



Nuclear Medicine

Sahar Rezaei, PhD

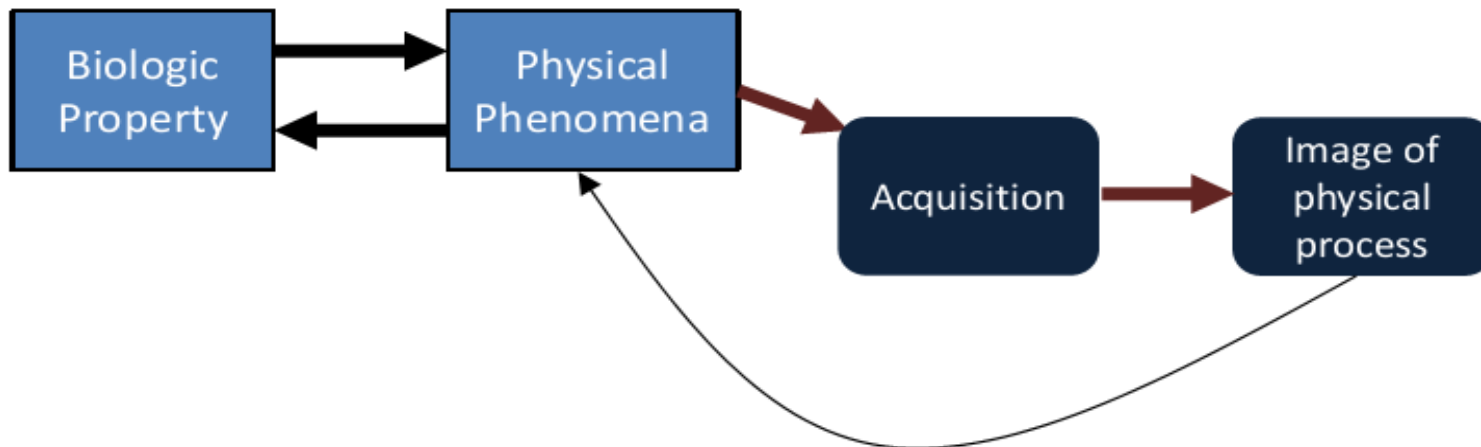
Assistant Professor

Tabriz University of Medical Sciences

PhD in Medical physics, Department of Medical physics and Biomedical Engineering, Tehran University Of Medical Sciences

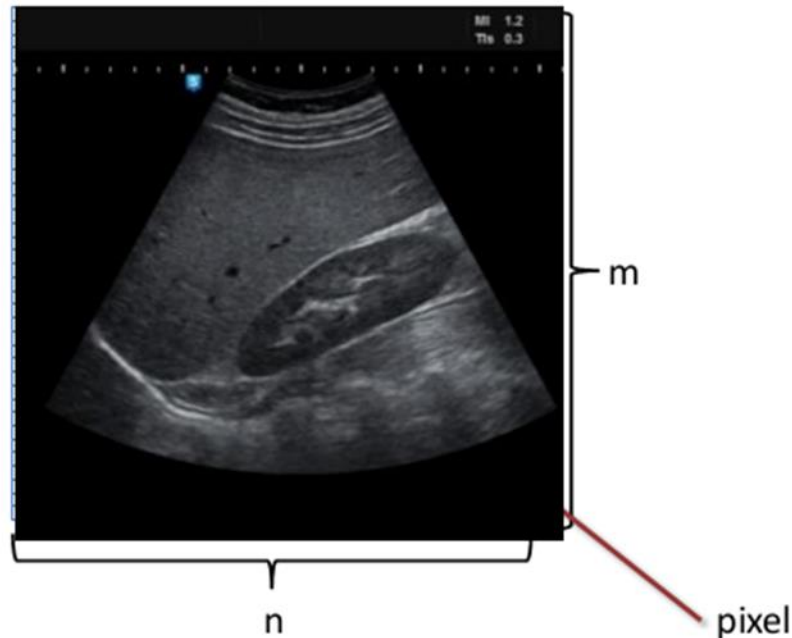
Medical Imaging

- Show and record the structural or functional state of the body.
- that cannot be observed by visual inspection or physical examination



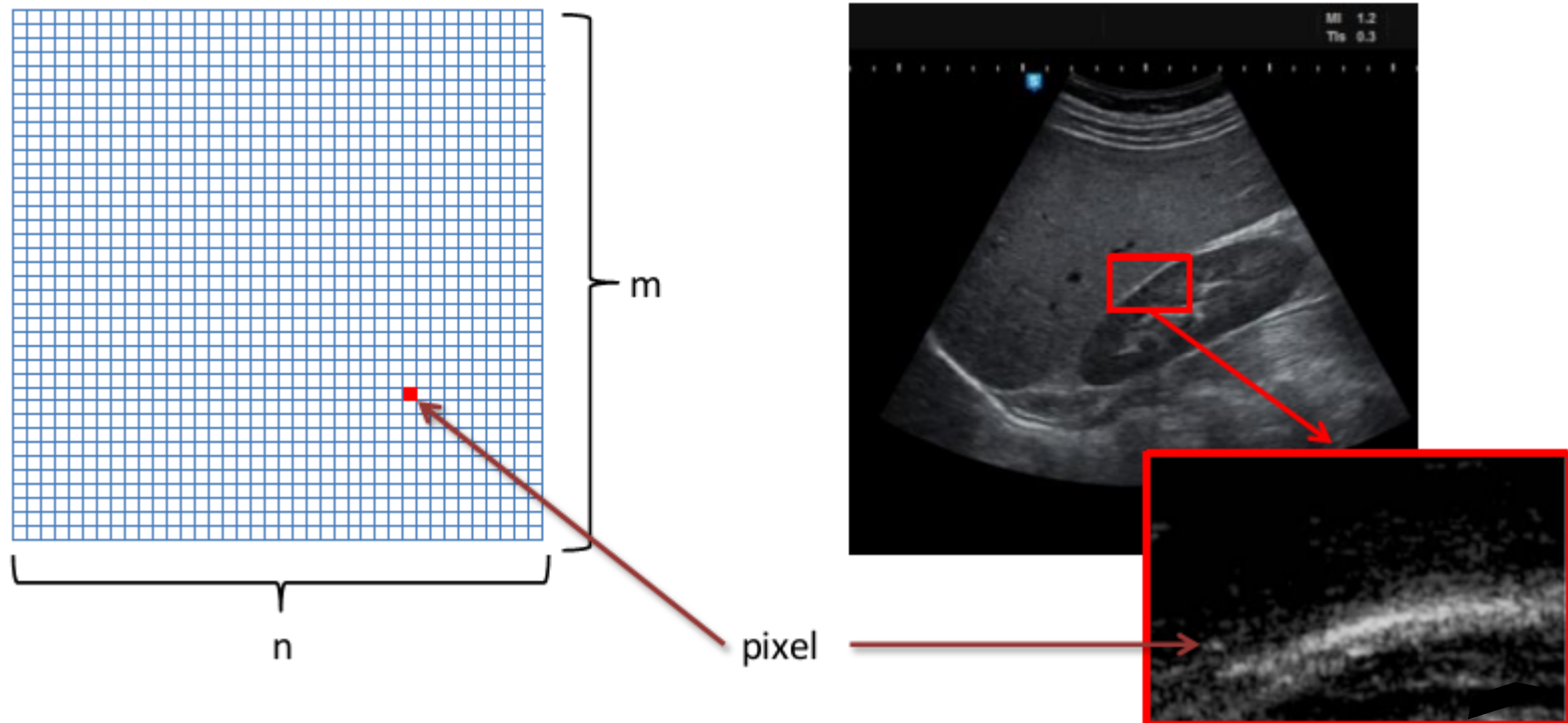
Medical Imaging -Image Matrix

- Image generation begins with an empty matrix.
- Image matrix is filled by **processed acquired data**.



Medical Imaging -Image Matrix

- We need to obtain each pixel value in imaging process



Medical Imaging

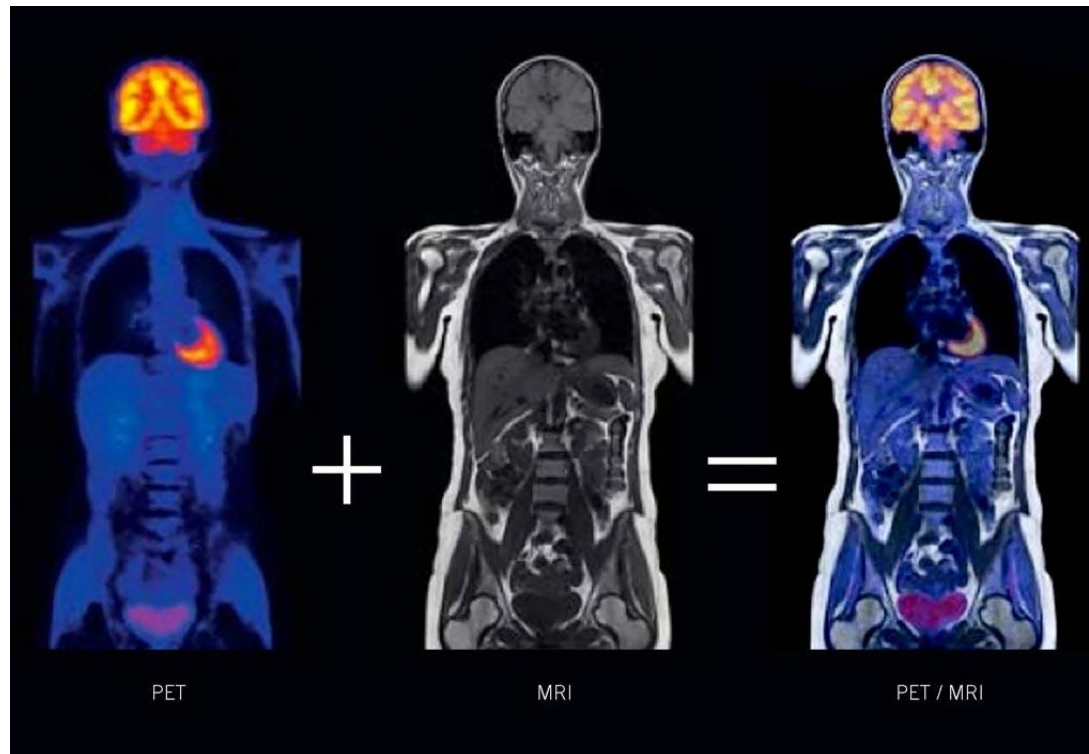
Imaging is the creation of a 2D, 3D or 4D representation of a physical phenomena by measurement of energy

- Emitted
- Reflected
- Transmitted

from the object.

