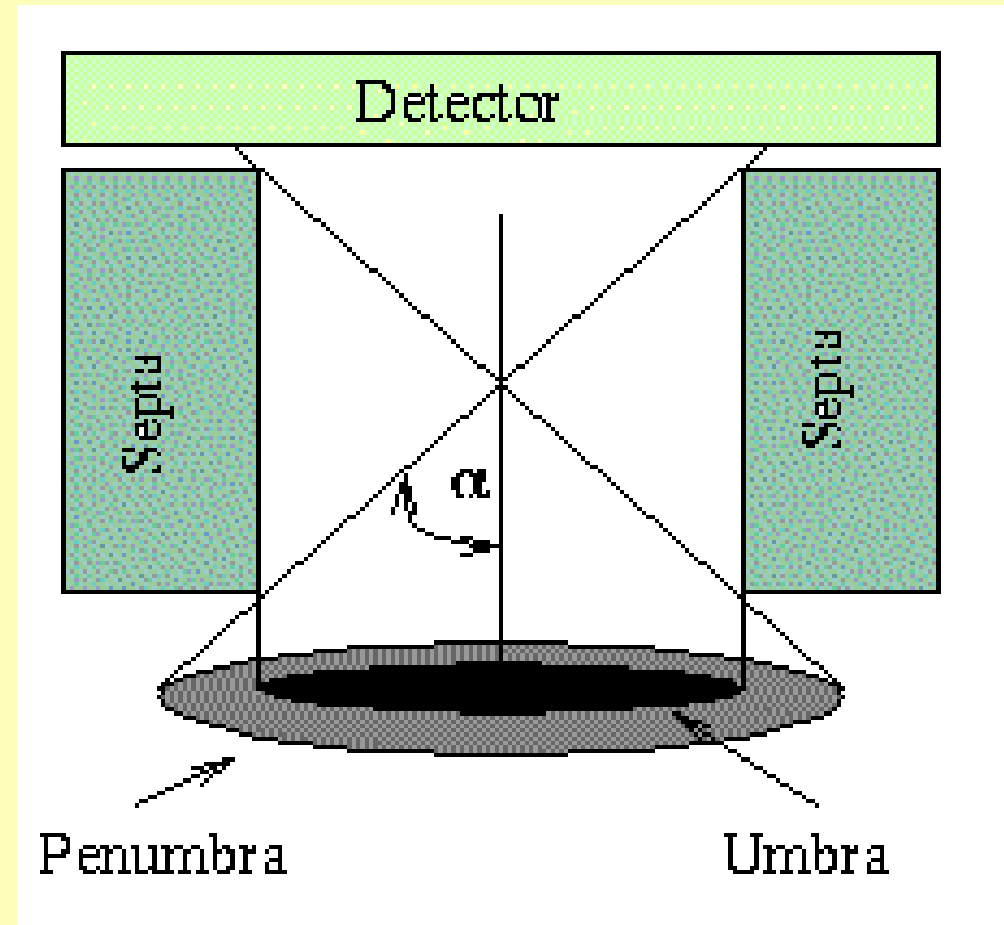


# Gamma Camera Collimators

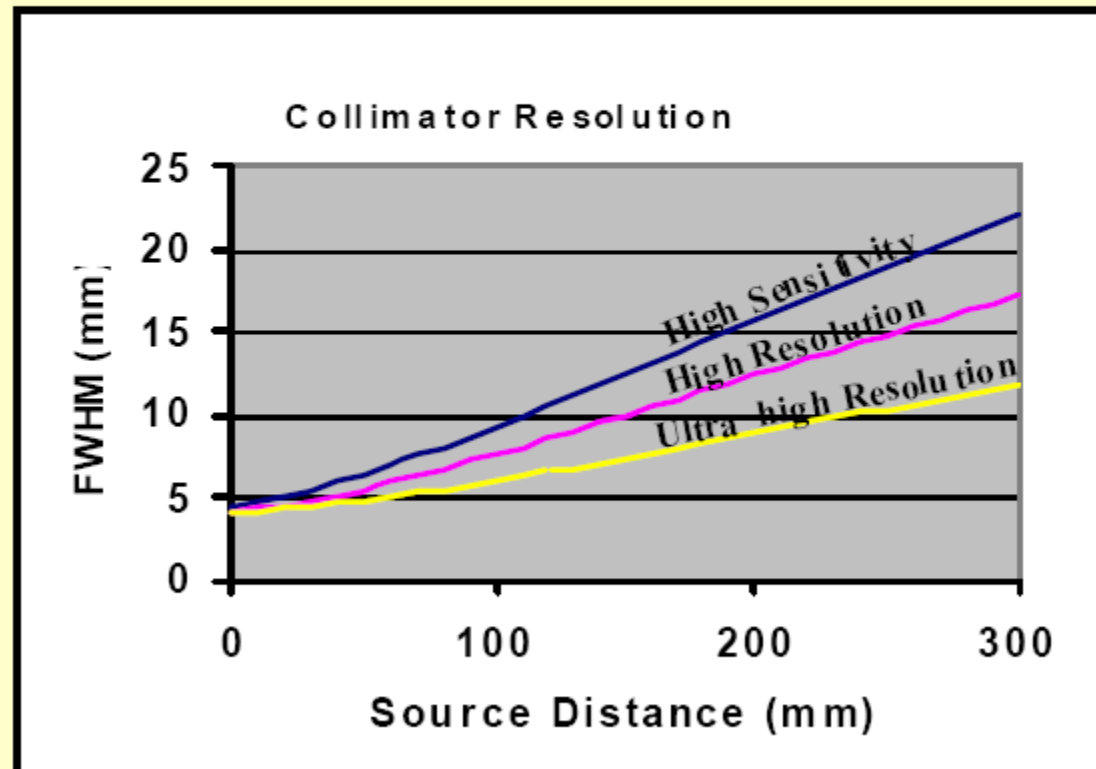


# Collimator

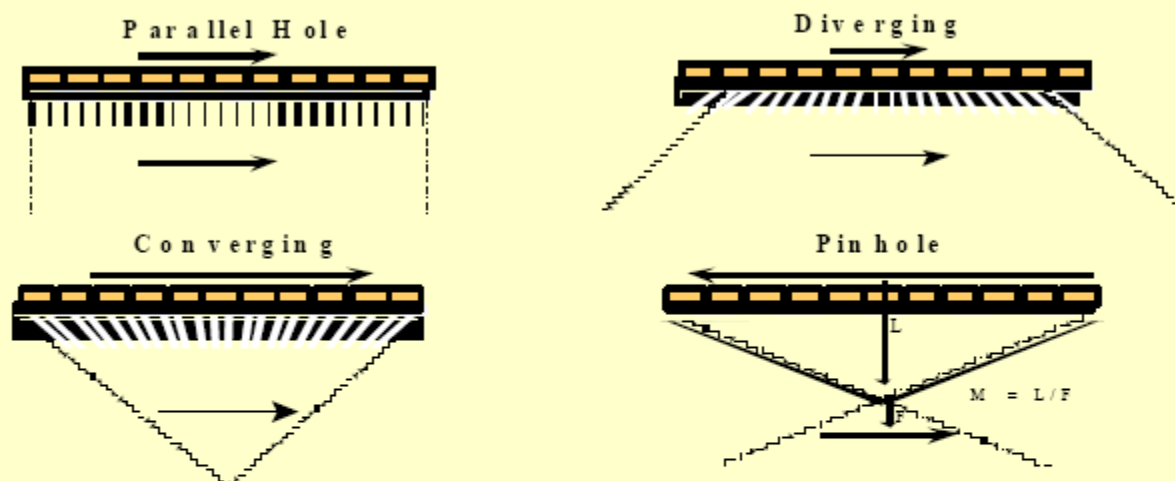
- ◆ **Collimator restricts direction from which photons reach the camera.**
- ◆ **Close to the collimator the umbra region determines the resolution.**
- ◆ **At distance the penumbra region dominates.**



