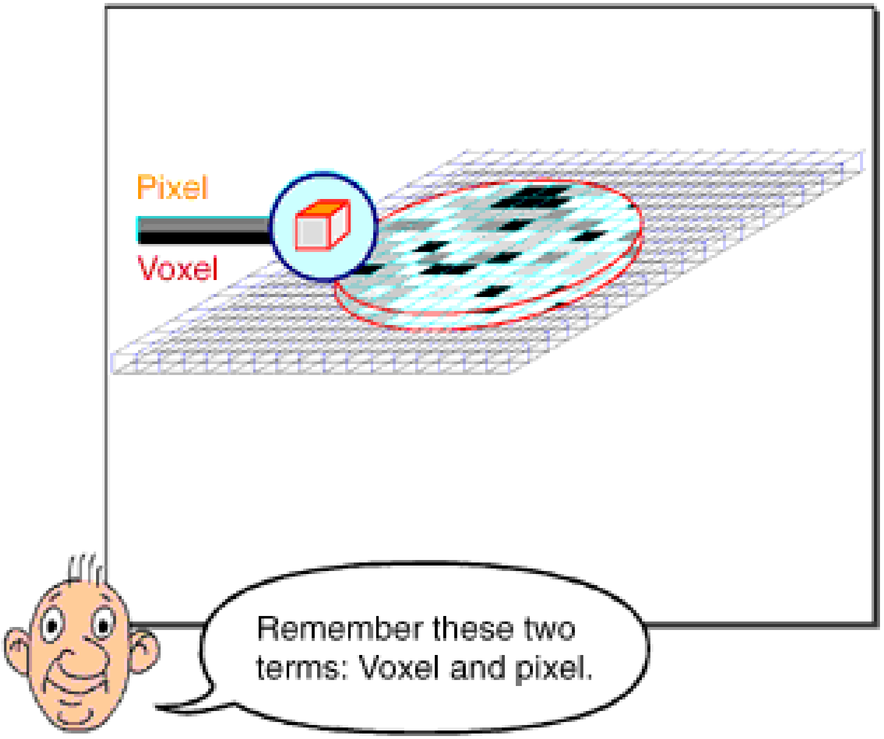
اصطلاحات متداول در دستگاه های تصویر برداری پزشکی

Pixel and voxel



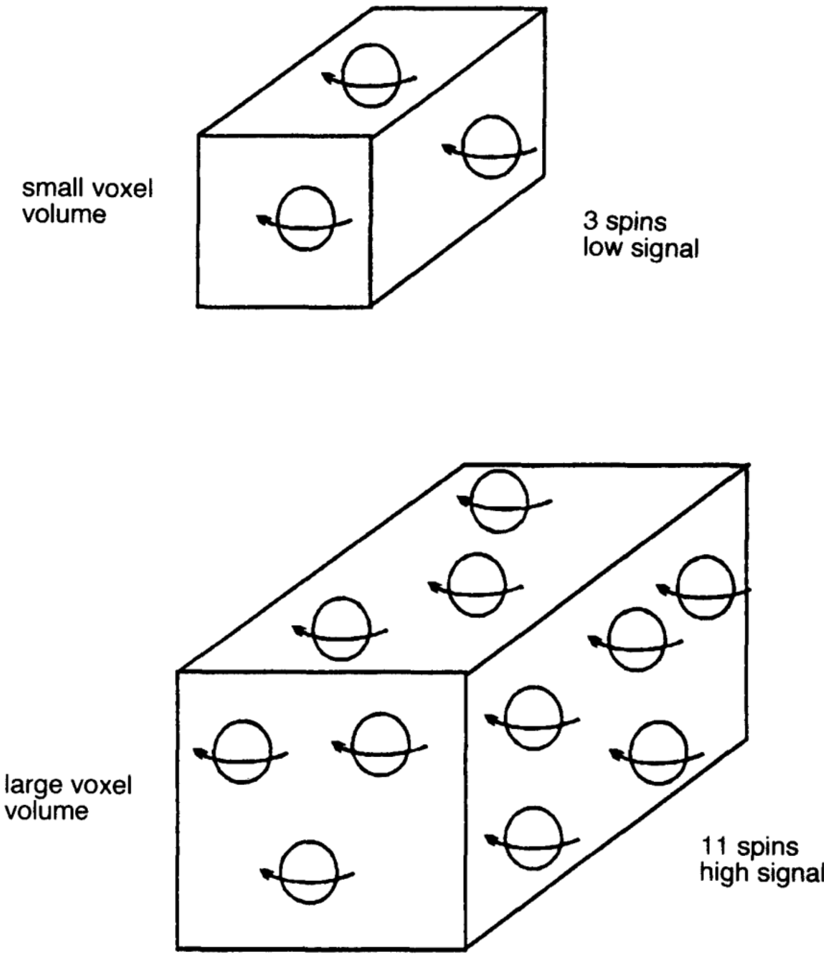
Images are composed of pixels, which are individual, square picture elements that have different grey values. These pixels represent the signal intensity from voxels, which are small 3D segments of a volume of tissue being sampled.

$$\sigma = \sqrt{\frac{\sum (X_i - \overline{X})^2}{N}} = \sqrt{\left(\frac{\sum X_i^{\,2}}{N} - \overline{X}^{\,2} \right)}$$

estimating the value of σ on generic bell-shaped plots. The mean can be computed from a series of N observations x_i, such as $x_1, x_2, x_3, \ldots\ldots x_N$, where

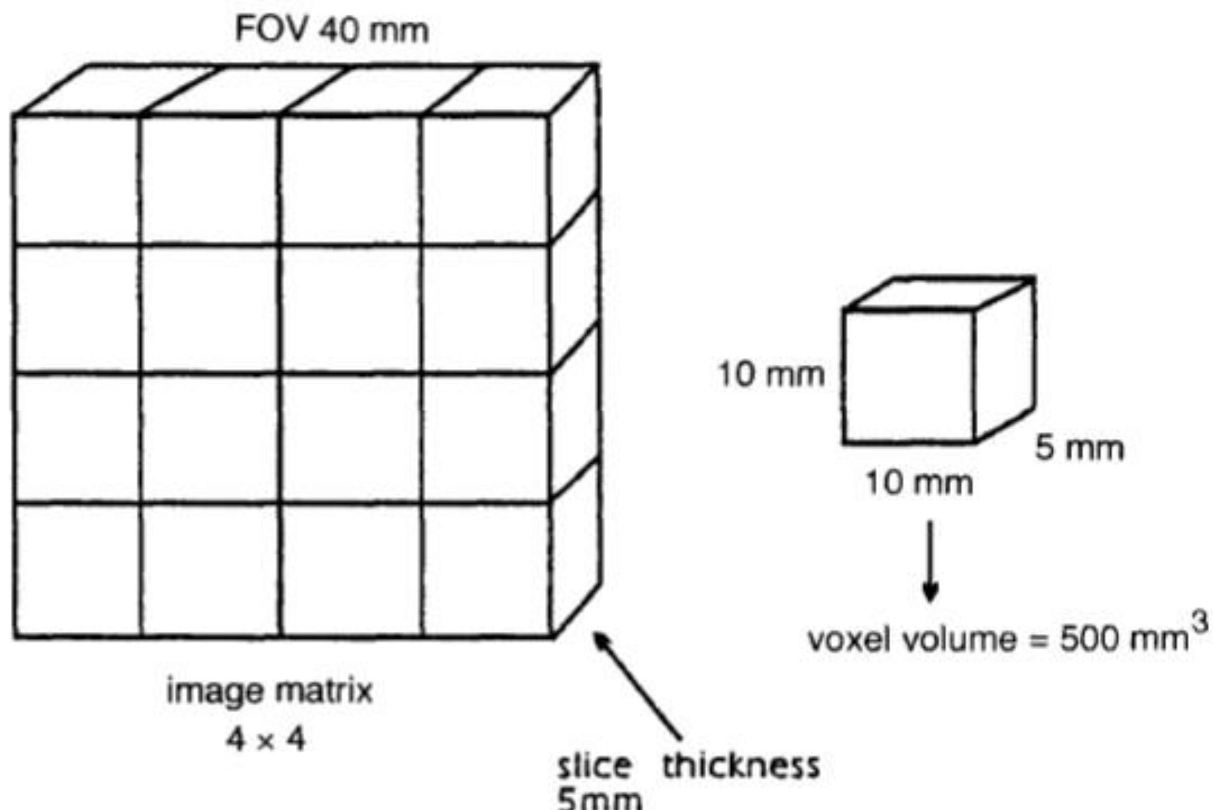
$$\overline{x} = \frac{1}{N} \sum_{i=1}^{N} x_i . \quad [4\text{-}13]$$

A fine matrix results in small pixels and voxels. Large voxels contain more spins or nuclei than small voxels, and therefore have more nuclei within them to contribute towards the signal. Large voxels have a higher SNR than small voxels (Fig. 4.2).



$$\text{pixel area} = \frac{\text{FOV dimensions}}{\text{matrix size}}$$

The SNR is therefore proportional to the voxel volume and any parameter that alters the size of the voxel changes the SNR. Any selection that decreases the size of the voxel decreases the SNR, and vice versa. The voxel is altered by a change in the slice thickness or the pixel area. Doubling the slice thickness doubles the voxel volume and the SNR, whilst halving the slice thickness halves the SNR (Fig. 4.3).



MRI in practice: Catherine Westbrook

Contrast to noise ratio (CNR)

This is defined as the difference in the SNR between two adjacent areas. It is controlled by the same factors that affect SNR. The CNR is probably the most critical factor affecting image quality as it directly determines the eyes' ability to distinguish areas of high signal from areas of low signal.

$$CNR \text{ (for tissue A and B)} = (SI_A - SI_B) / Noise$$

Spatial resolution

The spatial resolution is the ability to distinguish between two points as separate and distinct, and is controlled by the voxel size. Small voxels result in good spatial resolution as small structures can be easily differentiated. Large voxels, on the other hand, result in low spatial resolution, as small structures are not resolved so well. In large voxels, individual signal intensities are averaged together and not represented as distinct within the voxel. This results in partial voluming. The voxel size is affected by:

(1) slice thickness,
(2) FOV,
(3) number of pixels or matrix.