Medical Imaging Systems

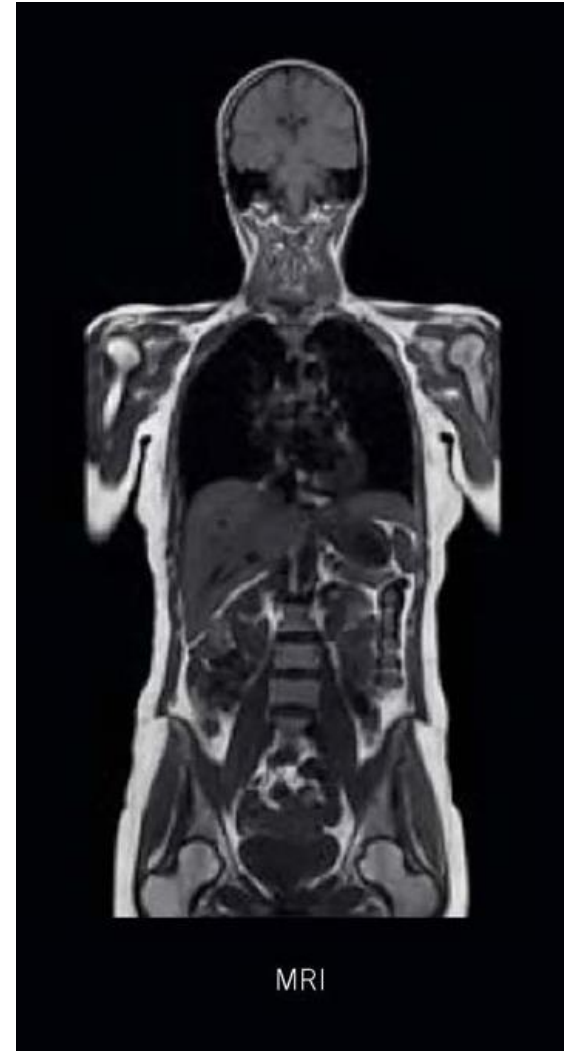
- Structural/Anatomical Imaging
- Functional Imaging
- Hybrid Imaging(mostly Anatomical+Functional)



Medical Imaging Systems

Structural Imaging

- Radiology
- Fluoroscopy / Angiography
- Computed Tomography (CT)
- Mammography
- MRI
- Ultrasound



Medical Imaging Systems

Functional Imaging

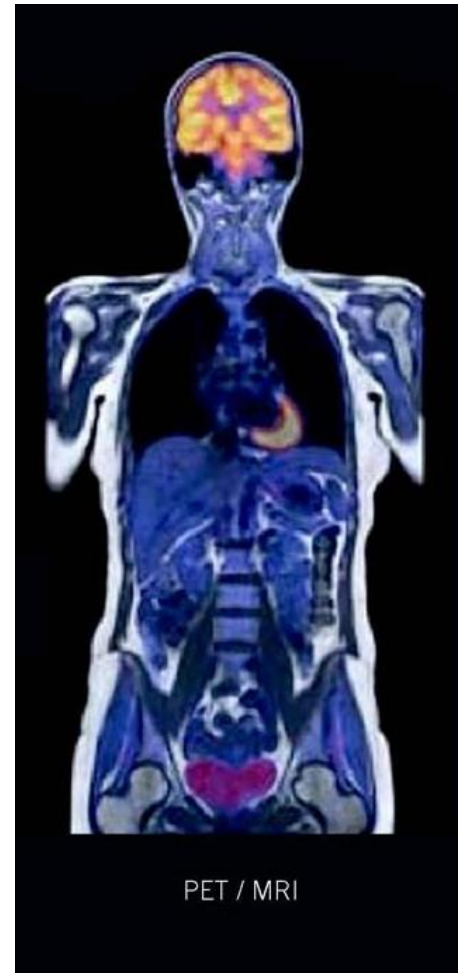
- Gamma Camera
- SPECT
- PET
- fMRI
- Molecular Imaging



Medical Imaging Systems

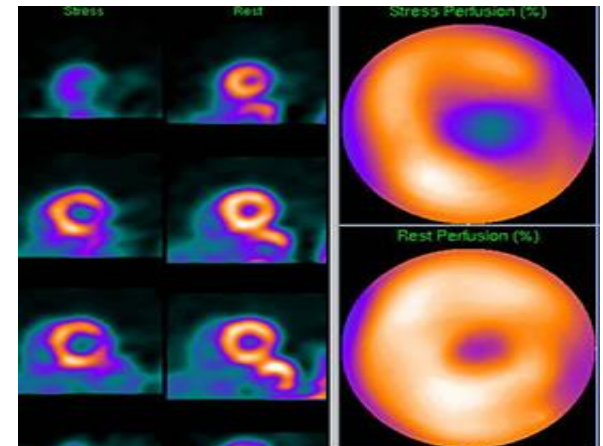
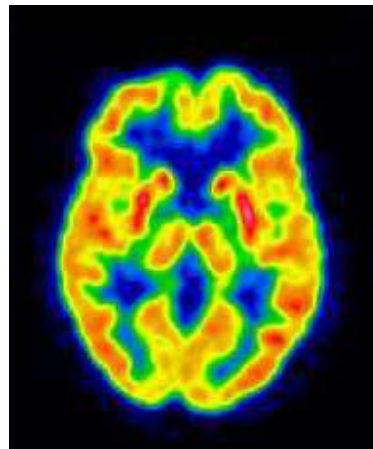
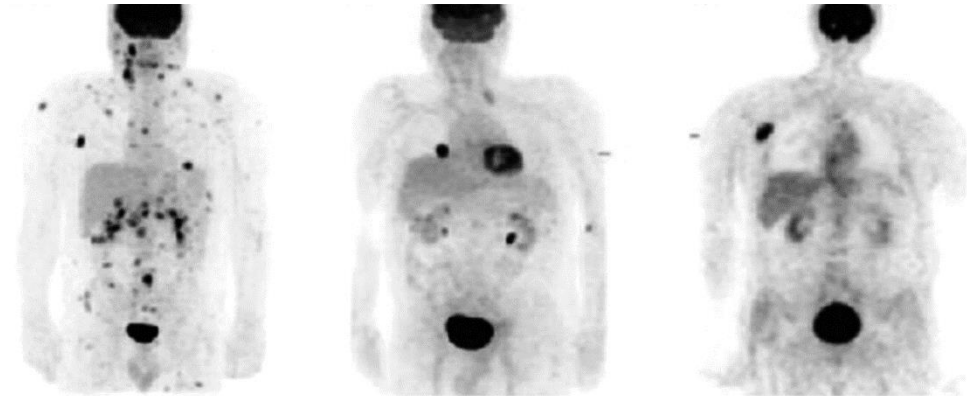
Hybrid Imaging

- SPECT/CT
- PET/CT
- PET/MRI
- MRI/Mammo
- • •



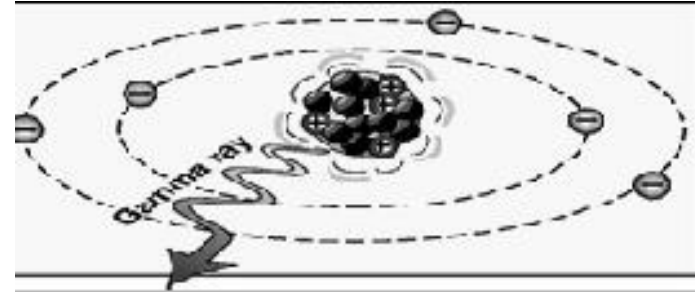
What is Nuclear Medicine?

- Nuclear medicine is a branch of medical imaging



How are images made

- Patient receives radioactive tracer tagged to a chemical
 - via injection, inhalation, or ingestion
 - painless process, cannot feel the painless process,
 - Small radiation dose equivalent to x-ray



How are images made

- Radioactive chemical travels to organ of interest
 - type of chemical determines into which organ(s) the radioactivity distributes

^{99m}Tc -MDP SPECT SCAN

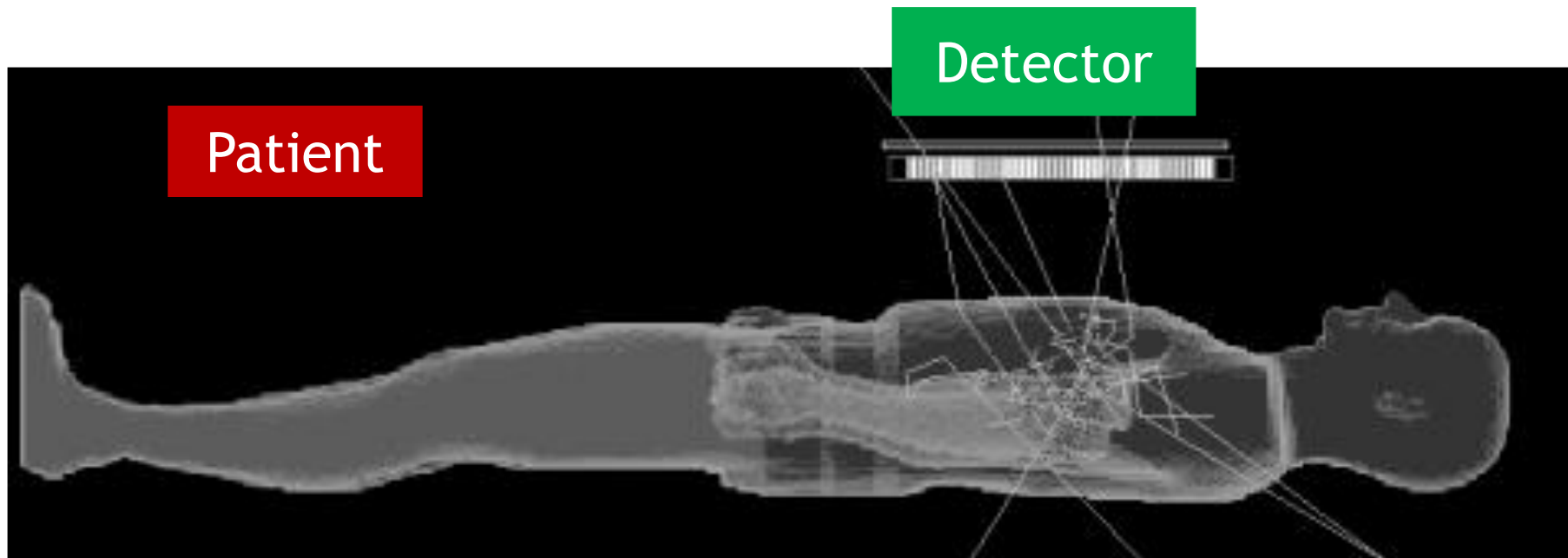


Whole body bone scan showing increased uptake in the lumbar Spine, maxillary sinuses, hemipelvis, right femoral neck, ribs

