# reSPECT

# PET & SPECT

Principles of PET & SPECT similar.

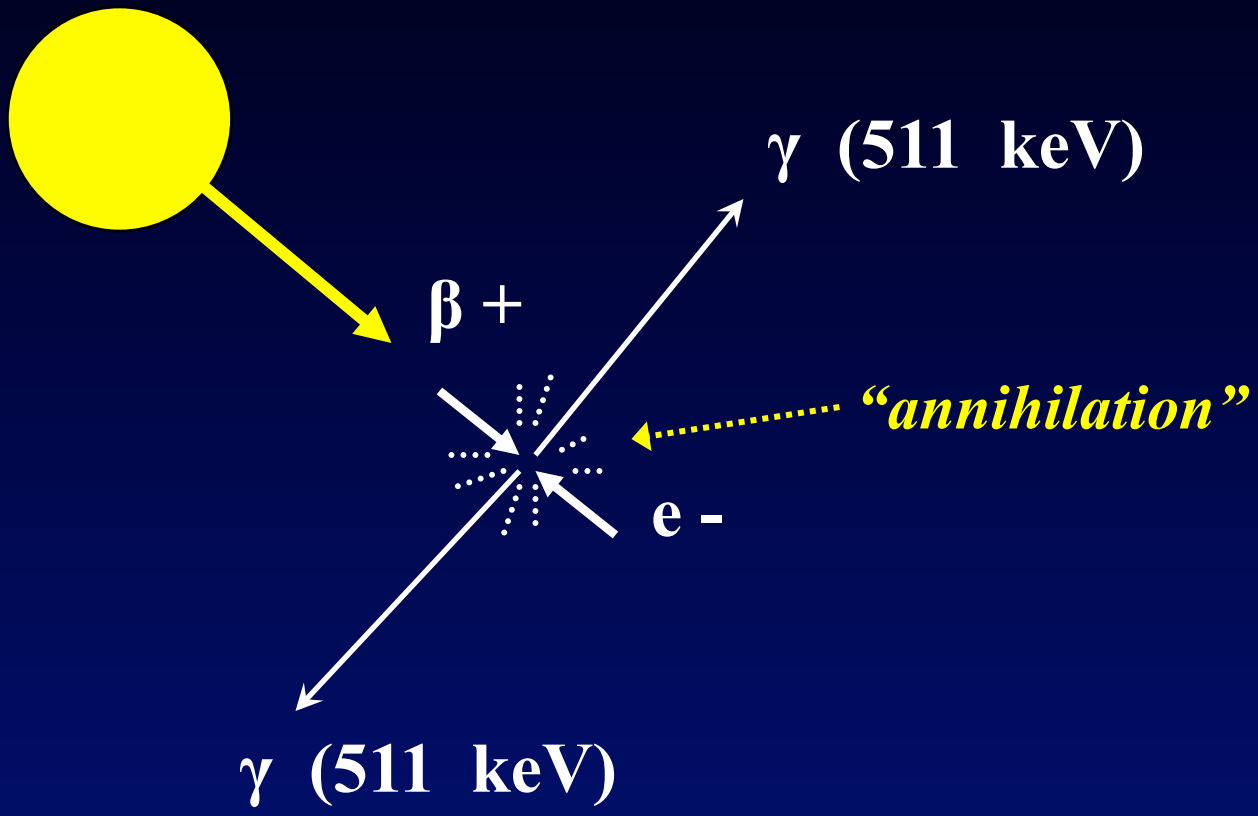
PET & SPECT differ in

- radiochemistry
- instrumentation
- physics of photon emission

# Decay Characteristics of Commonly Used PET & SPECT Nuclides

| Radionuclide | $T_{1/2}$ | Photon Energy |
|---|---|---|
| **PET** | | |
| 15-Oxygen ($^{15}O$) | 2.1 min | 511 keV |
| 13-Nitrogen ($^{13}N$) | 10.0 min | 511 keV |
| 11-Carbon ($^{11}C$) | 20.3 min | 511 keV |
| 18-Fluorine ($^{18}F$) | 109 min | 511 keV |
| **SPECT** | | |
| 99mTechnetium ($^{99m}Tc$) | 6 h | 140 keV |
| 123Iodine ($^{123}I$) | 13 h | 159 keV |
| 133 Xenon ($^{133}Xe$) | 5.3 d | 80 keV |