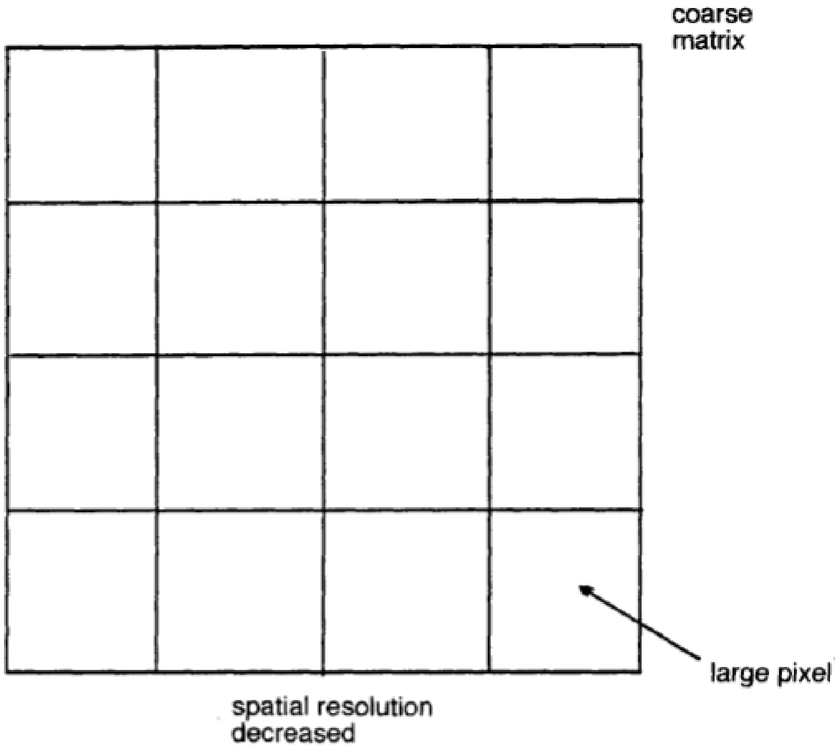
The thinner the slice, the greater the ability to resolve small structures in the slice select plane. Reducing the slice thickness therefore increases spatial resolution, whereas increasing the slice thickness reduces spatial resolution and increases *partial voluming*.

The matrix determines the number of pixels in the FOV. Small pixels increase spatial resolution as they increase the ability to distinguish between two structures close together in the patient. Increasing the matrix therefore increases the spatial resolution (Fig. 4.9).

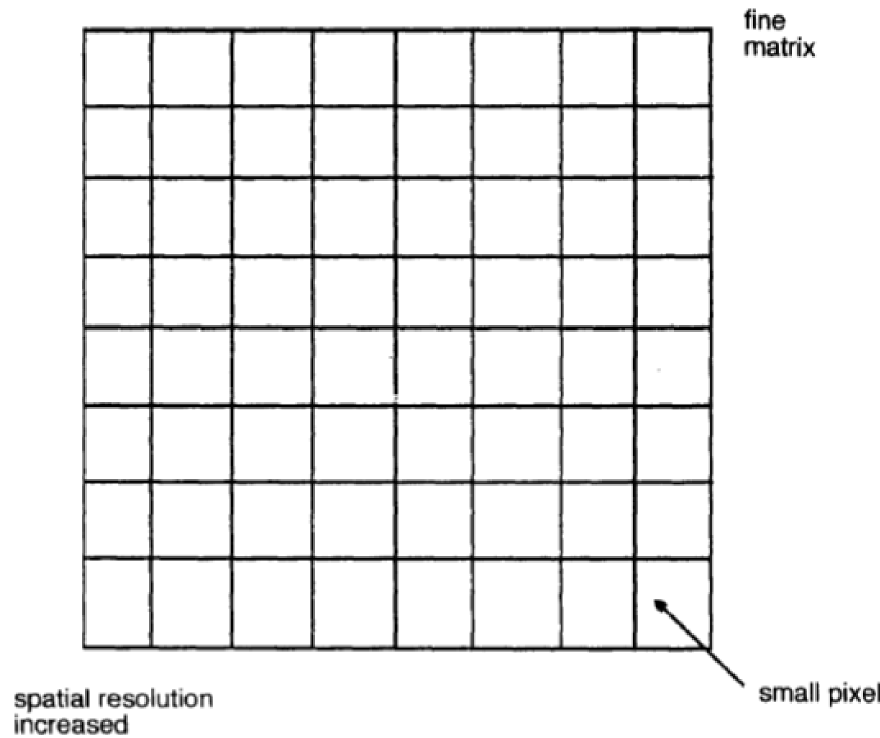
The size of the FOV also determines the pixel dimensions. A large FOV results in large pixels, whereas a small FOV produces small pixels. Increasing the FOV size therefore decreases the spatial resolution.

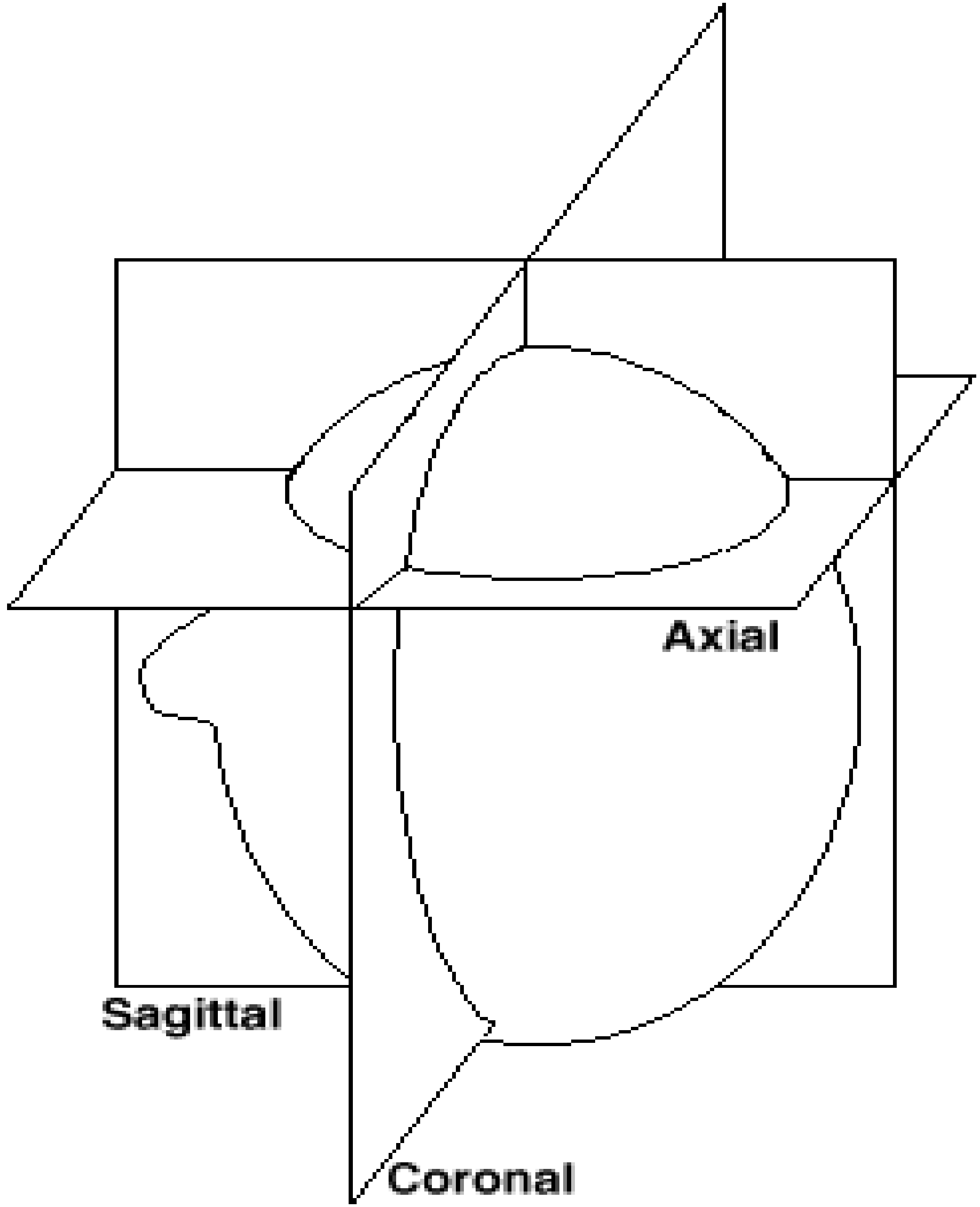
- The **in-plane resolution** is a function of FOV / matrix size