How are images made

Patient imaged with camera

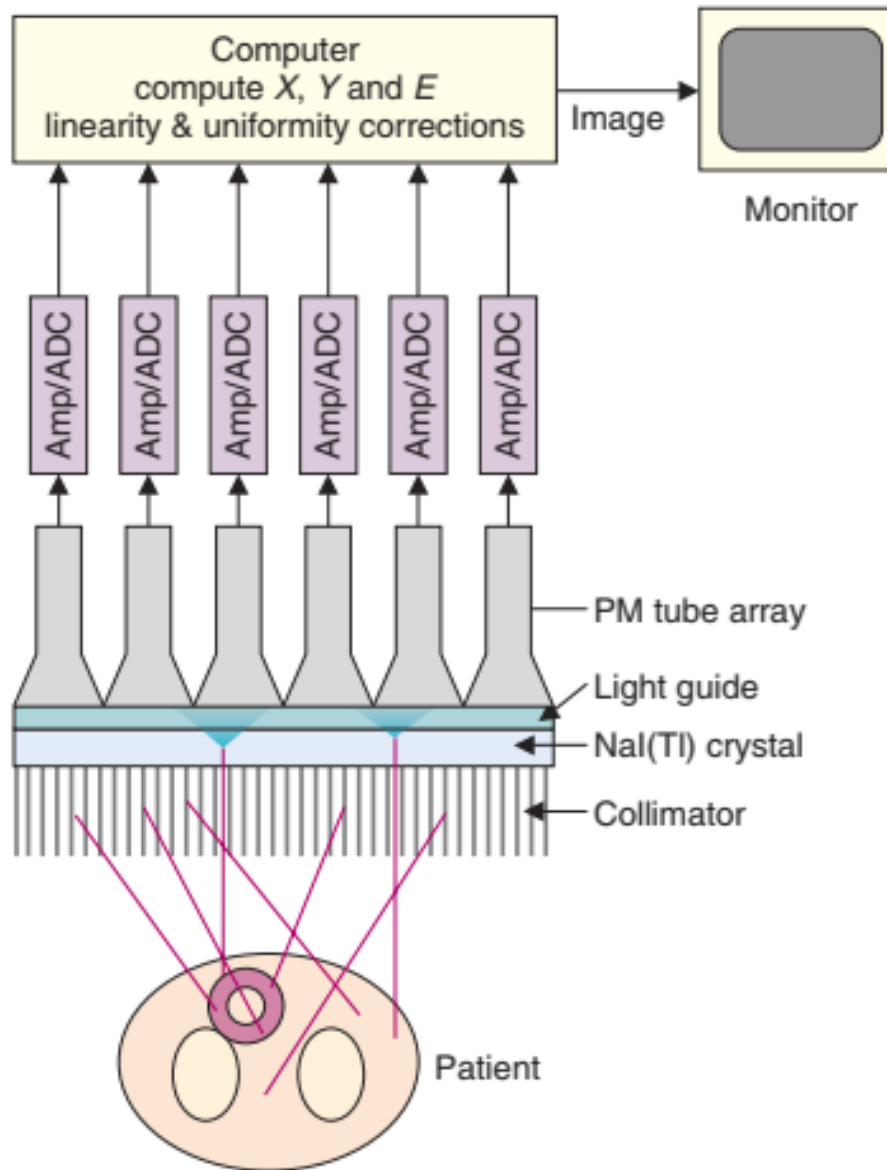
- as radiation decays, it emits energy that exits the body
- camera absorbs this energy and creates a picture



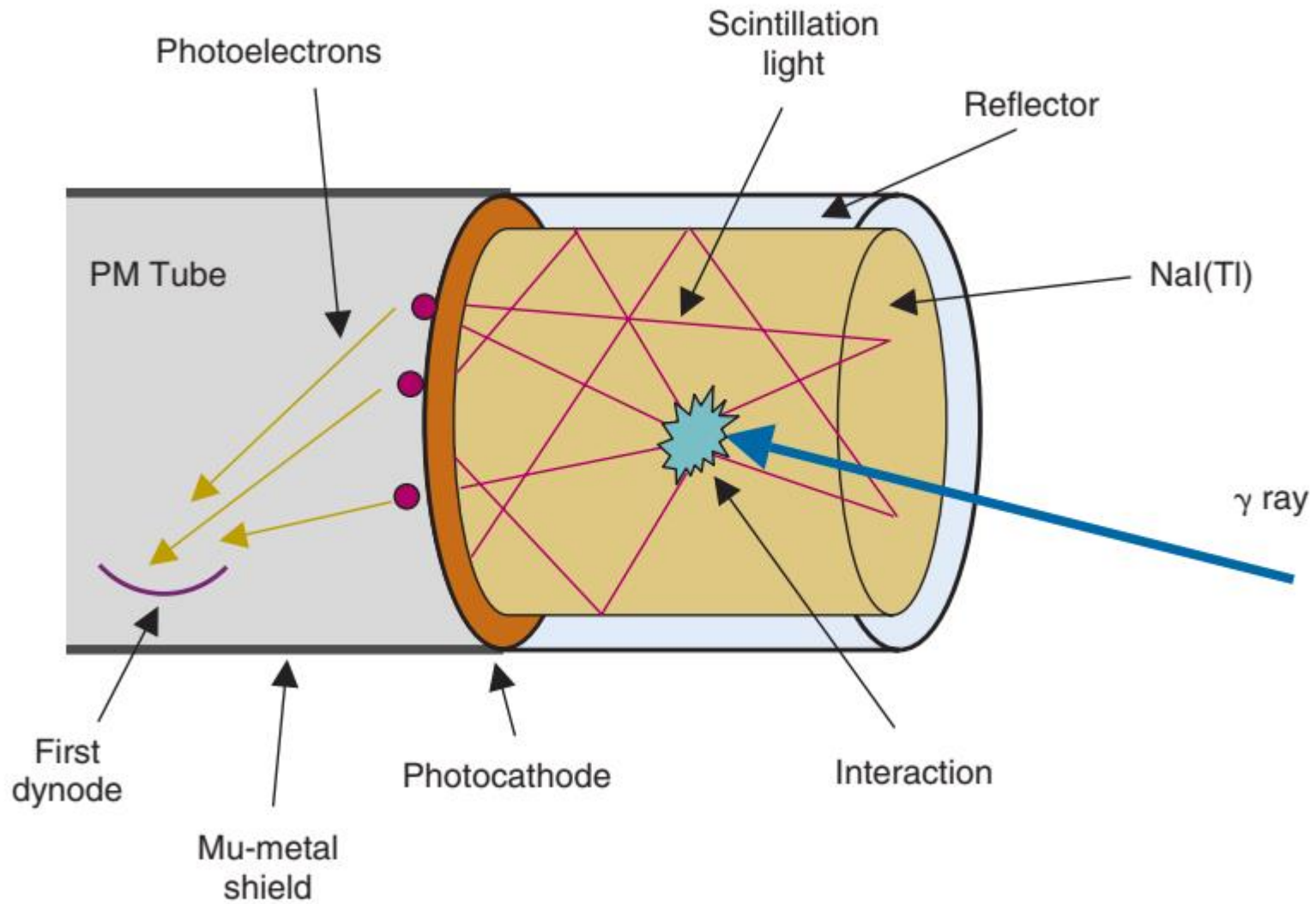
Nuclear Medicine Instrumentation

- Gamma Scintillation Camera
- Single-Photon Emission Computed Tomography (SPECT)
 - SPECT/CT
- Positron Emission Tomography (PET)
 - PET/CT