# PET

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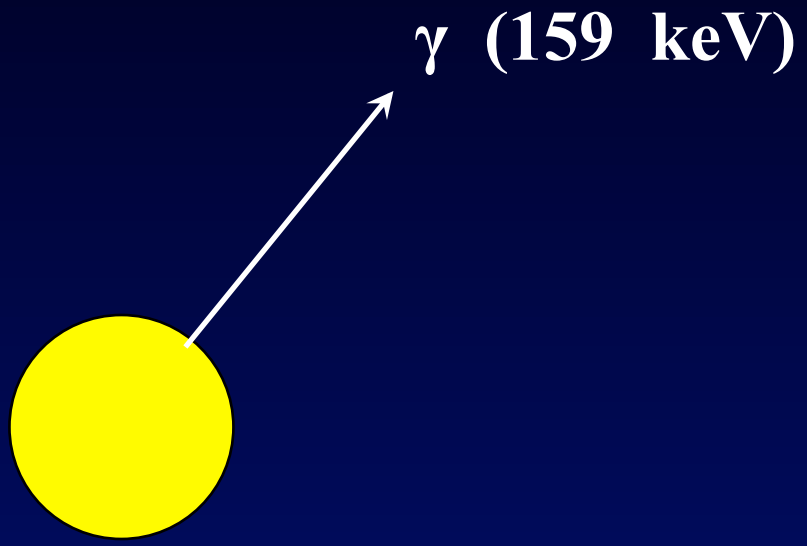
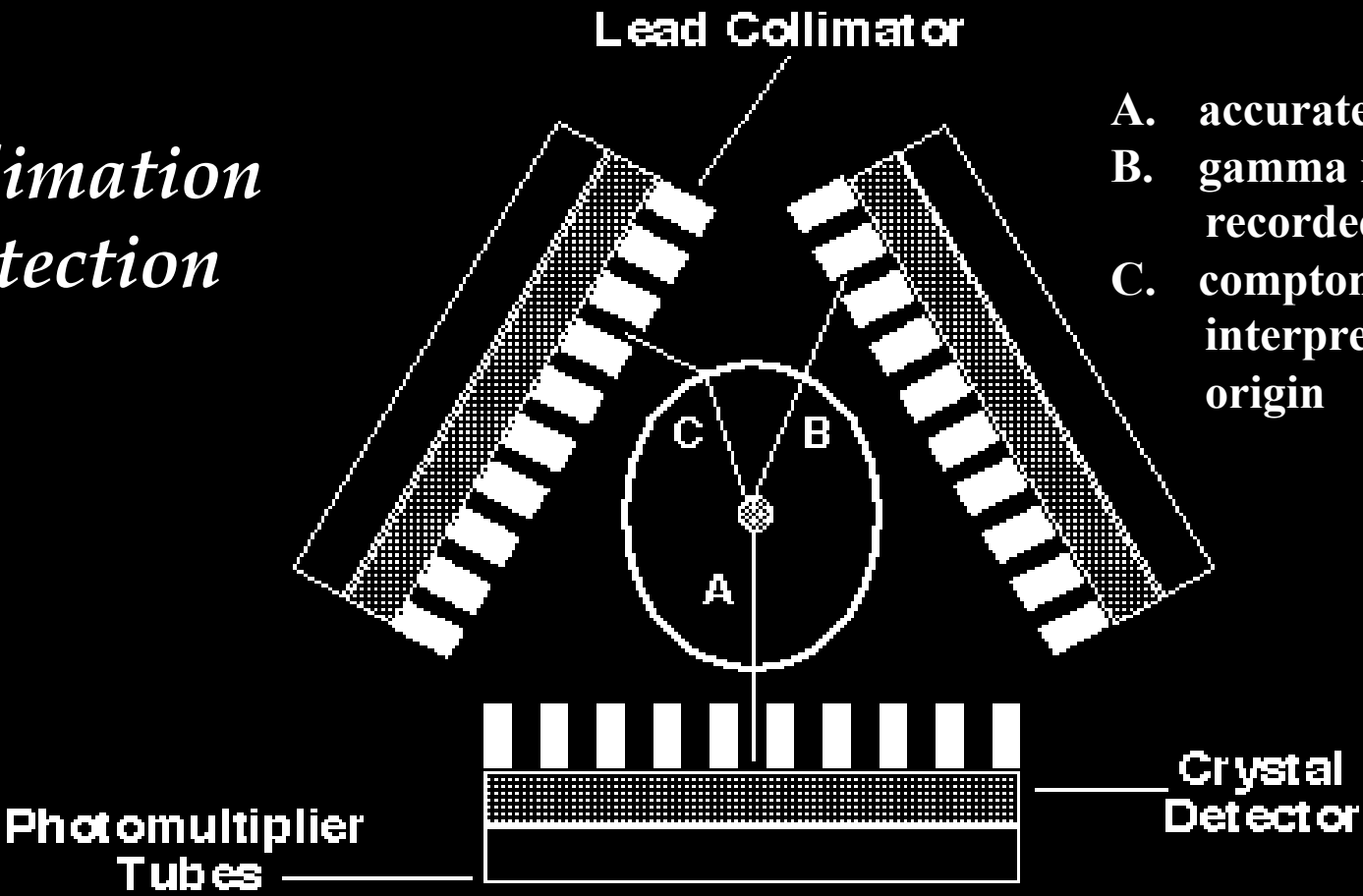
# SPECT



# SPECT Scanner

[Adapted from Malison et al., Psychopharmacology: The Fourth Generation of Progress
Ed Bloom ED & Kupfer DJ, NY p865-879 1995]

*Collimation*
*Detection*




A. accurately recorded photon
B. gamma ray deviated, not recorded
C. compton scatter – false interpretation of path and origin