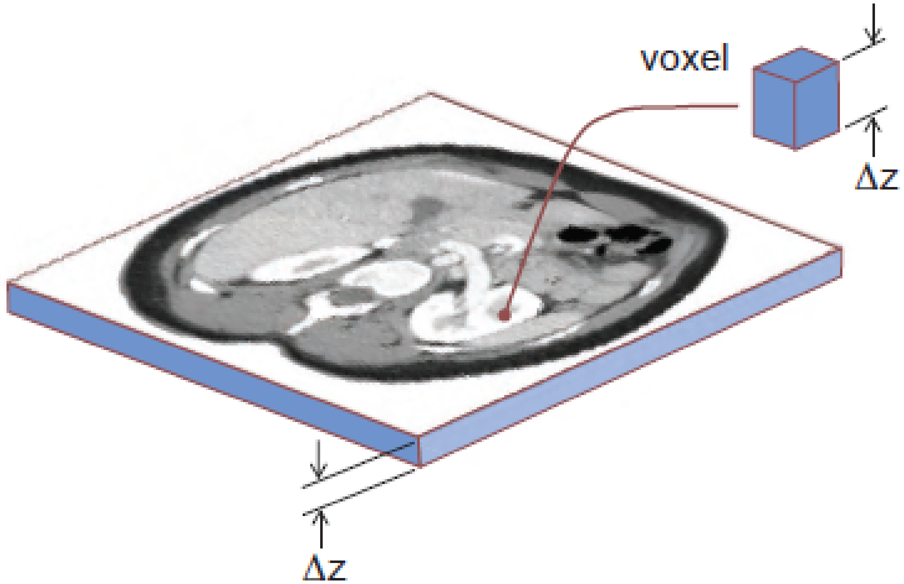
$$\text{pixel area} = \frac{\text{FOV dimensions}}{\text{matrix size}}$$


coarse
matrix
large pixel
spatial resolution
decreased

P=89 book


fine
matrix
small pixel
spatial resolution
increased

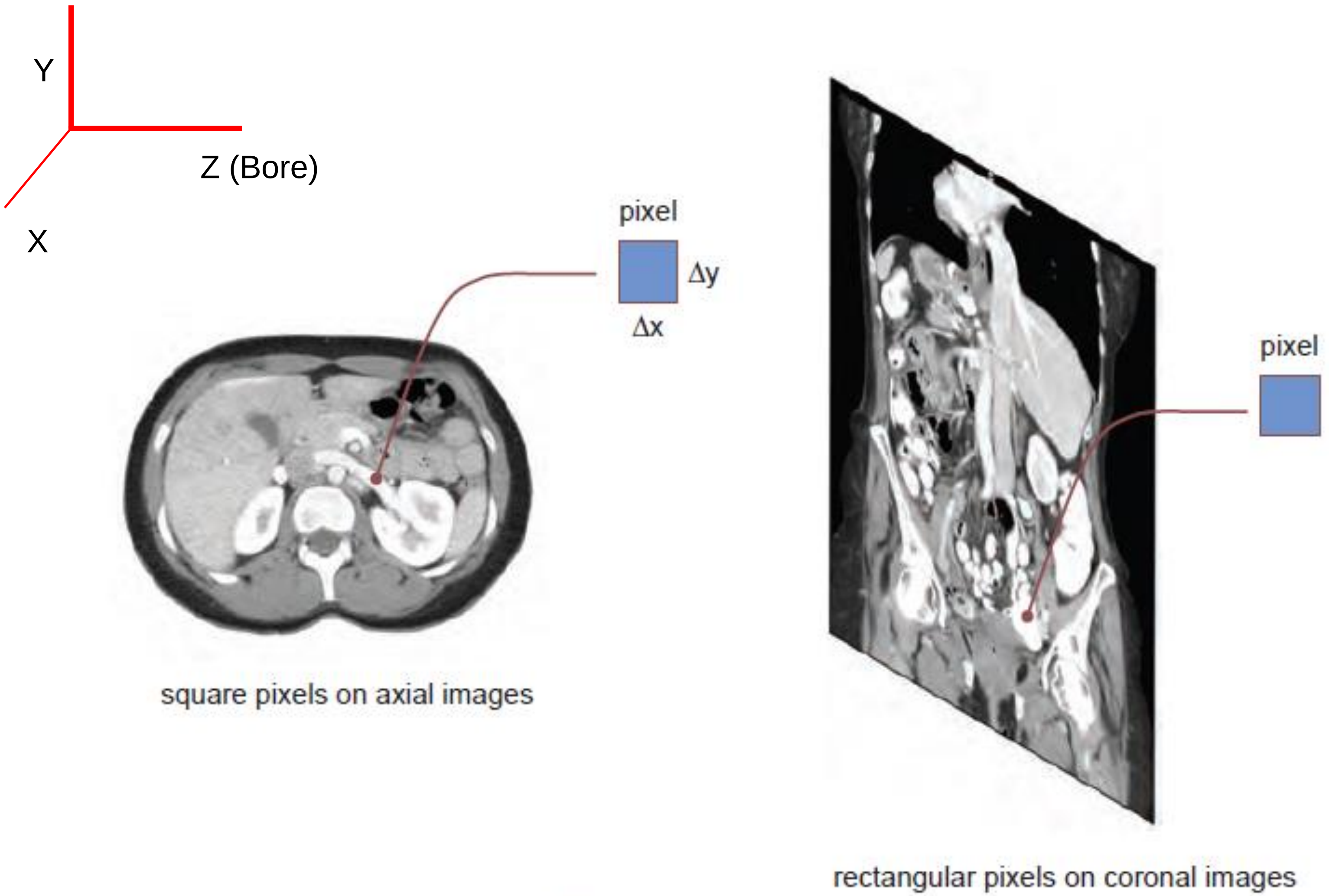

Axial
Sagittal
Coronal



A. in the patient

FIGURE 10-21 A. The dimensions of the in-plane (Δx, Δy) and the slice thickness in the z-axis (Δz) are combined to form the volume element or *voxel*. In modern MDCT scanners, the dimensions of the voxel are approximately equal on thin-slice reconstructions, where $\Delta x = \Delta y \approx \Delta z$.

Modern CT scanners (multidetector CT, or **MDCT**) work very fast and detailed. They can take images of the beating heart, and show calcium and blockages in your heart arteries. Quick facts. **MDCT** is a very fast type of computed tomography (CT) **scan**. Axial image



B. in the images

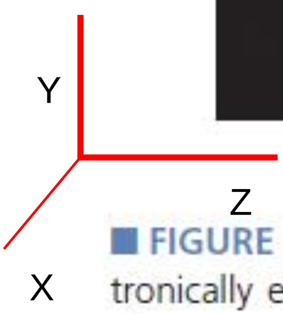
■ **FIGURE 10-21** (*Continued*) **B.** Despite the three-dimensional nature of most CT scan data, the individual images are fundamentally two dimensional. Like all digital images, each picture element is called a *pixel*. The pixel on an axial image (x,y) is square; however, the coronal image (x, z) and sagittal image (y, z) usually have rectangular pixel which can be resampled along z such that $\Delta x = \Delta y = \Delta z$.

■ **FIGURE 10-2** Multiple detector array CT has led to a drastic reduction in slice thickness, and this means that the spatial resolution of CT is nearly isotropic. Thus, in addition to the natively reconstructed axial images, high-resolution coronal and sagittal images are routinely produced and used.

Two-Dimensional Multiplanar Acquisition MRI

Direct axial, coronal, sagittal, or oblique planes can be obtained by energizing the appropriate gradient coils during the image acquisition, as shown in Figure 12-60. The SSG determines the orientation of the slices: axial uses z-axis coils; coronal uses y-axis coils; and sagittal uses x-axis coils for selection of the slice orientation. Oblique plane acquisition depends on a combination of the x-, y-, and z-axis coils energized simultaneously. SSG, PEG, and FEG applications are perpendicular to each other, and acquisition of data into the k-space matrix remains the same, with the FEG along the k_x axis and the PEG along the k_y axis.

Axial Coronal Sagittal



■ FIGURE 12-60 Direct acquisitions of axial, coronal, and sagittal tomographic images are possible by electronically energizing the magnetic field gradients in a different order without moving the patient. Oblique planes can also be obtained. PEG (k_y axis) and FEG (k_x axis) are perpendicular to the SSG.

The Essential Physics of Medical Imaging

THIRD EDITION

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Wolters Kluwer Health | Lippincott Williams & Wilkins

Philadelphia • Baltimore • New York • London
Buenos Aires • Hong Kong • Sydney • Tokyo

Interactive Data Language (IDL, Research Systems, Inc., http://www.rsinc.com)

IDL

Lecture_mn_read_image_brain_new.pro

IDL
Lecture_Auto_measur_mean_Max_SI_Box_cursor_normal_subject_new. Pro

Lecture_Plot_Errorbar_new.pro

autorun.inf

D:\mn_server\Lecture_mn_95_Azad\shvins – Shortcut

starter.exe

MRIcro (Introduction to MRIcro)

D:\mn_server\Lectuer_mn\MRIcro_mn\IM4_SE4

دستگاه های تصویر برداری پزشکی

The some instruments can be used in medical imaging:

•**X - ray**

• Dynamic or Xenon - enhanced Computed Tomography (**Xe - CT**)

•Transcranial Doppler Ultrasonography (**TCD**)

•Single - Photon Emission Computed Tomography (**SPECT**)

•Positron Emission Computed Tomography (**PET**)

•Magnetic Resonance Imaging (**MRI**)

سونوگرافی

Transcranial Doppler Ultrasonography (TCD)

Transcranial Doppler Ultrasonography (TCD)