Gamma Scintillation Camera



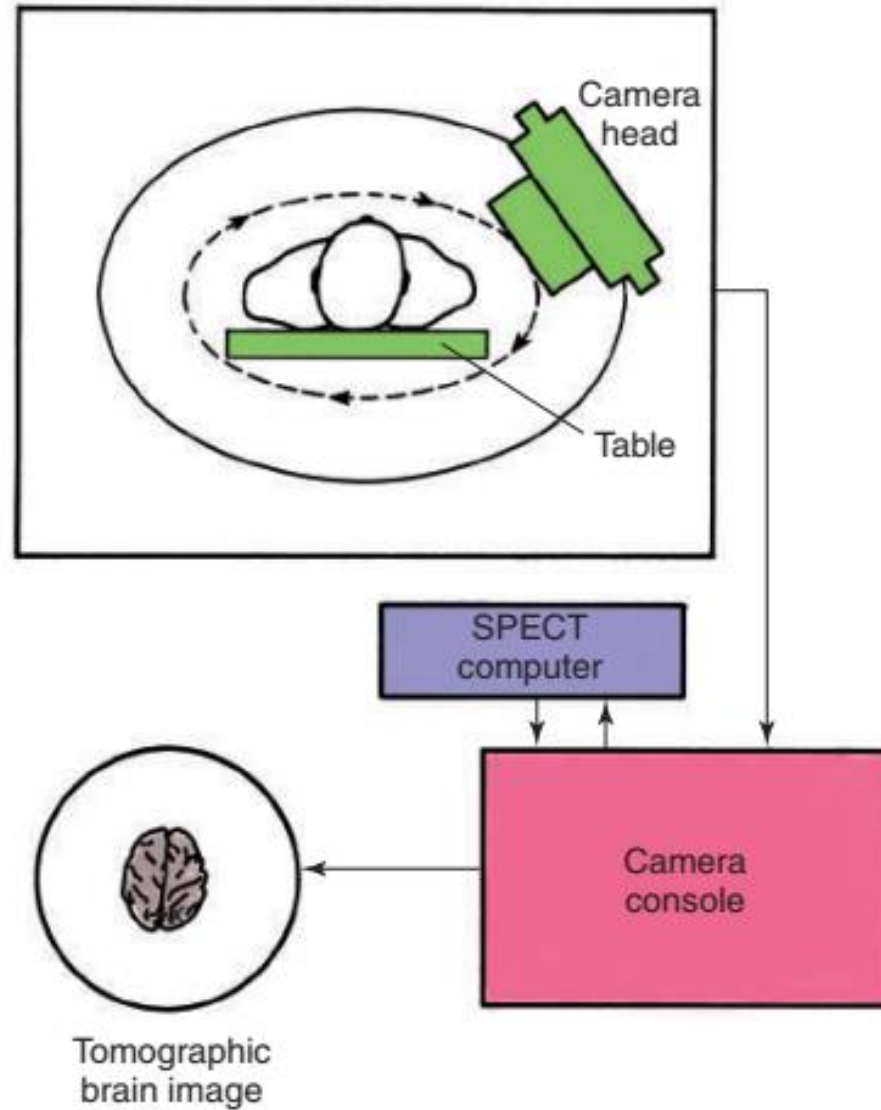
Gamma Scintillation Camera

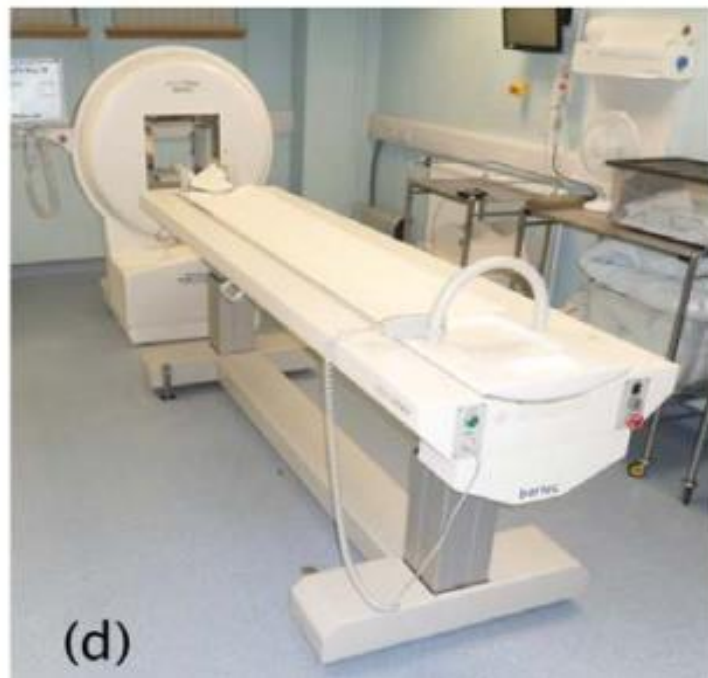
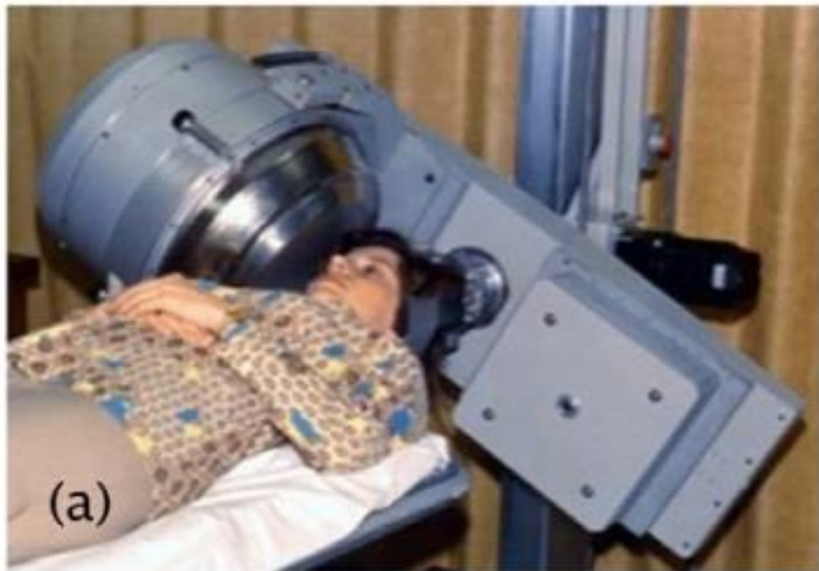


Nuclear Medicine Instrumentation

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SPECT





SPECT

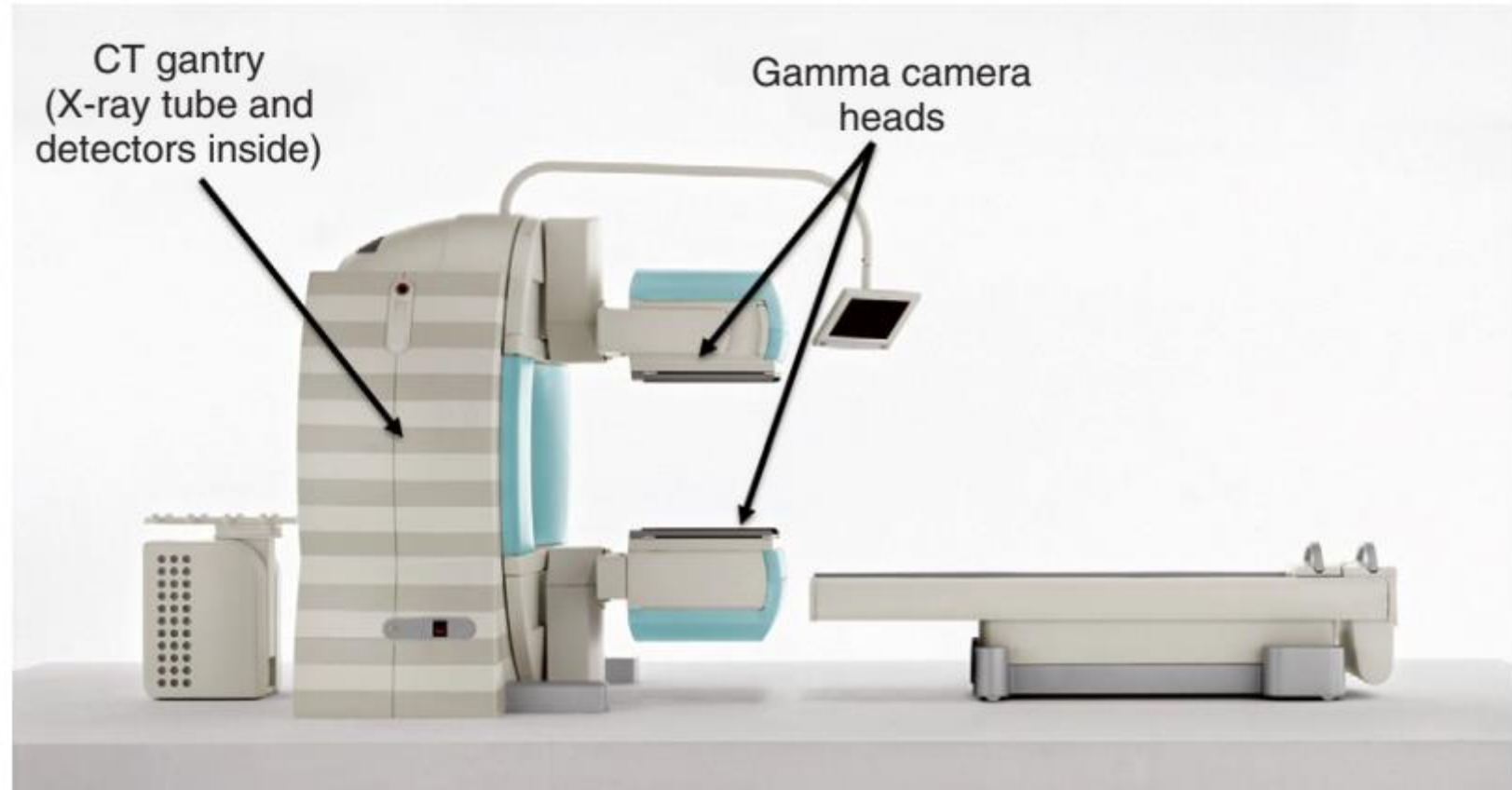


Dual Head Gamma Camera in Cardiac Configuration

Characteristics of Commonly Used Radionuclides

	Symbol	Physical Half-Life	Approximate Energy
Photon-Emitting Radionuclides for Imaging			<u>Gamma (keV)</u>
Technetium-99m	^{99m}Tc	6 h	140
Molybdenum-99	^{99}Mo	67 h	181, 740, 780
Iodine-123	^{123}I	13.2 h	159
Iodine-131	^{131}I	8.0 days	364
Xenon-133	^{133}Xe	5.3 days	81
Gallium-67	^{67}Ga	78.3 h	93, 184, 296, 388
Indium-111	^{111}In	67 h	173, 247
Indium-113m	^{113m}In	1.7 h	392
Thallium-201	^{201}Tl	73.1 h	69, 81 (x-rays from mercury daughter)
Krypton-81m	^{81m}Kr	13 s	191