# Extrinsic Resolution Vs. Distance



# Collimator Sensitivity

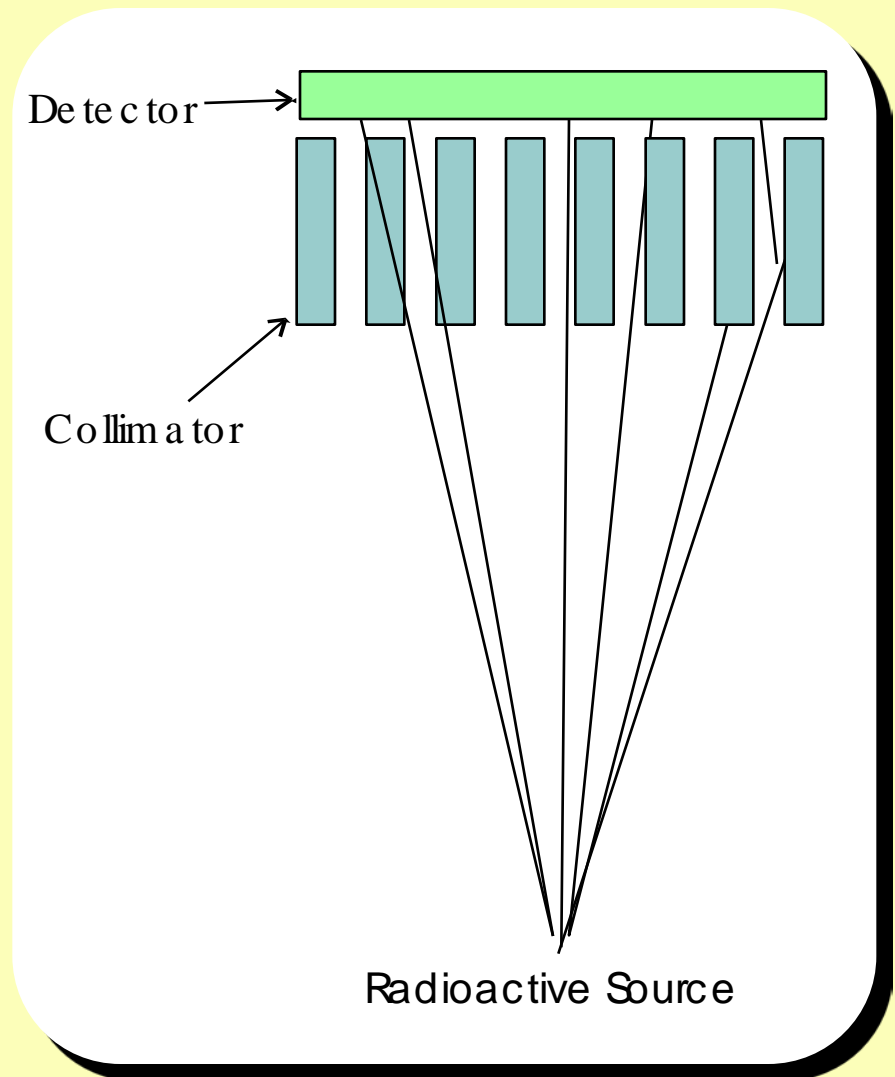


Rank in order of Decreasing Sensitivity:

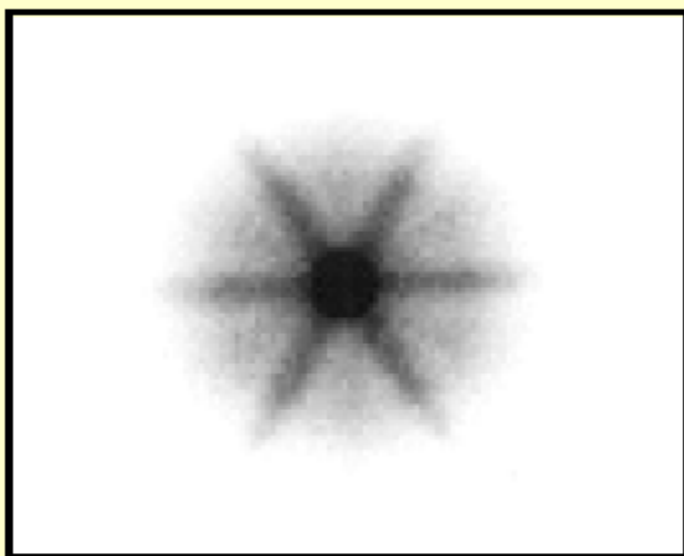
Collimator	Sensitivity (CPM/ $\mu$ Ci)	% Efficiency
1. Converging	450	0.020
2. Parallel Hole	300	0.014
3. Diverging	150	0.007
4. Pinhole	75	0.004