TCD100Munit

Scanpack_use

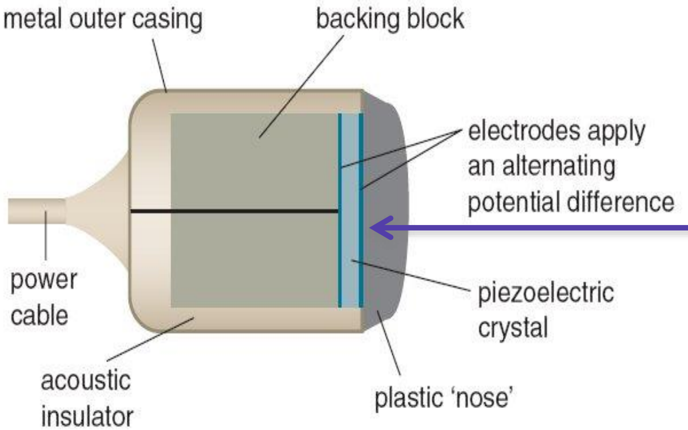
TCD

Photo_titan_stand

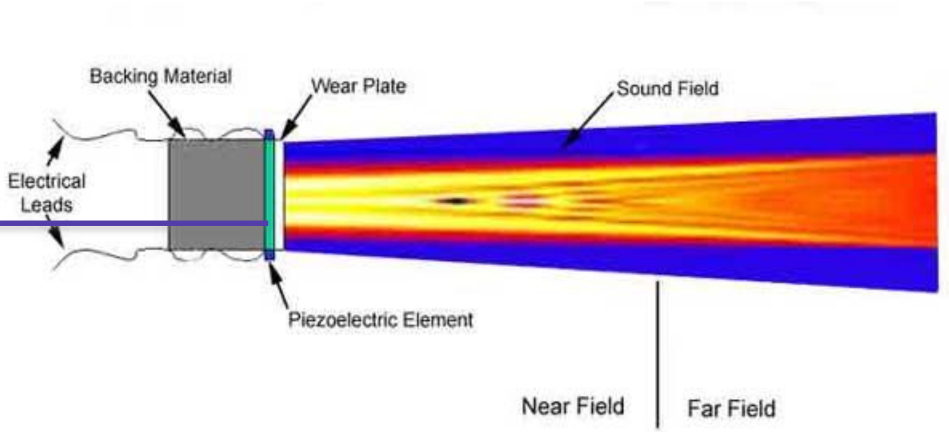
Transcranial Doppler Ultrasonography (TCD)

The Physics of Ultrasound:

•Ultrasonography is a diagnostic procedure employing high frequency (between 2.5 and 40 MHz) sound waves from a source (a transducer) and to detect the resultant fainter echoes.



http://www.genesis.net.au/~ajs/projects/medical_physics/graphics/transducer.jpg



http://www.ndt-ed.org/EducationResources/CommunityCollege/Ultrasonics/EquipmentTrans/radiatedfields.htm

- A piezoelectric is a material that has a well defined oscillation frequency and the material is put into oscillation by an oscillating electric field (or by an oscillating current.)

- The piezoelectric material can not only generate but also detect sound vibrations.

- The echoes are turned into an electrical signal (a voltage) and the voltages are processed and displayed on an oscilloscope (or TV screen.)

- The transducer head contains the piezoelectric material and the transducer is acoustically coupled to the body by using a gel.

- The gel minimizes reflections of the ultrasound at the skin's surface and a beam of ultrasound pulses are delivered to the body.

• The velocity of sound in soft tissue is approximately 1540-m/s.

• The ultrasound pulse has an intensity that decreases exponentially as it passes through the body's tissues and organs.

•TCD is a **noninvasive technique** can be used for frequent imaging or measurement of blood flow in arteries and veins such as cerebral blood flow (CBF).

•Other tools such as MRI, CT, SPECT and PET are more expensive or the patient is exposed to a prohibitive quantity of **radioactivity**, which limits the number of studies that can be performed.

•Believed that the risks of using ultrasound as a diagnostic tool are low.

TCD

- Ultrasonography is the ideal technique for distinguishing between **cysts** and **solid** structures, but it is not always possible to distinguish between different fluids (e.g. **blood, pus, ascetic fluid**).

- The **quality** of image dependent on **operator**.

- TCD has **poor spatial resolution**.

    - **Resolution** (pixels per "distance“) is a function of slice thickness, field of view (FOV), and matrix size.

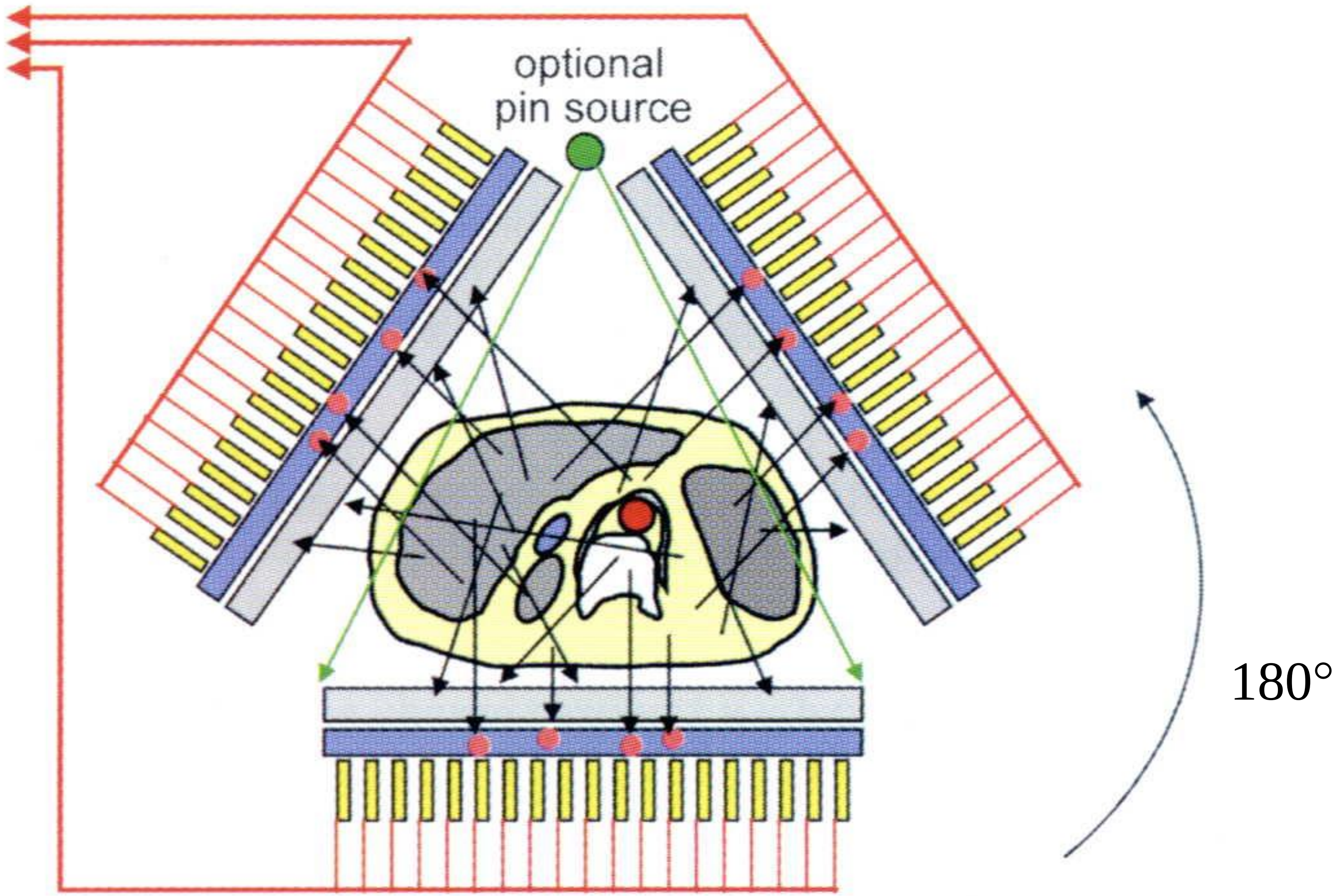
    - The **in-plane resolution** is a function of FOV / matrix size

پزشکی هسته ای

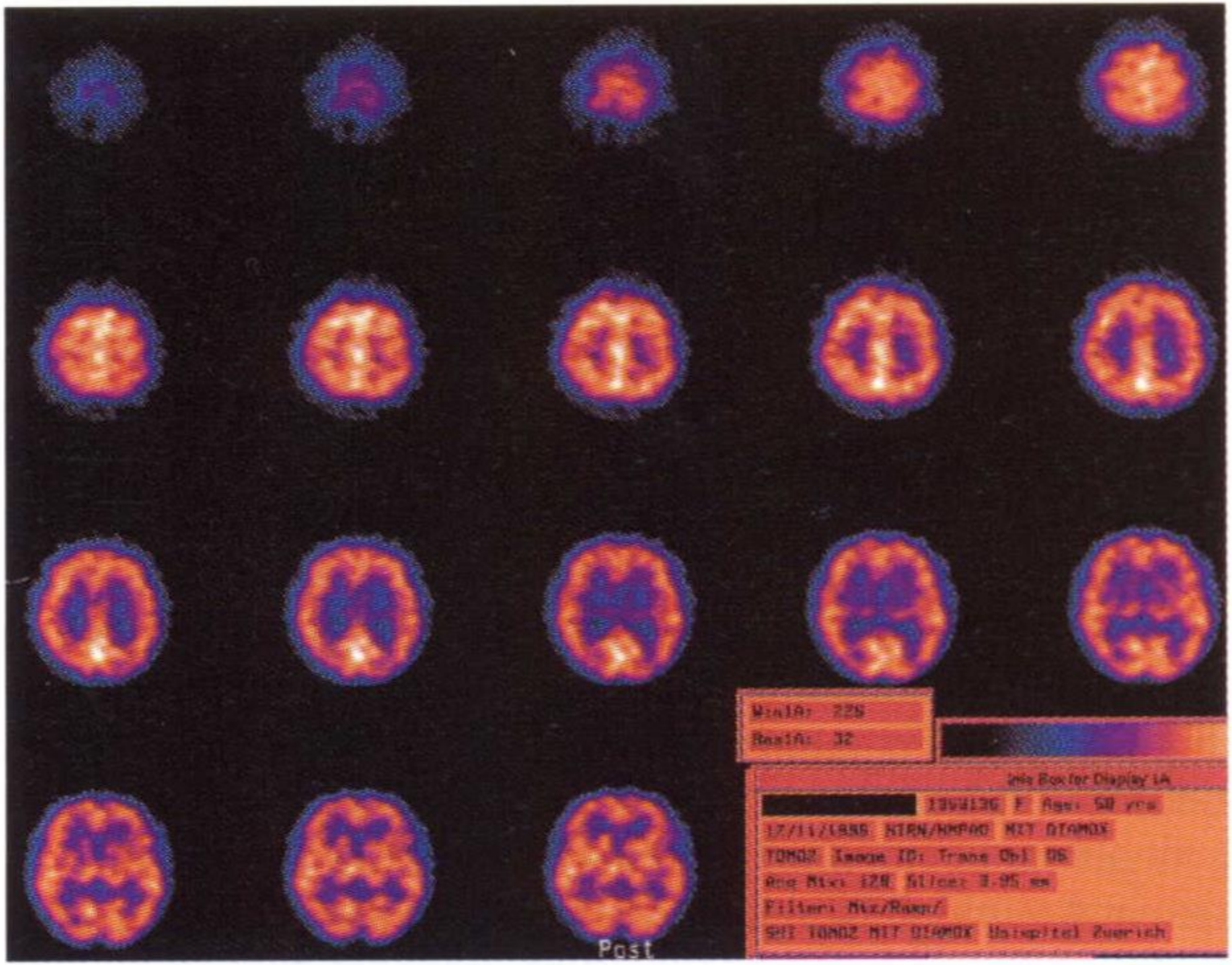
Single - Photon Emission Computed Tomography SPECT)

Single - Photon Emission Computed Tomography (SPECT)

It shows a gamma camera configured for a cardiac study.