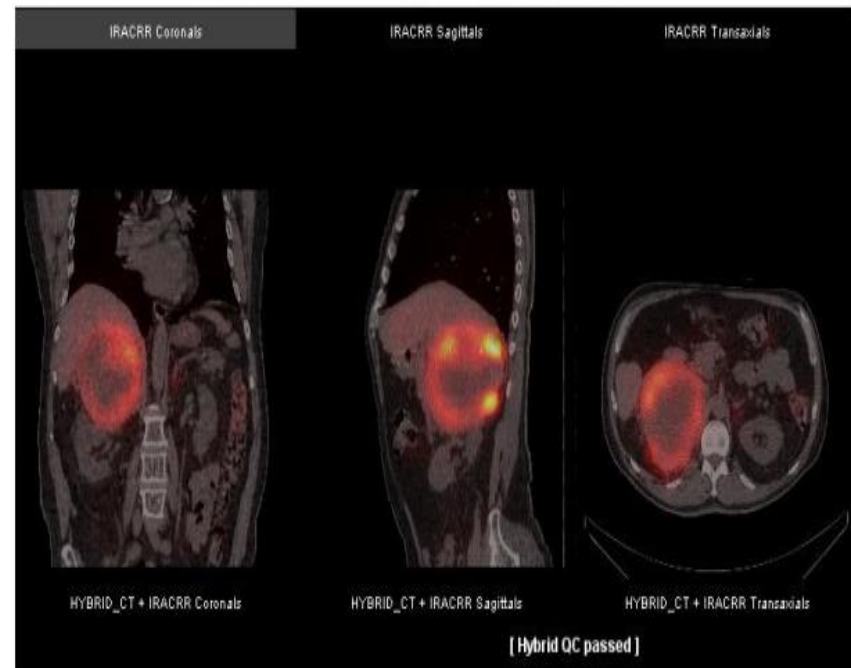
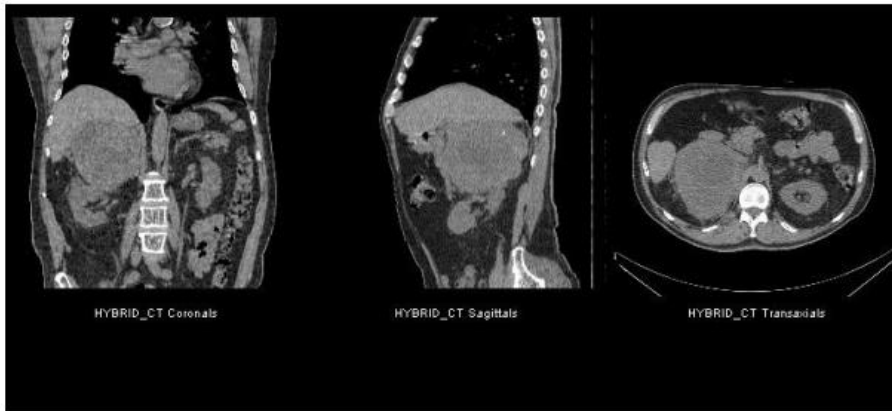
SPECT/CT



SPECT/CT

Benefits of SPECT/CT

- Functional mapping



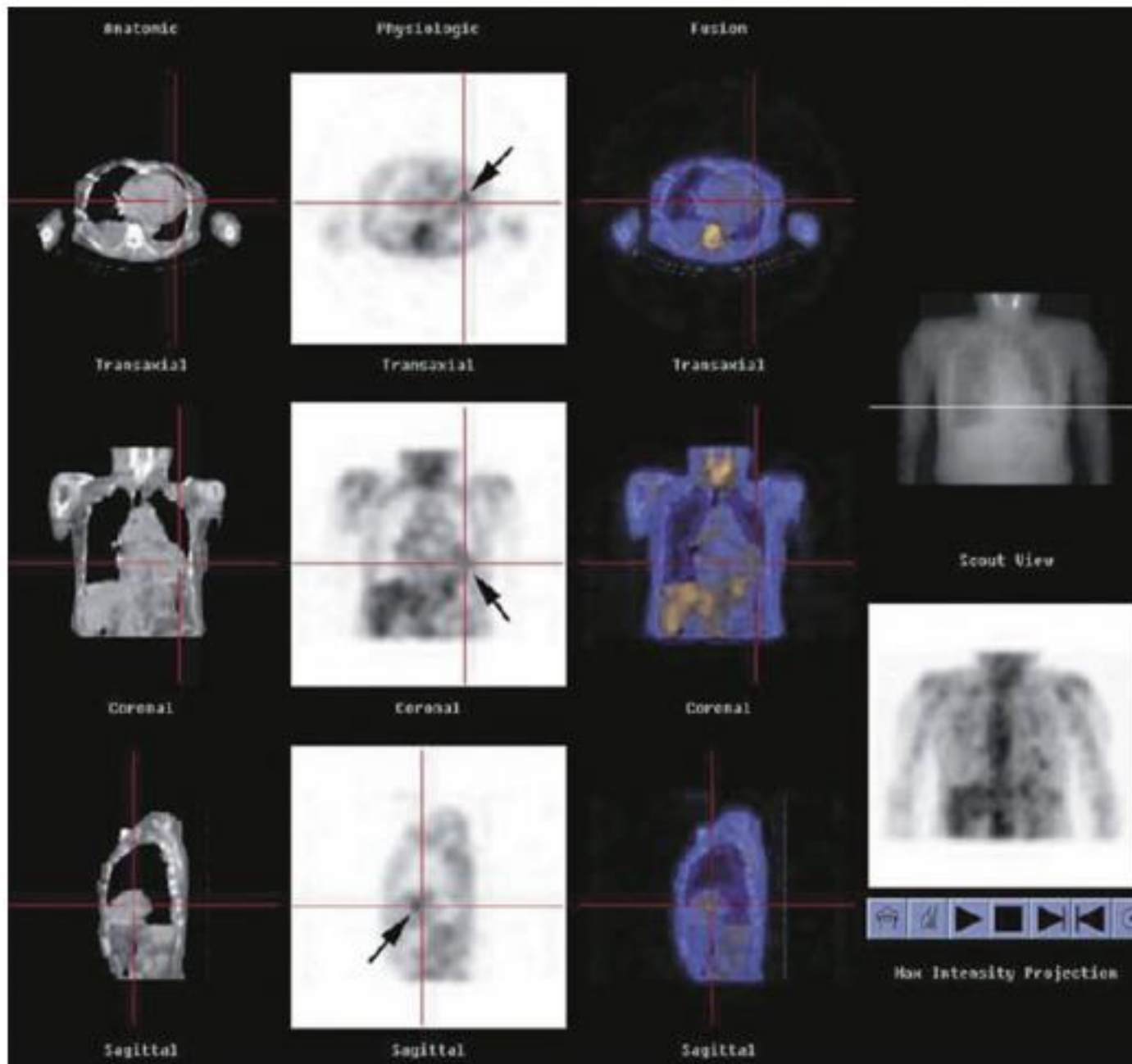
SPECT/CT

Benefits of SPECT/CT

- Functional mapping
- Quantitative SPECT

SPECT & SPECT/CT

- **Cardiac Imaging**
- **Inflammation Imaging**
- **Brain Imaging**
- **Radiation Planning**



A 60-year-old female patient with cardiac sarcoidosis.

Nuclear Medicine Instrumentation

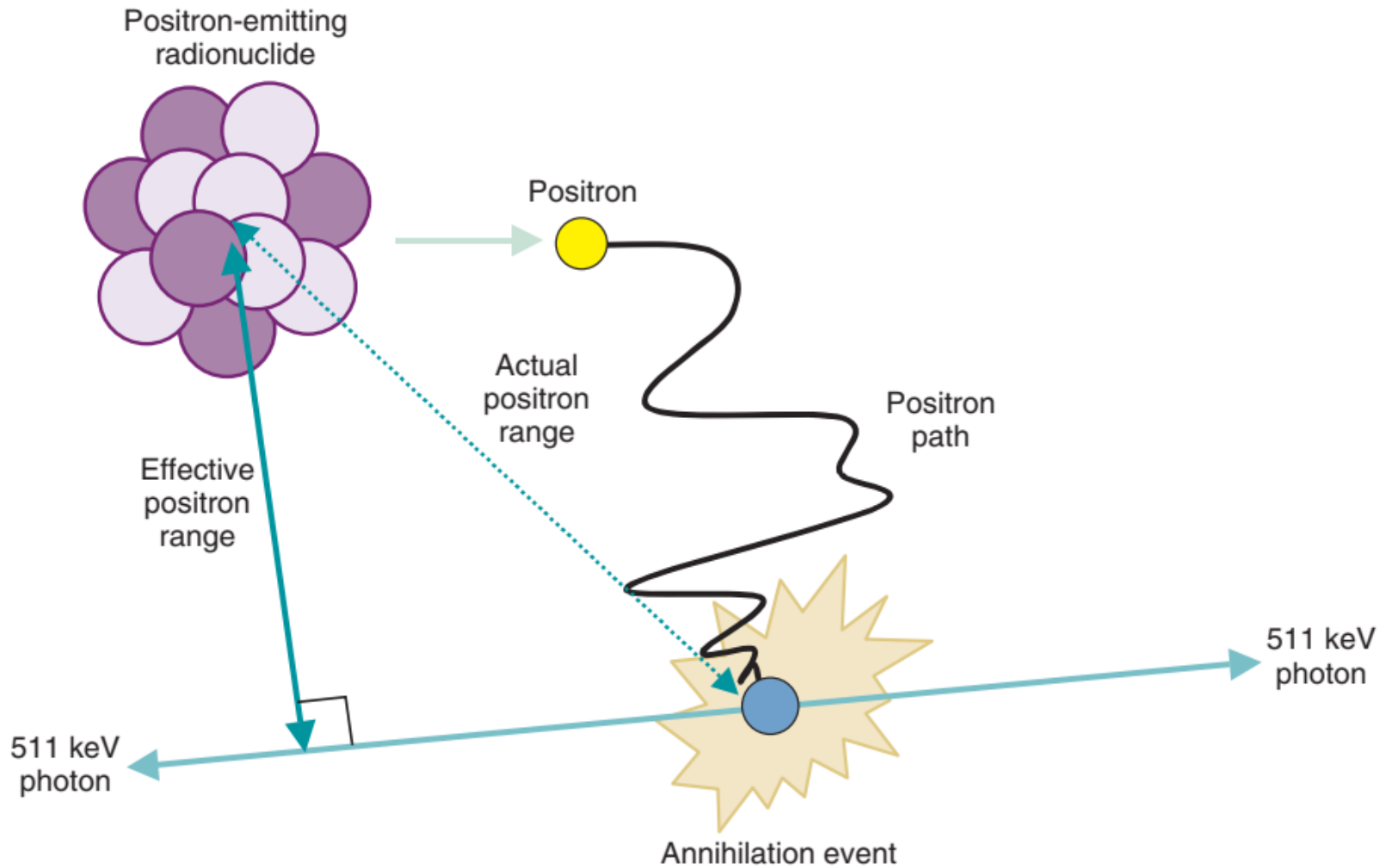
- Gamma Scintillation Camera
- Single-Photon Emission Computed Tomography (SPECT)
 - SPECT/CT
- Positron Emission Tomography (PET)
 - PET/CT

PET

PET Radionuclides

Isotope	Half life	Positron energy (MeV)
C-11	20 minutes	0.385
N-13	10 minutes	0.492
O-15	2 minutes	0.735
F-18	110 minutes	0.250
K-38	8 minutes	1.216
Cu-62	10 minutes	1.315
Cu-64	12.7 hours	0.278
Ga-68	68.1 hours	0.836, 0.352
Rb-82	1.3 minutes	1.523, 1.157
I-124	4.2 days	1.691, 7.228, 1.509, 1.376