# Collimator

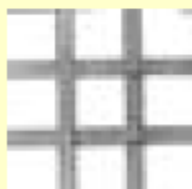
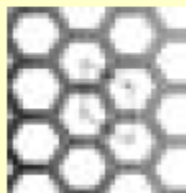
- ◆ **Collimator restricts direction from which photons reach the camera.**
- ◆ **Made of lead with holes.**
- ◆ **High gamma energies can penetrate the lead septa leading to deterioration in resolution.**



# Septal Penetration



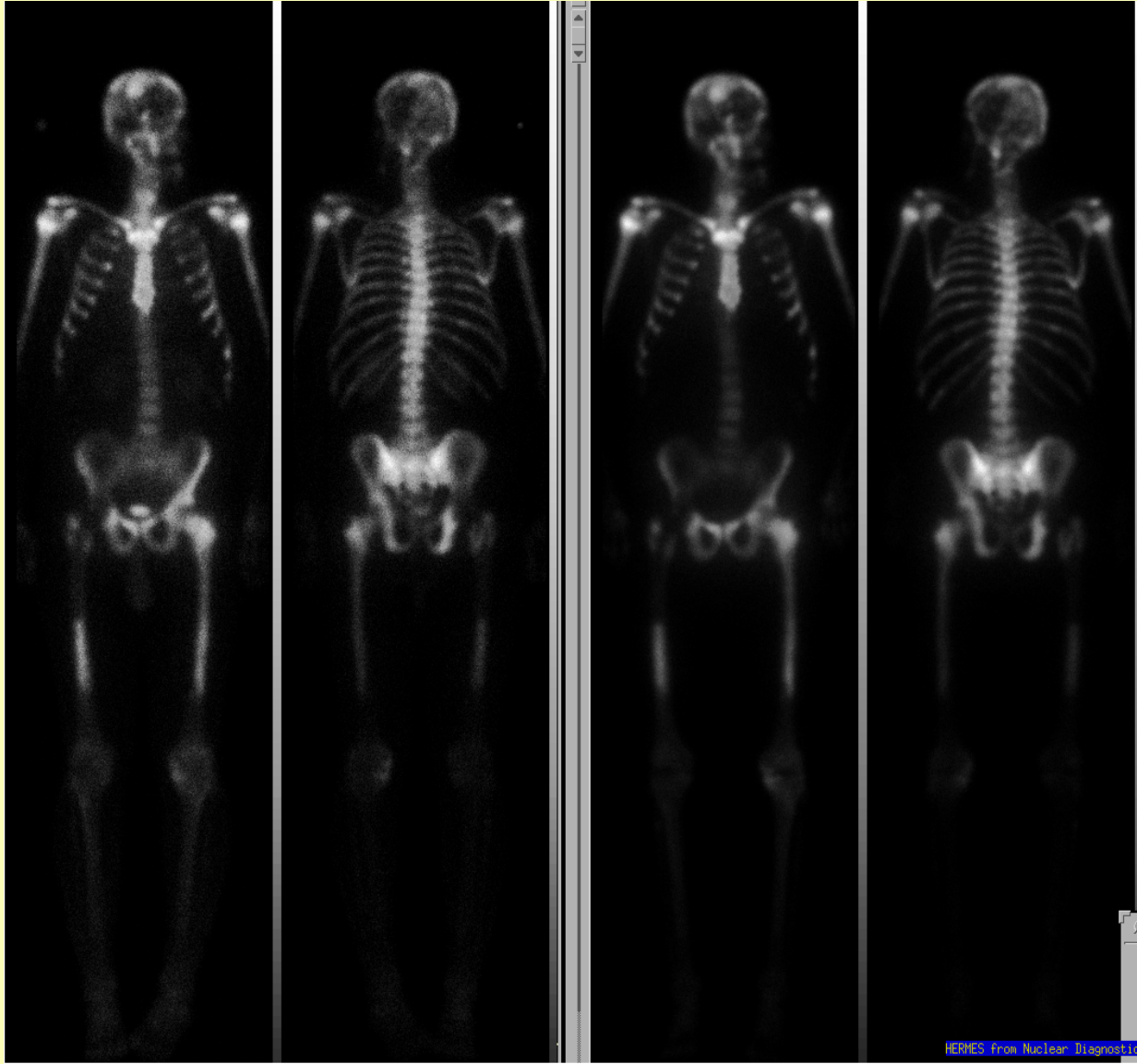
- Image Resulted from imaging a  $^{131}\text{I}$  point source using a LEHR collimator.
- Penetration artifacts appear along directions of septa that is thinnest.
- The LEHR collimator has hexagonal holes