SPECT imaging, Fig. 1
Schematic representation of triple head SPECT camera.



SPECT imaging, Fig. 2
Head SPECT image (technetium-99m HMPAO), showing a normal brain perfusion.

SPECT

- The **majority of radioactive isotopes** which have potential for imaging, decay by releasing energy as **gamma rays** (photon) with a range of energies, commonly 80-400 Kev.

- Mass of photon in the stationary state is 0 and it has no electrical charge. It is a package energy which travel with velocity of light, C.

- In SPECT, the photon is detected by a sodium iodide crystal in a **gamma camera** rotating around the patient. The distribution of radioactivity is displayed as a **cross-sectional** image.

SPECT

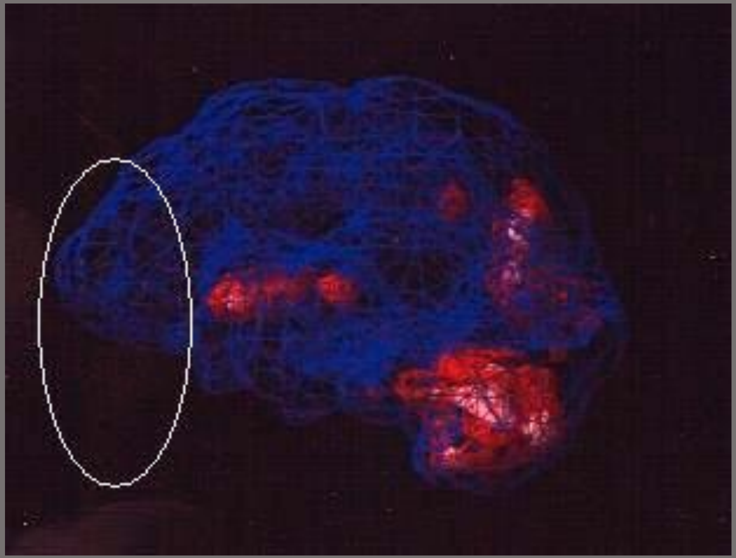
•SPECT is one of the methods for the study of **cerebral metabolism** and **blood flow**.

•SPECT is performed with a bolus injection of a **diffusible** radioactive isotope which has similar **side-effects** to other diffusible tracers (e.g Technetium-99m, m shows this is instable atom).

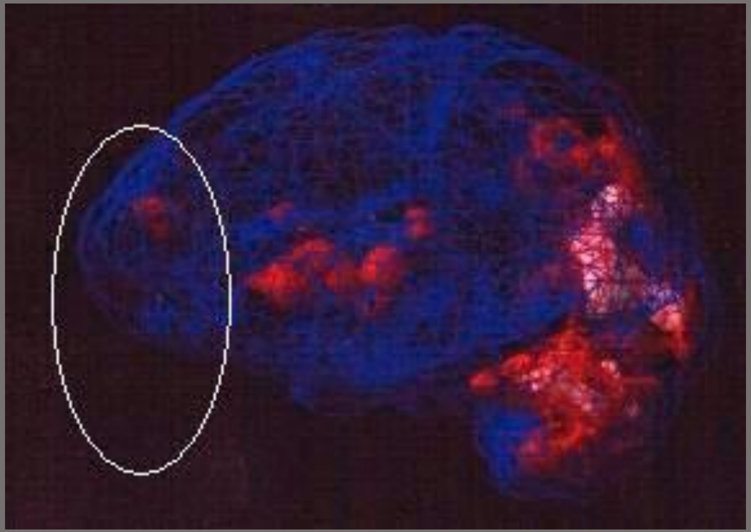
• SPECT has **poor spatial resolution** (10×10 mm).