PET

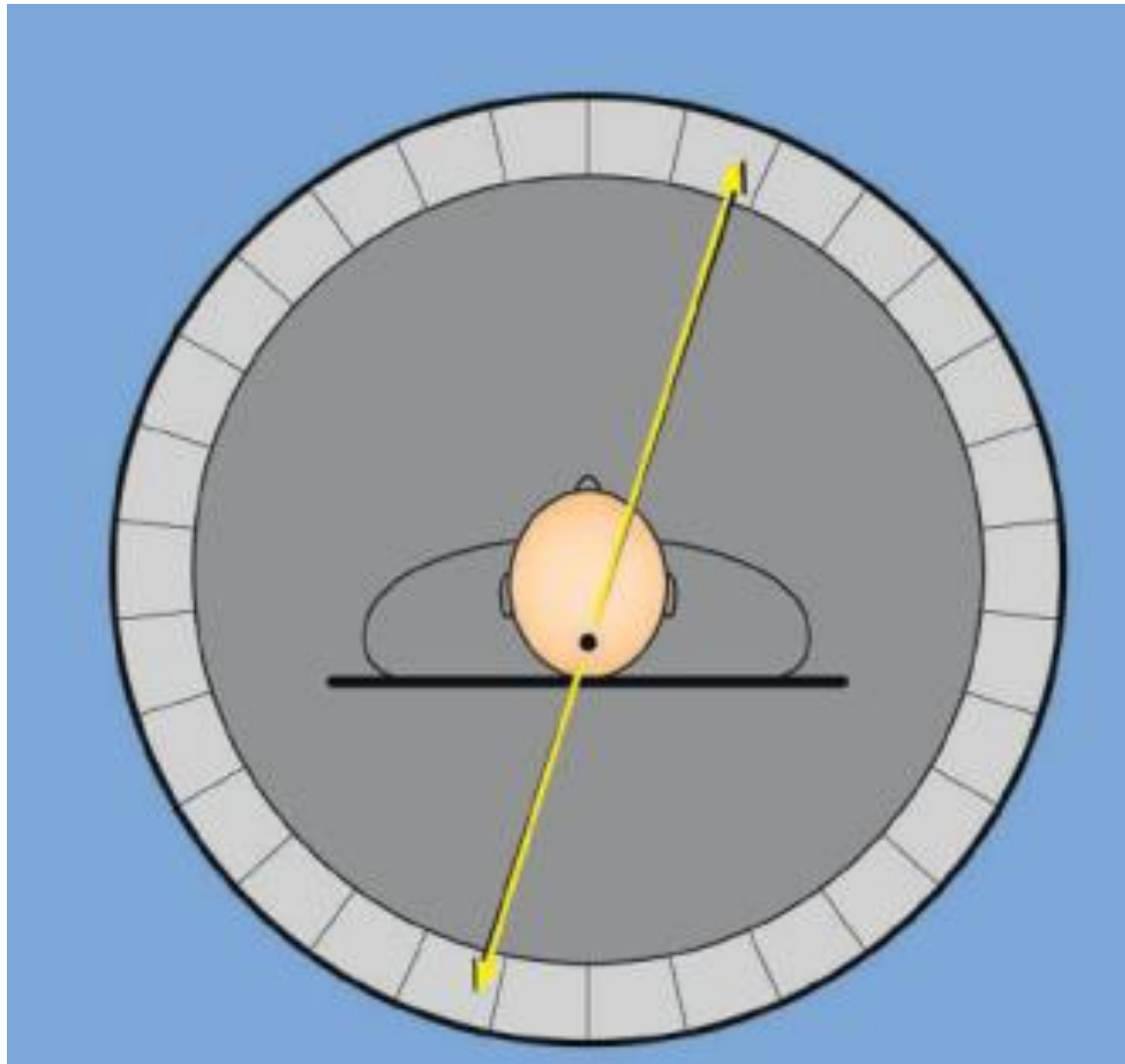


PET

PET radiopharmaceuticals for brain imaging

Compound	Application
O-15 H ₂ O	Blood flow
O-15 O ₂	Oxygen metabolism / flow
O-15 or C-11 Carboxy haemoglobin	Blood volume
C-11 Methionine	Amino acid metabolism
C-11 Ephedrine	Adrenergic terminals
C-11 Carfentanil	Opiate receptor activity
C-11 Flunitrazepam	Benzodiazepine receptor activity
C-11 Methylspiperone	Dopamine receptor activity
C-11 Scopolamine	Muscarinic cholinergic receptor activity
F-18 Fluorodeoxyglucose (FDG)	Glucose metabolism
F-18 Fluoro-dopa	Presynaptic dopamine system
F-18 Fluorothymidine (FLT)	DNA synthesis

PET



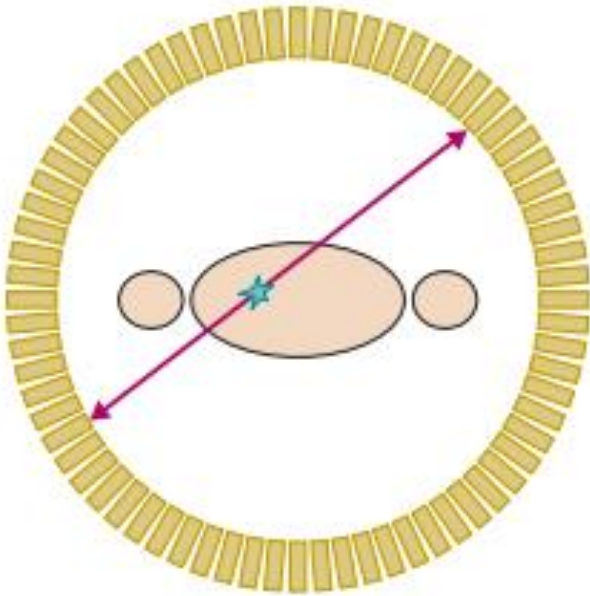
PET/CT



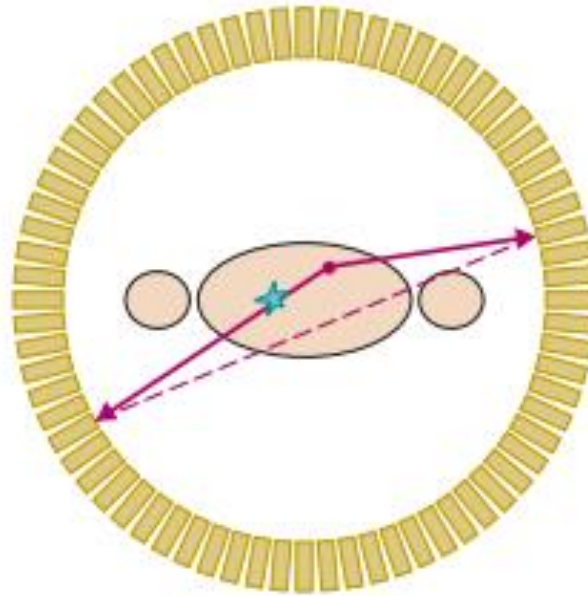
Hybrid PET/CT scanner.