# SPECT: Collimation Detection

**Collimator-**Typically a block of lead with drilled holes placed between the source of activity and the camera's sodium iodide crystal detectors

- Photon energy is absorbed by crystal, light in the visible range is emitted and is detected by photomultiplier tubes
- Holes in collimator set limits on the possible locations of the source of emission because the walls (septae) block the photons that enter at too sharp of an angle
- By viewing the source of activity from multiple angles, the reconstruction algorithm uses the principle of backprojection to determine the distribution of activity in the source

# Filtered Back-Projection

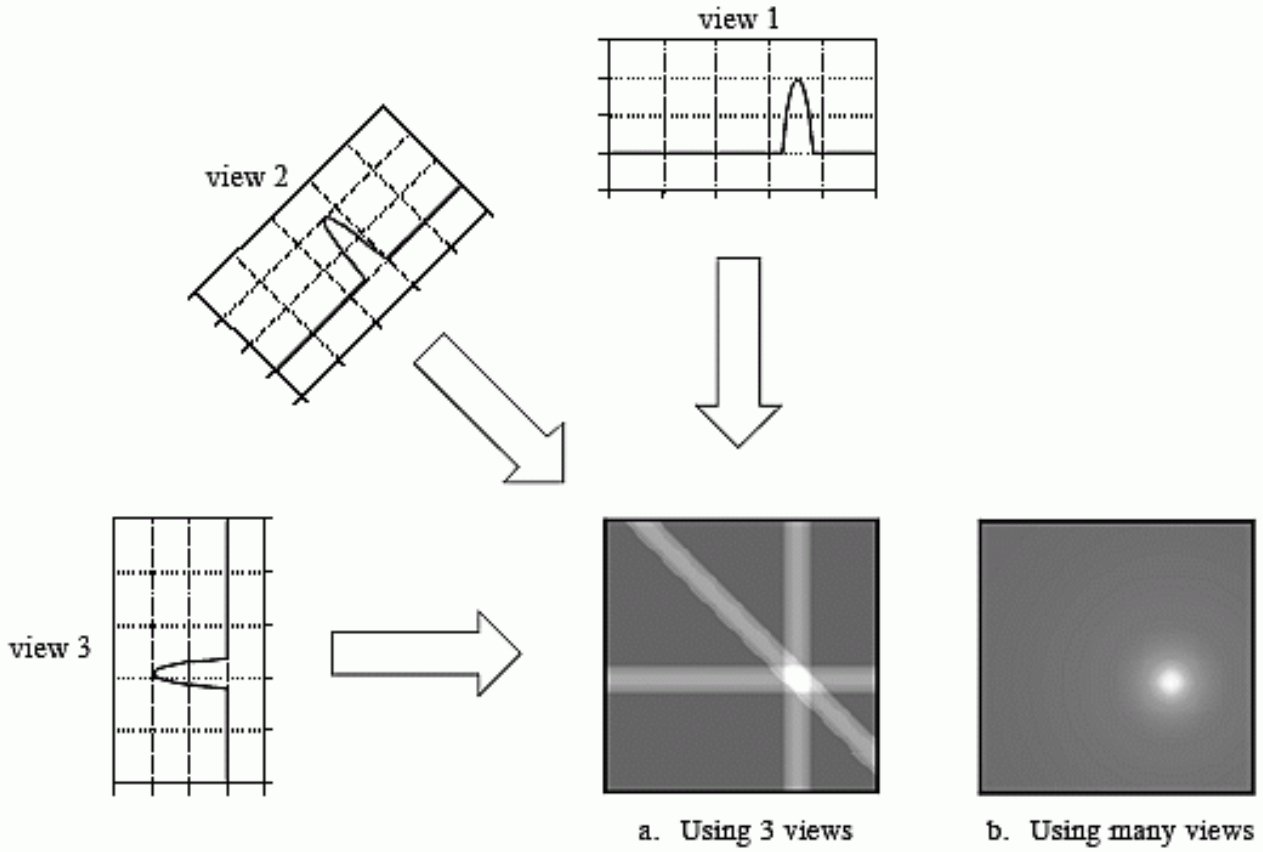



FIGURE 25-16
Backprojection. Backprojection reconstructs an image by taking each view and *smearing* it along the path it was originally acquired. The resulting image is a blurry version of the correct image.

*From: The Scientist and Engineer's Guide to Digital Signal Processing By Steven W. Smith, Ph.D.*

# PET vs SPECT

- radioisotope $T_{1/2}$ < 2 h
- requires rapid synthesis by robot or radiochemist
- requires onsite cyclotron
  - costs $1-2.5 million
  - Technical staff for operation & maintenance
- $\beta^+ + e^-$ → two 511 keV photons
- Coincidence detection

- radioisotope $T_{1/2}$ > 6 h
- allows more time for synthesis of radiopharmaceutical
- produced commercially ($^{123}I$) or locally onsite very inexpensively ($^{99m}Tc$)
- single γ photon 159 keV
- Collimation detection