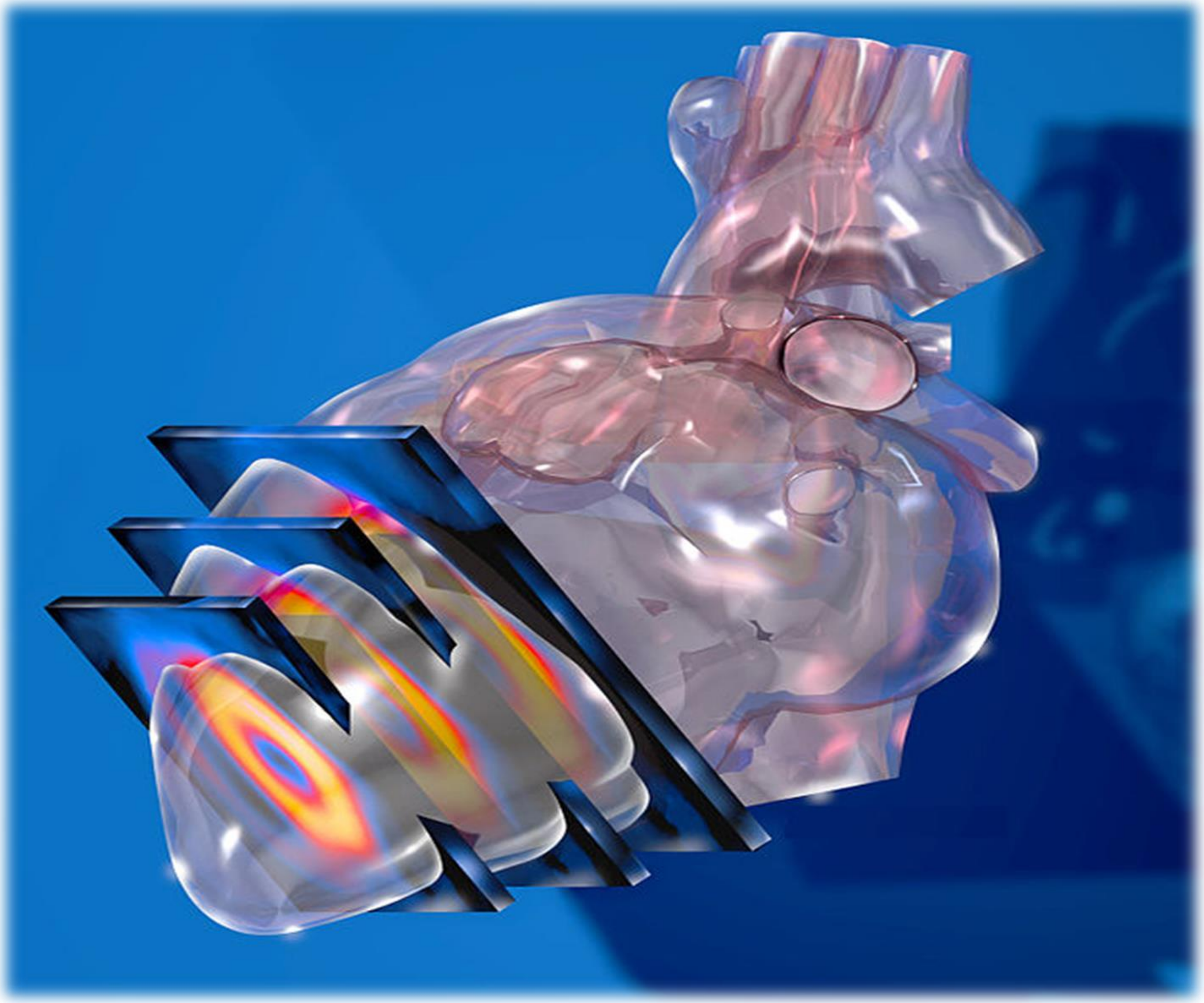
Head SPECT scan

Normal Patient
Baseline Scan
Little Activity During Rest

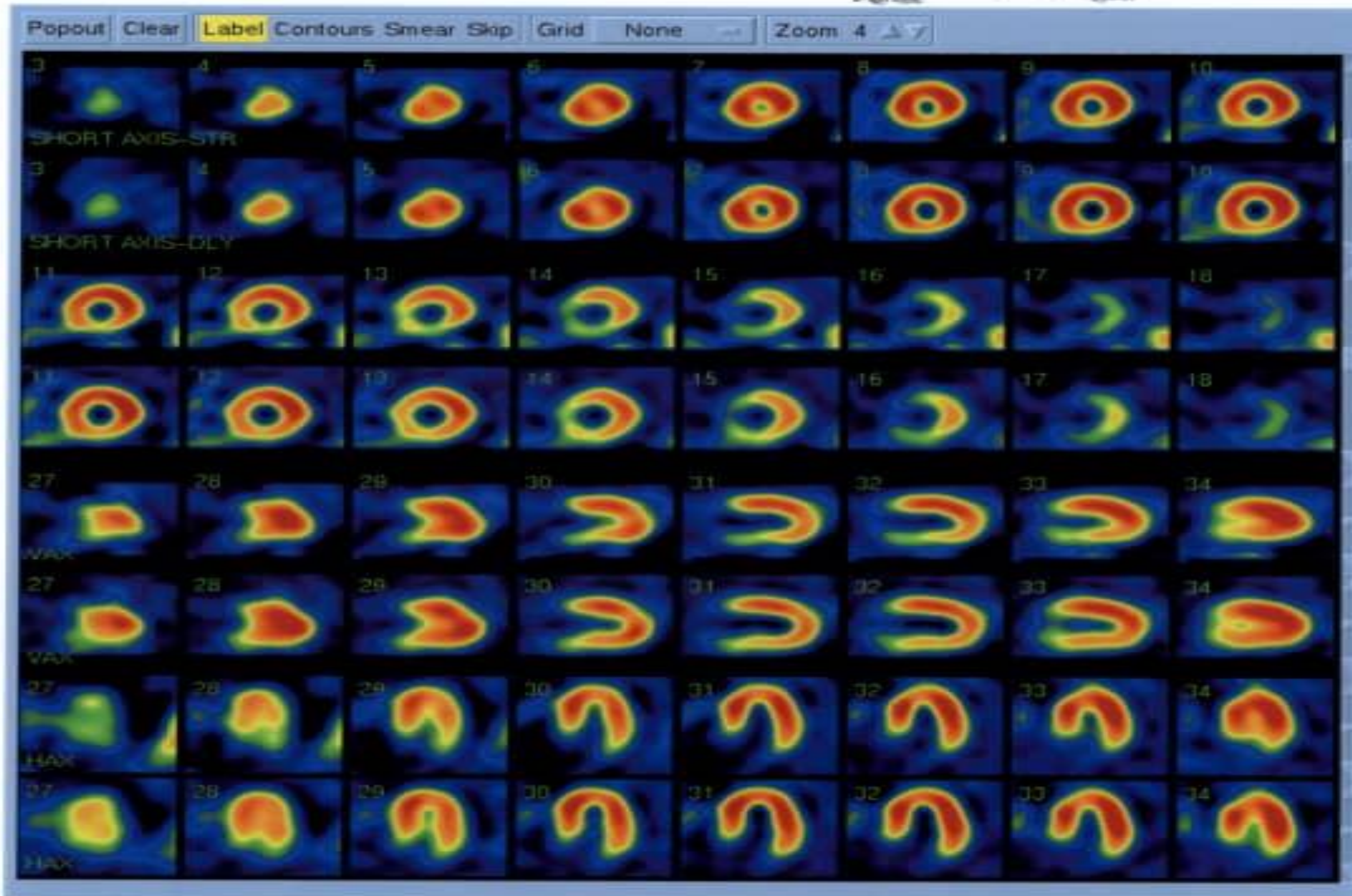


Normal Patient
Activation Scan
Activity Increases after Performance Test





اسکن قلب


Popout
Clear
Label
Contours
Smear
Skip
Grid
None
Zoom 4
SHORT AXIS-STR
SHORT AXIS-DLY
VAX
VAX
HAX
HAX

پزشکی هسته ای

Positron Emission Tomography (PET)

Positron Emission Tomography (PET)

PET

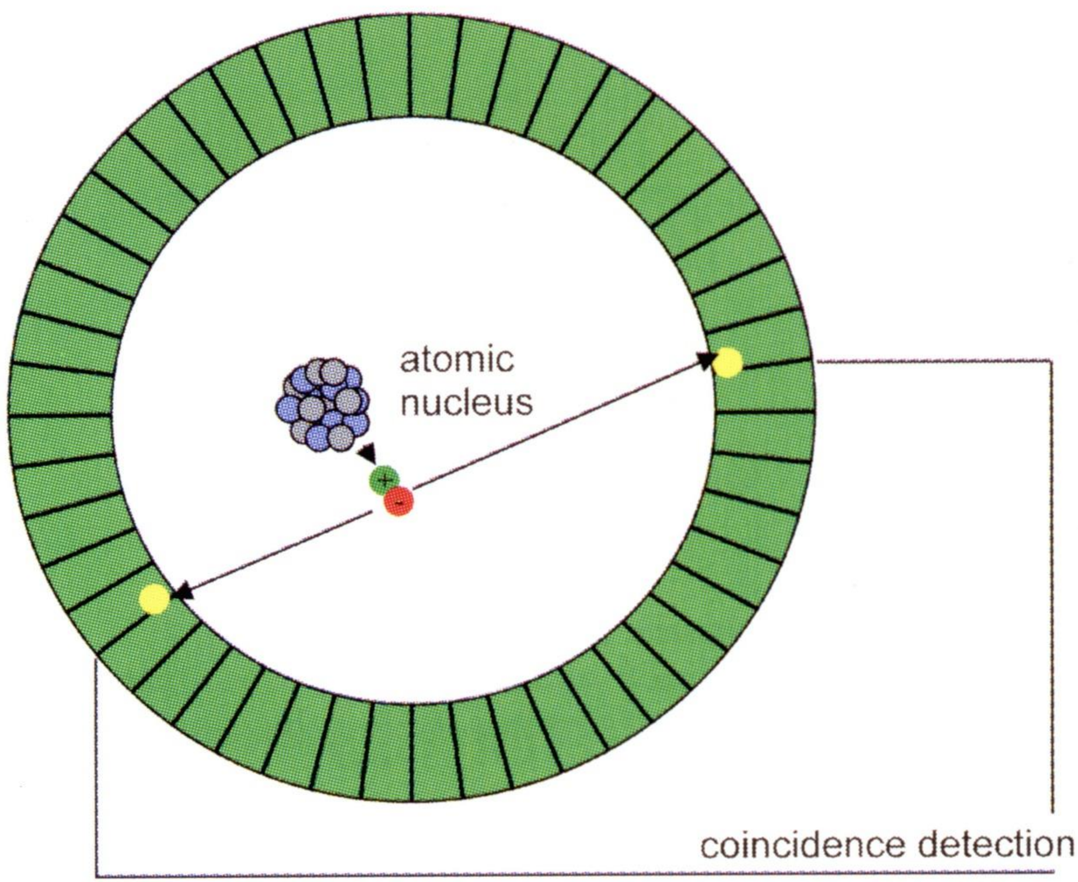
- PET is a tomographic nuclear imaging procedure, in which a low dose of a radiopharmaceutical labelled with a **positron**, is injected into the patient, who is then scanned by the tomographic system.

- Tomography is from the Greek word "tomos" meaning "slice" or "section" and graphia meaning "describing".

- Some radioactive isotopes (***C-11, N-13, O-15 or F-18***) decay by the emission of a **positively charged electron** (positron) from the nucleus.

- The positron usually **travels a short distance** (1-2 mm) before colliding with a local electron.

•**Positron** combine with **electron** of tissue and produce **two gamma rays** (photons) of high energy (511 Kev) at almost **exactly 180 degree** to each other (annihilation radiation).



Radionuclide Production (PET)

The materials or tracers injected for PET studies are radioactive. Starting from nonradioactive atoms, a device called a particle accelerator is used to produce radioactive isotopes or more correctly radionuclides. The specific device is a compact medical cyclotron, which is a **cyclic accelerator**. Particles such as protons or deuterons (hydrogen and deuterium atoms without their orbital electrons) are brought to high energies by traversing several hundred orbits within the cyclotron. During each orbit the particle receives about 90 keV (90,000 electron volts) of energy.

When the orbits near the maximum radius of the **cyclotron**, they are removed through electrostatic deflection and impinge upon small volume hollow **metallic cylinders** filled with a nonradioactive gas or liquid. Nuclear reactions take place **within the cylinder** (also called a target) between the high energy particle (proton or deuteron) and the contents of the target (also called target material) to produce the necessary radioactivity for incorporation into the PET radiotracers. The radionuclides produced with the cyclotron for PET imaging are shown in the following table.

Nuclide	Half-Life	Target	Nuclear Reaction
O-15	2 min	N_2gas	$^{14}N(d,n)^{15}O$
N-13	10 min	water	$^{16}O(p,\alpha)^{13}N$
C-11	20 min	N_2gas	$^{14}N(p,\alpha)^{11}C$
F-18	110 min	^{18}O water	$^{18}O(p,n)^{18}F$

The short half-lives of the routinely produced PET nuclides require that the cyclotron be located very near to where the nuclides will be synthesized into radiotracers for PET imaging.

$$^{A}X^{Z}_{N} \rightarrow \quad {}^{16}O^{8}_{8} \quad , \quad {}^{27}Al^{13}_{14} \quad , \quad {}^{238}U^{92}_{146}$$

$$^{A}_{Z}X \quad \rightarrow \quad {}^{60}_{27}CO$$

(A) =(Mass Number)
(Z)=(Atomic Number)
http://images.google.com/imgres?imgurl=http://pet.radiology.uiowa.edu/webpage/Overview/cyclotron.jpg&imgrefurl=http://pet.radiology.uiowa.edu/webpage/Overview/RadionuclideProduction.htm&h=240&w=320&sz=20&tbnid=It1lAl8tGrkJ:&tbnh=84&tbnw=112&start=80&prev=/images%3Fq%3Dcyclotron%26start%3D60%26hl%3Den%26lr%3D%26sa%3DN