PET

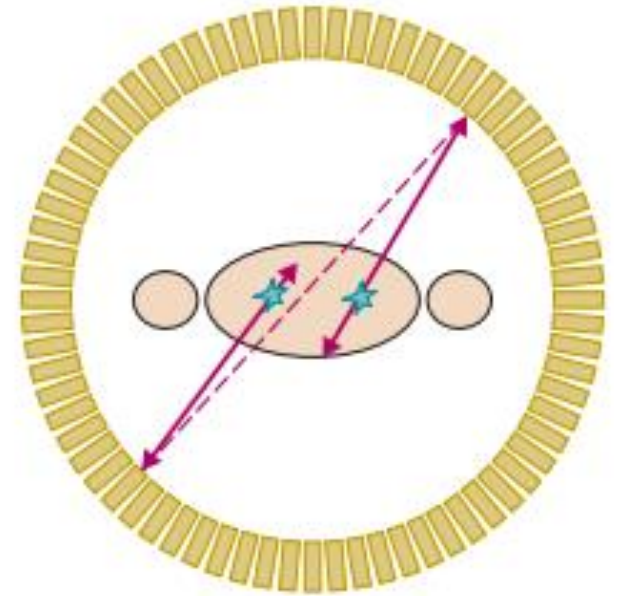
True coincidence



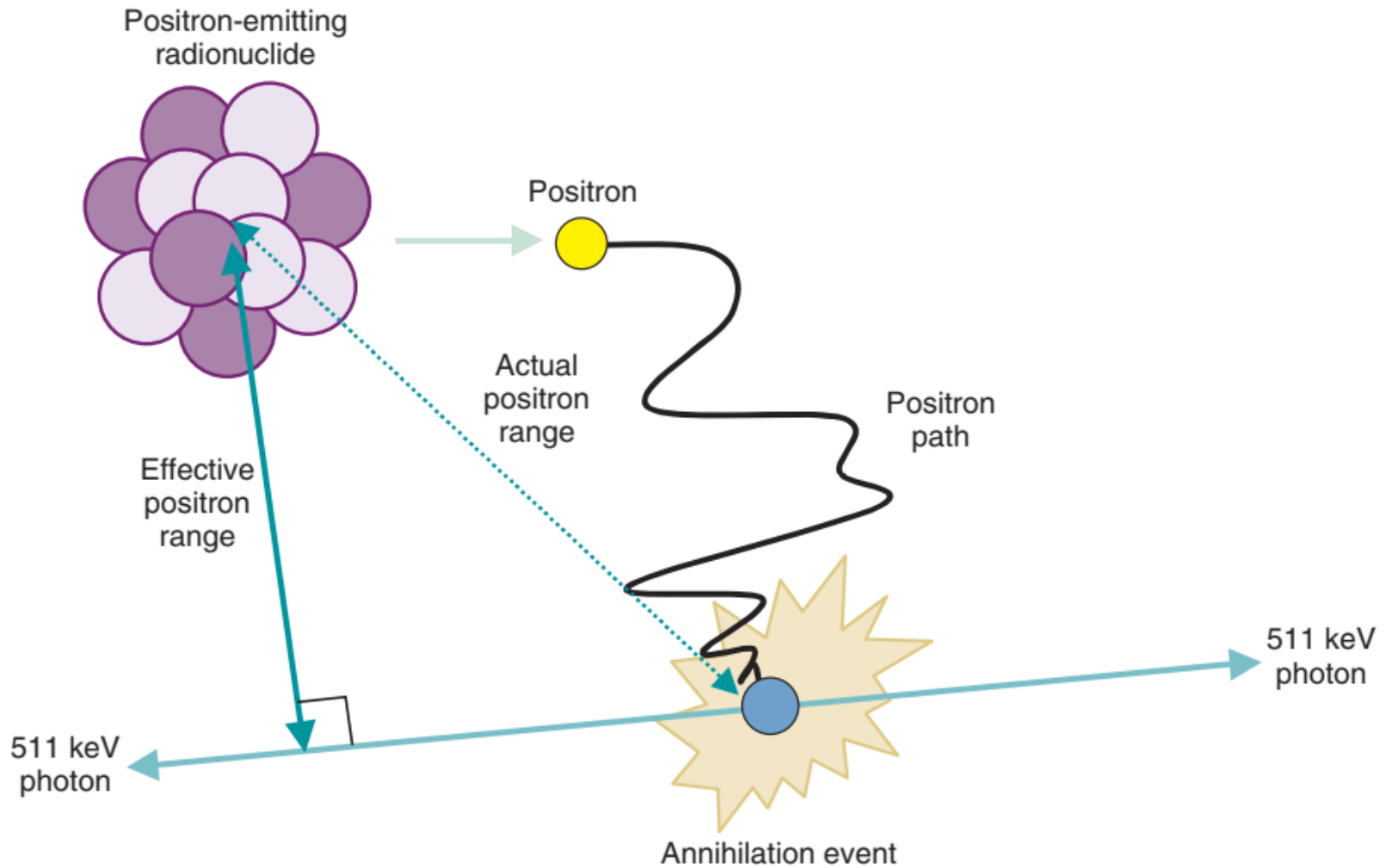
Scatter coincidence



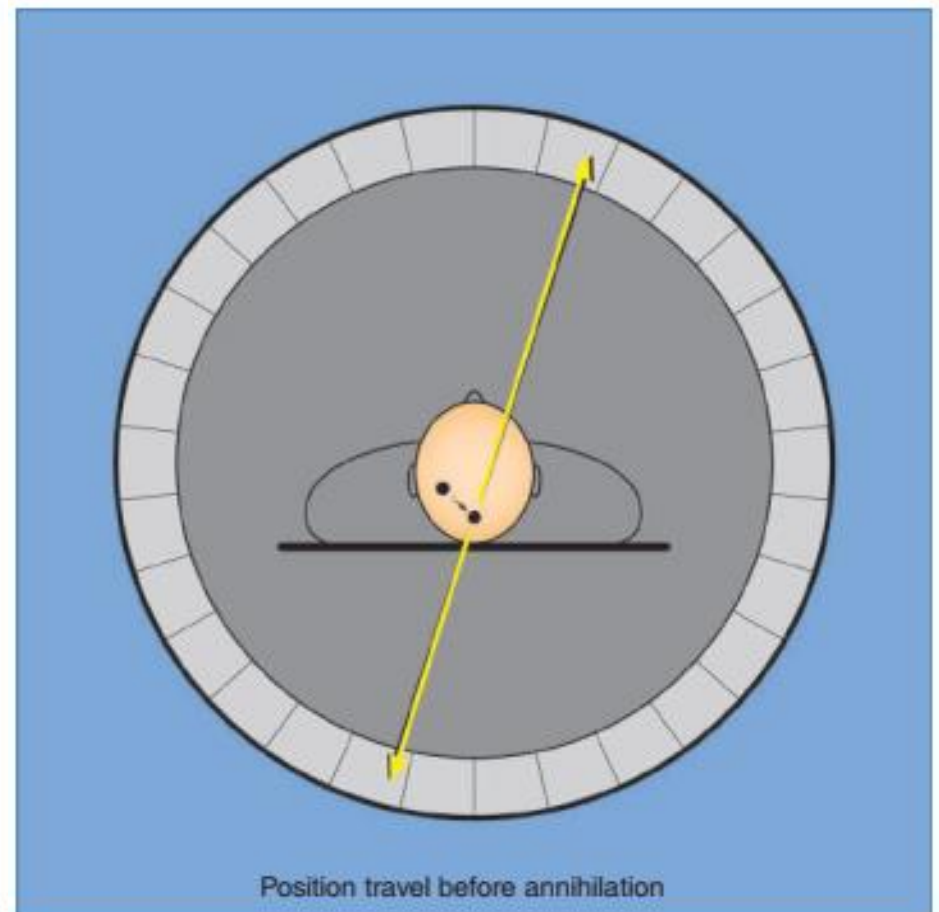
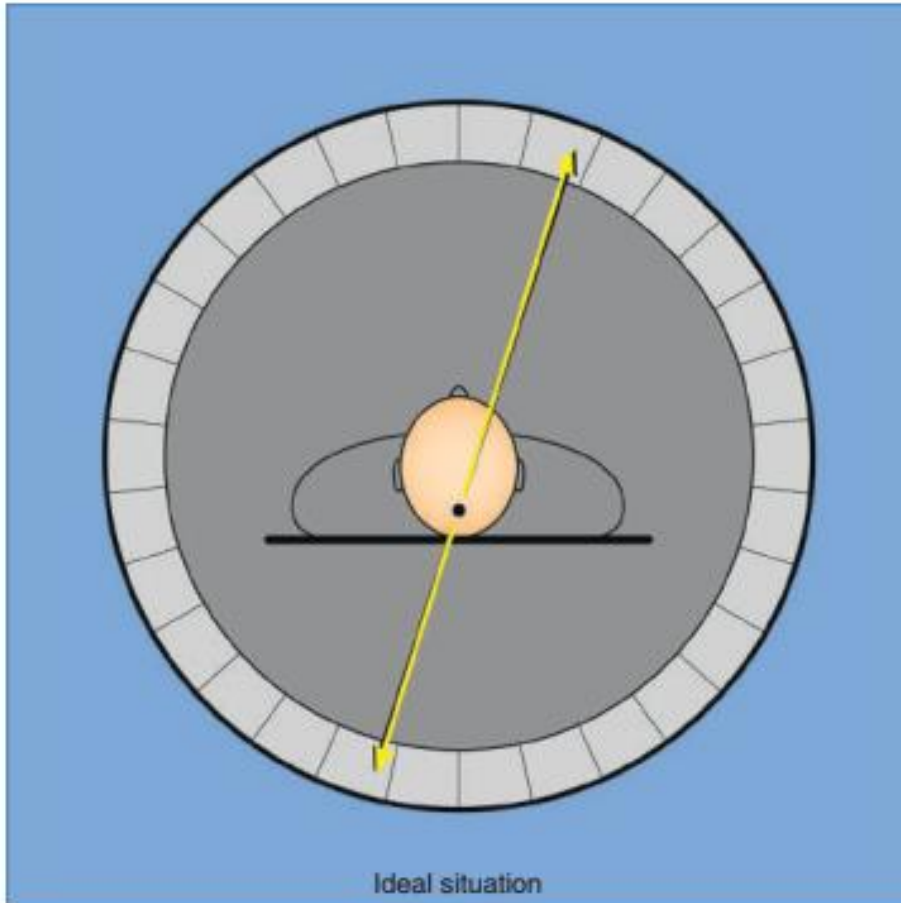
Random coincidence