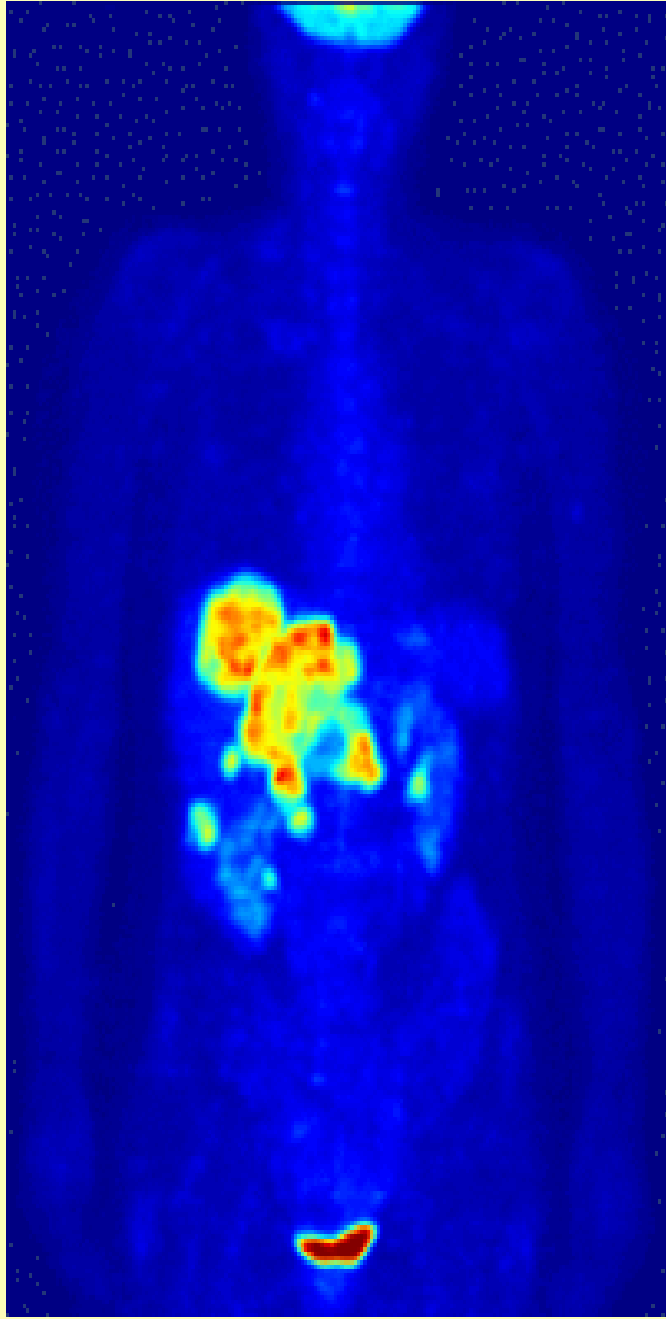
Collimator Holes Shapes



# ***Diagnosics and therapy, $^{99m}\text{Tc}$ and $^{153}\text{Sm}$***







# Lung metastases (SPECT/CT)