Gopal B. Saha

Basics of PET Imaging

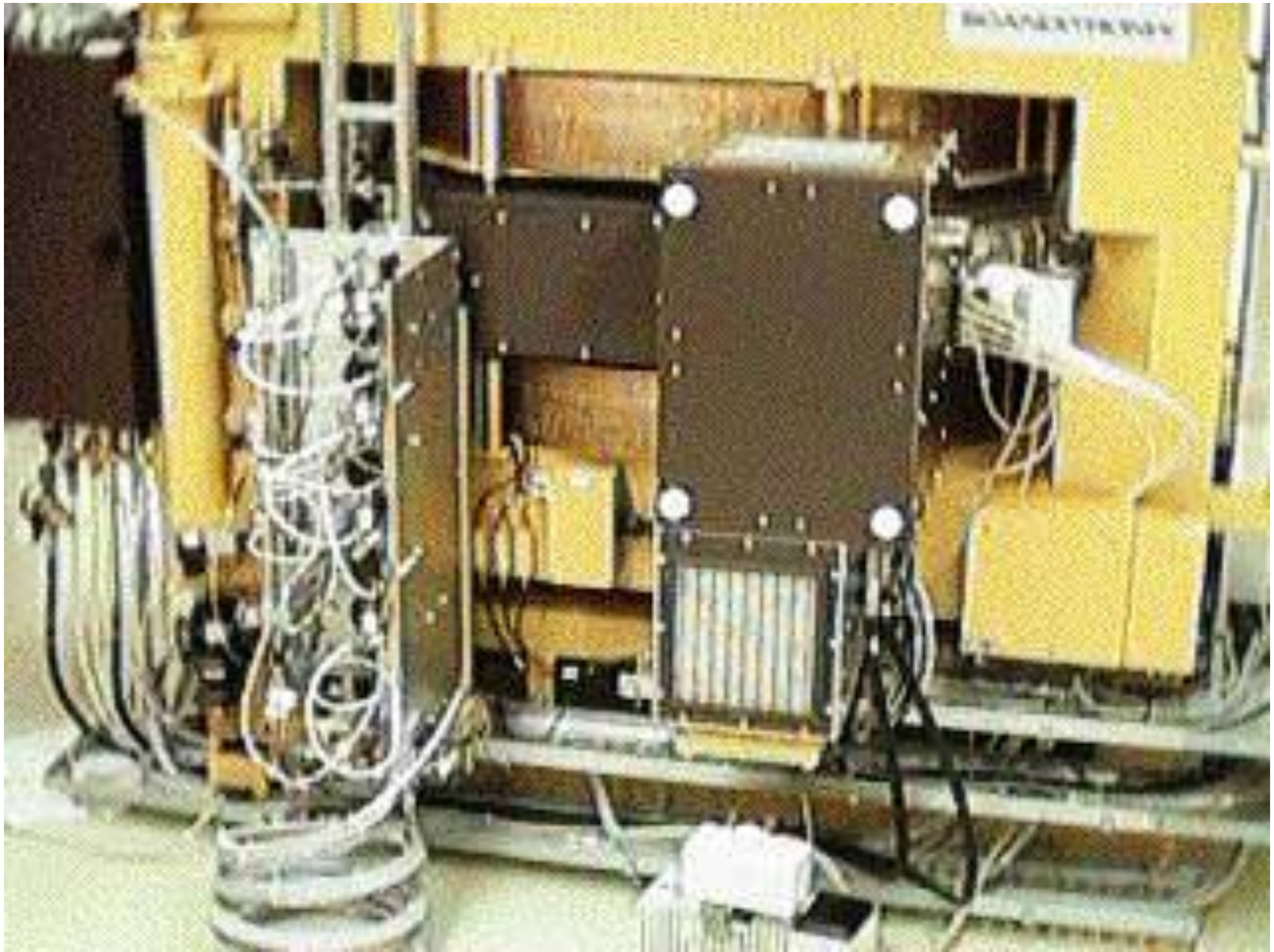
Physics, Chemistry, and Regulations

Third Edition

FHB
(Radiology golden books)

The Scanditronix MC-17F cyclotron shown in the figure below weighs 22 tons and is located within a vault that has 5 ft thick concrete walls. Unlike nuclear reactors, when the cyclotron is **turned off**, it immediately stops producing radionuclides.

1 feet is equal to 30.48 centimeters. http://www.sciencemadesimple.net/length.php



تولید عناصر رادیواکتیو در داخل راکتور با بمباران توسط نوترون است ولی در سیکلوترن از ذرات مختلف بعنوان ذره بمباران کننده استفاده می شود.

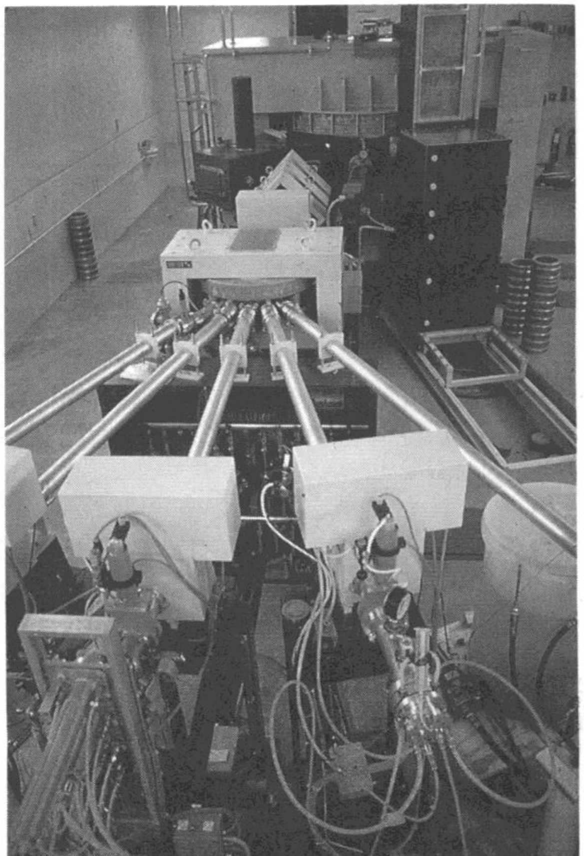
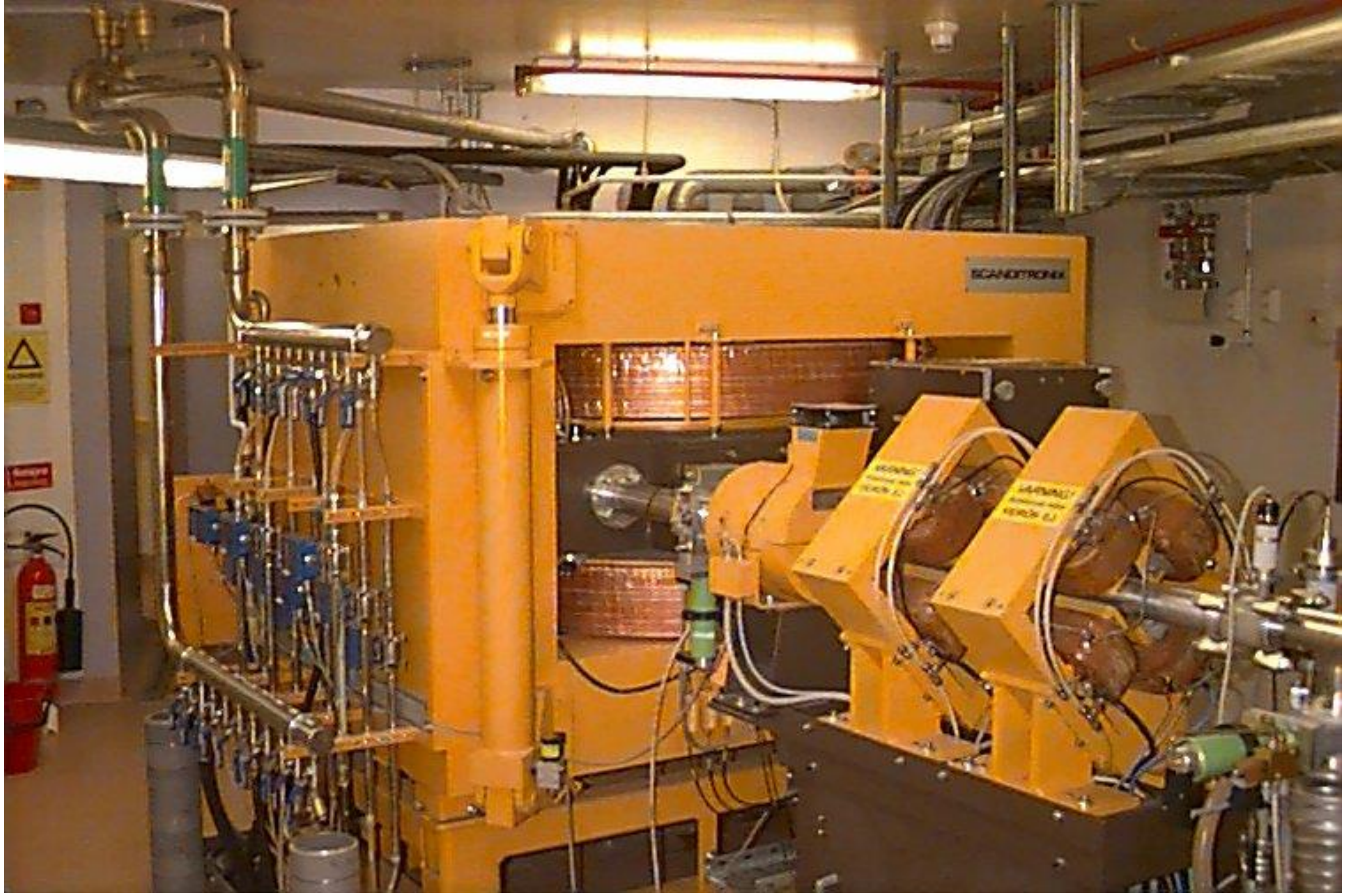


Fig 10.4 Hospital cyclotron at the Texas Medical Centre, Houston, USA.