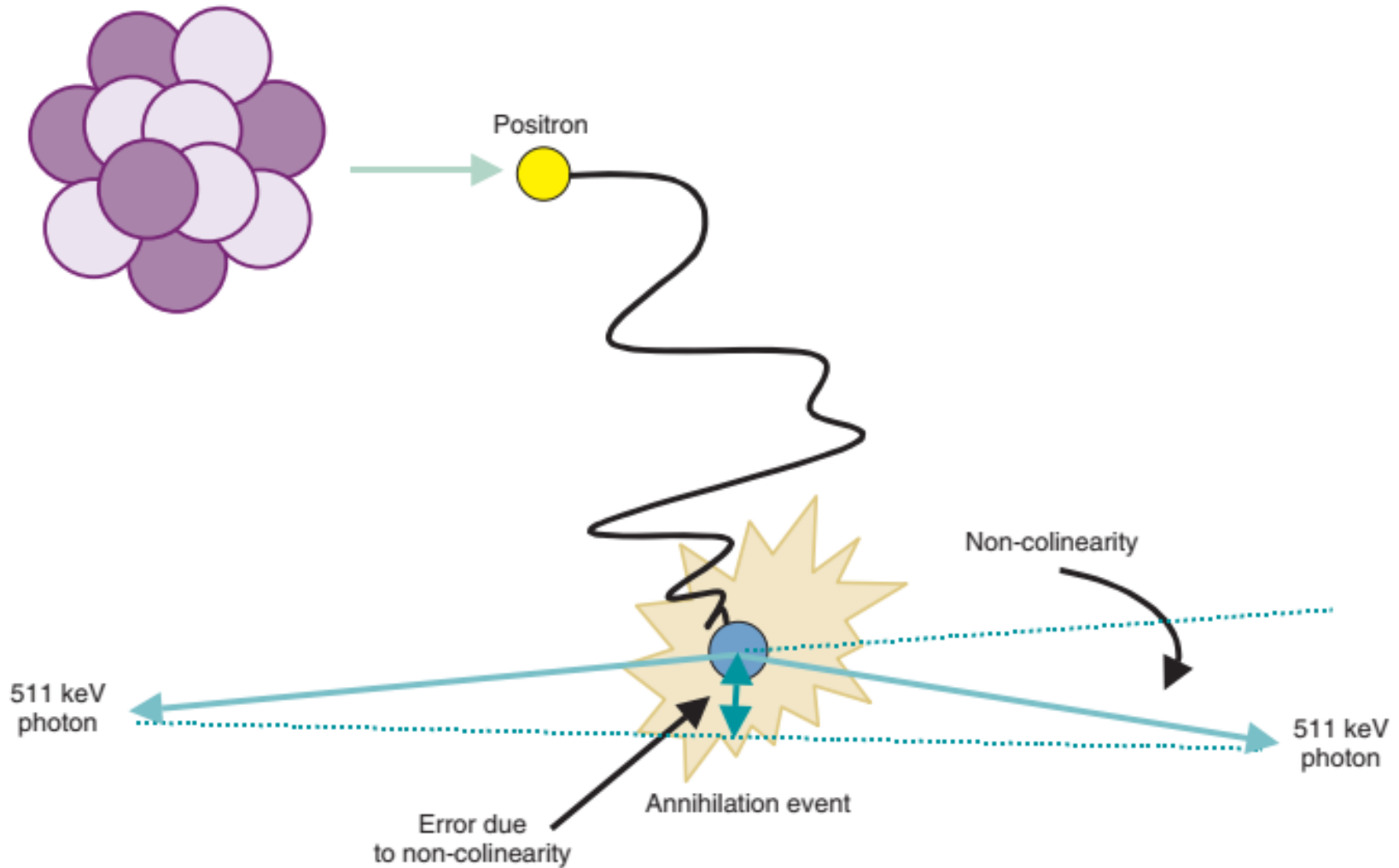
PET



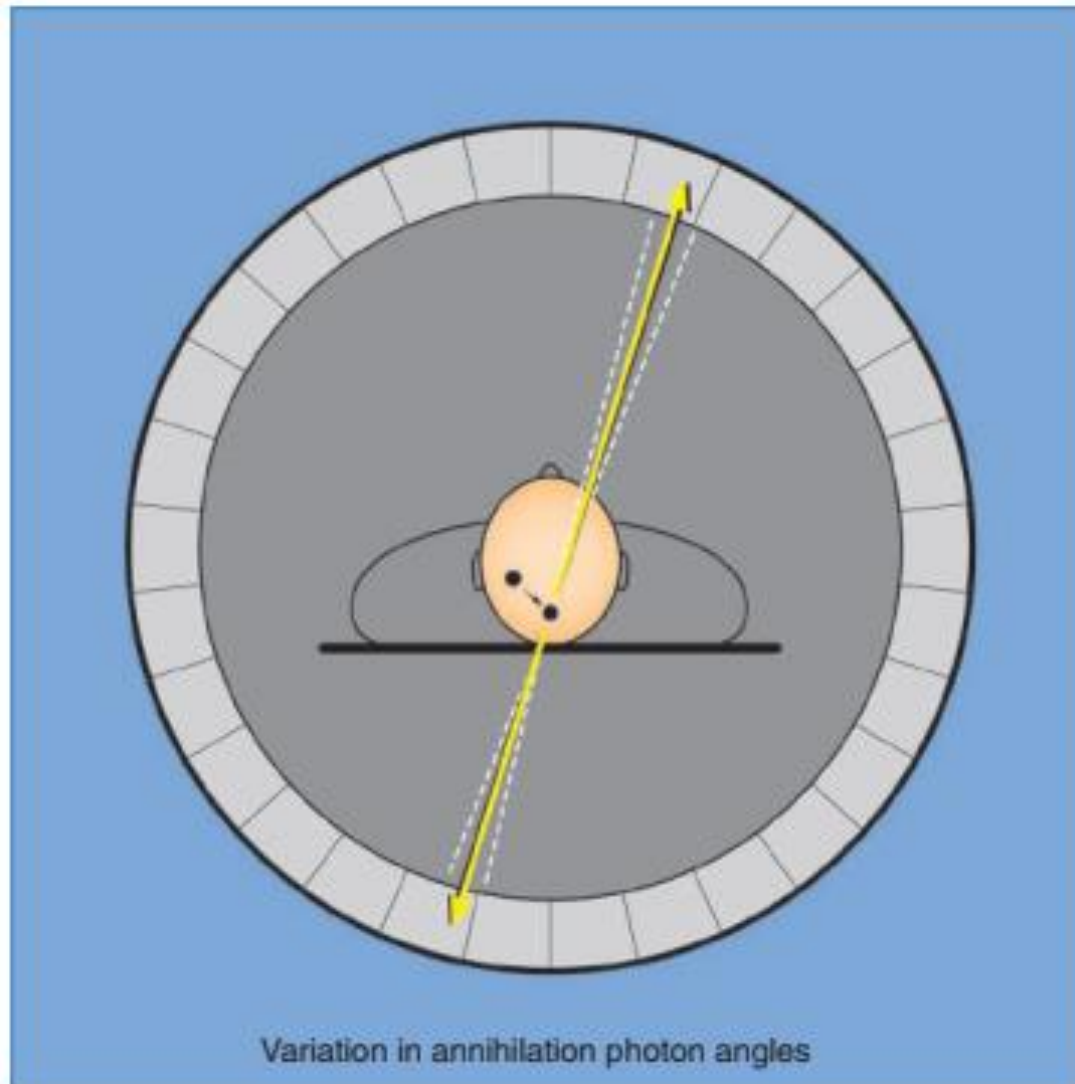
PET



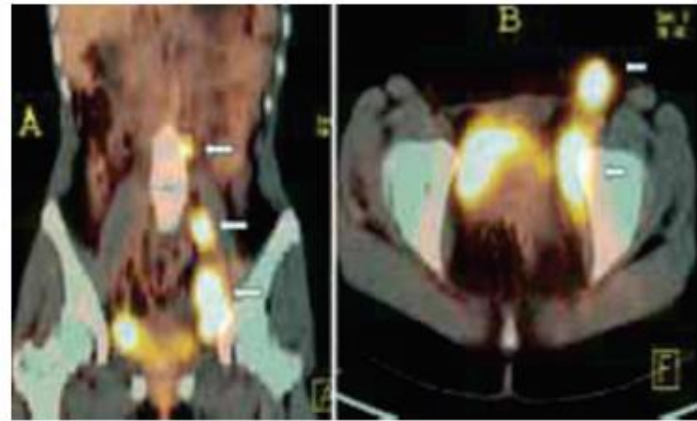
PET



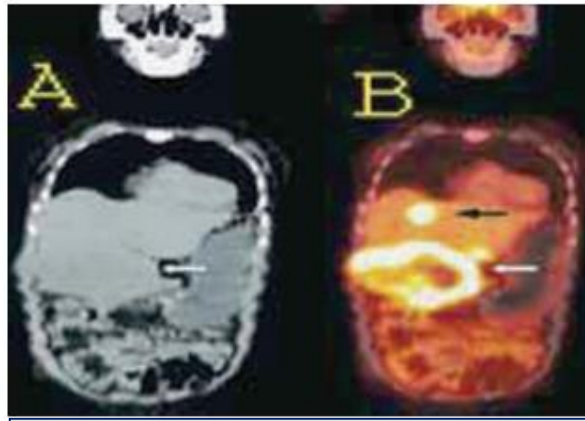
PET



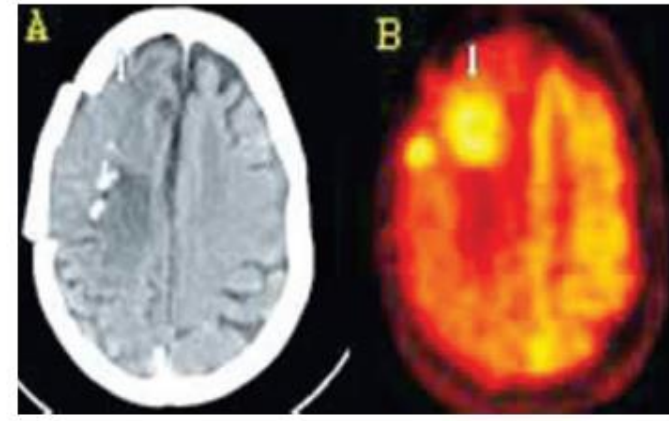
Clinical Applications of PET and PET-CT



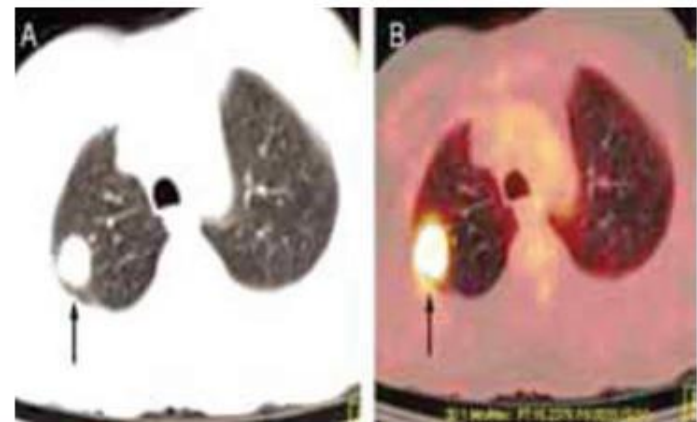
FDG PET/CT for staging a case of NHL



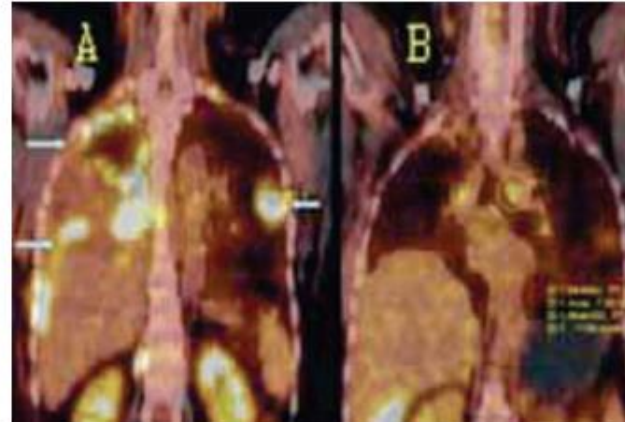
FDG uptake at the periphery of an abdominal mass lesion with central cold area of necrosis



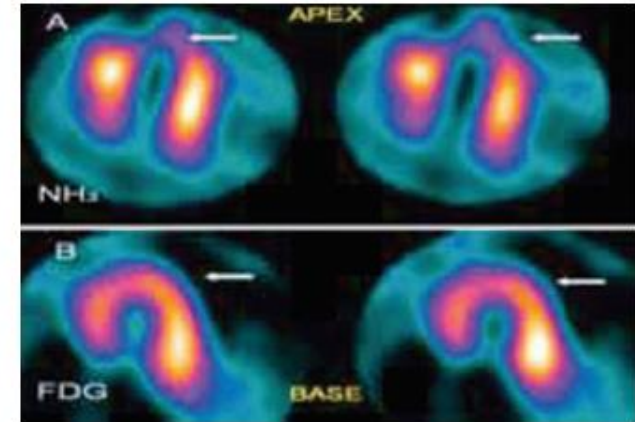
Brain FDG PET/CT scan



FDG PET/CT Scan for solitary pulmonary nodule



FDG PET/CT for therapeutic assessment in a case of metastatic breast carcinoma



Cardiac PET/CT Scan

End of this Part