Table 10.3 Summary of the production of radioisotopes

	Nuclear reactor	Cyclotron
Mode of operation	.... bombardment and fission	Bombardment by protons, deuterons and ....particles
Major reactions	(n,γ), (n, p) (n, α) U (n, f)	(d, n), (α, d) (α, np) (p, n) and others
Neutron-proton ratio	....	....
Mode of decay	....	.............., EC
If carrier free	(n, y) .... (n, p), (n, α), U (n, f) } Yes	....
Cost	Comparatively low	Comparatively high

The majority of radioisotopes are produced in reactors. Cyclotrons are a more expensive way of producing radioisotopes because only small quantities can be handled at any one time. Nevertheless they are particularly useful in producing a number of radioisotopes of biologically important elements such as oxygen, carbon and nitrogen. These have short half-lives so some hospitals, such as the Hammersmith in London, have their own small cyclotron dedicated to producing isotopes for medical use (Fig 10.4). The original cyclotron at Hammersmith in London was the fi world to be built for this purpose. It closed down in 1985 after 30 years service and has recently been replaced.

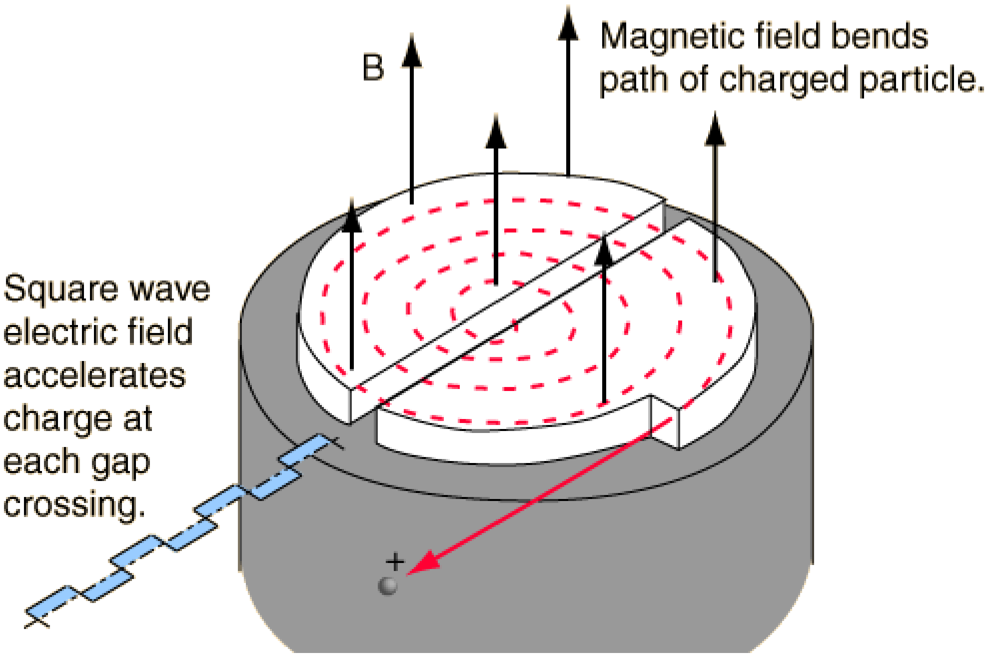


Uppsala University PET centre. Equipment for radiochemistry and tracer production

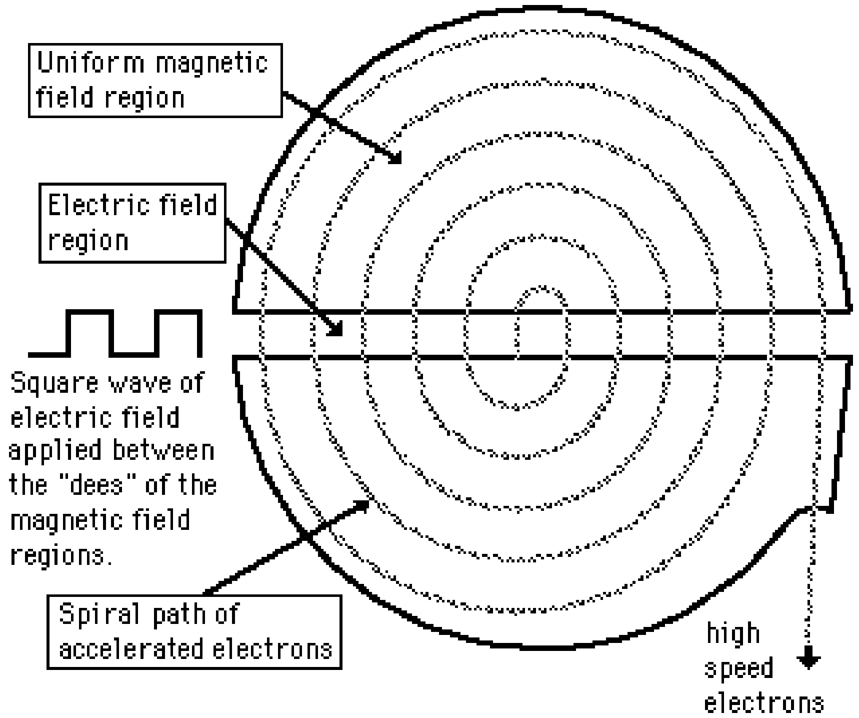
Cyclotron

The cyclotron is a Scanditronix MC17 delivered from GEMS in1991. It produces 8.5 MeV deuterons and 17 MeV protons on the target with beam current of 50 mAh. The cyclotron is equipped with a PLC controller, Simatic S-5, which controls the cyclotron and the gas processing system.

Cyclotron

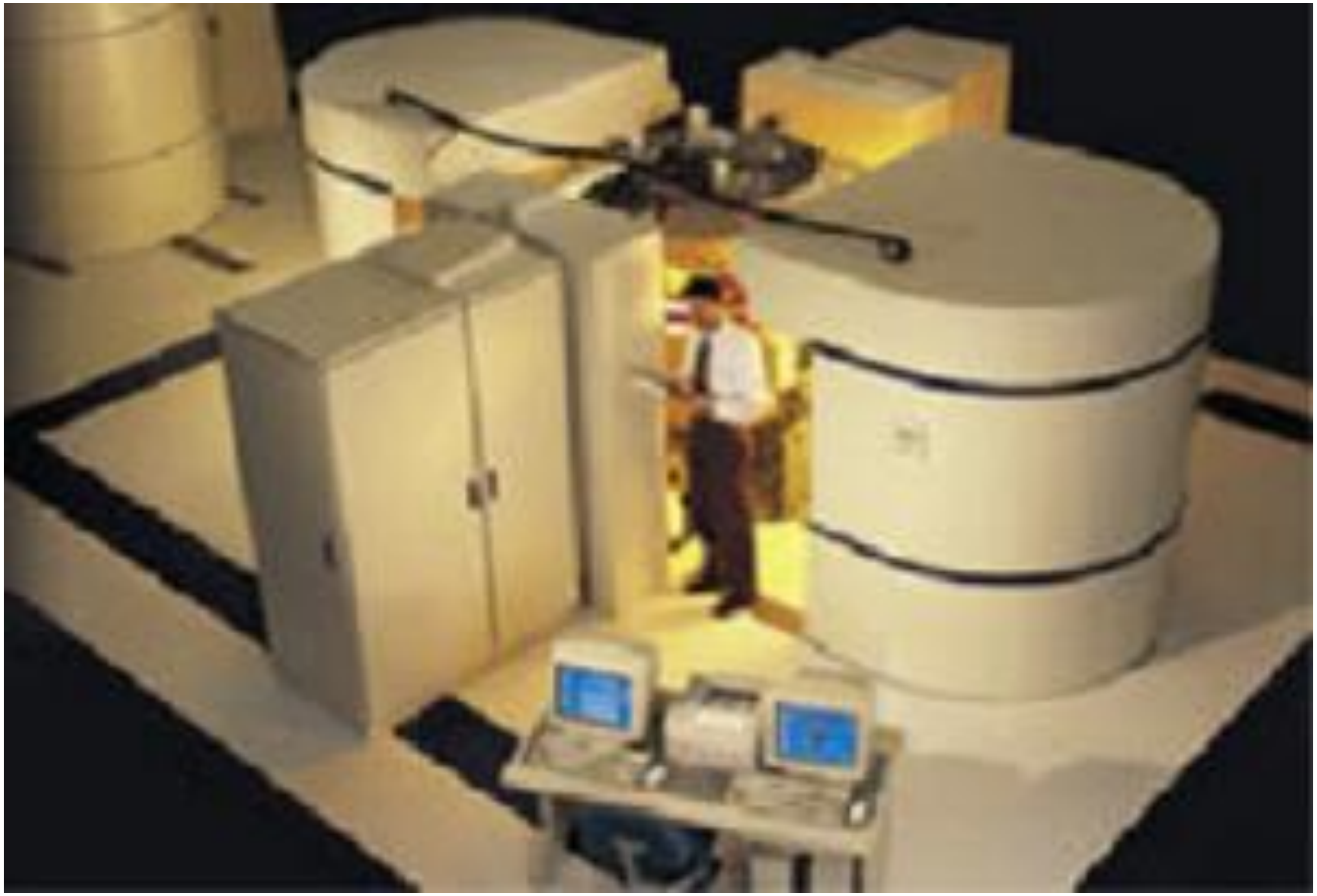


http://images.google.com/imgres?imgurl=http://hyperphysics.phy-astr.gsu.edu/hbase/magnetic/imgmag/cyclo2.gif&imgrefurl=http://hyperphysics.phy-astr.gsu.edu/hbase/magnetic/cyclot.html&h=275&w=327&sz=5&tbnid=6ckocy-jAAEJ:&tbnh=95&tbnw=112&start=10&prev=/images%3Fq%3Dcyclotron%26hl%3Den%26lr%3D

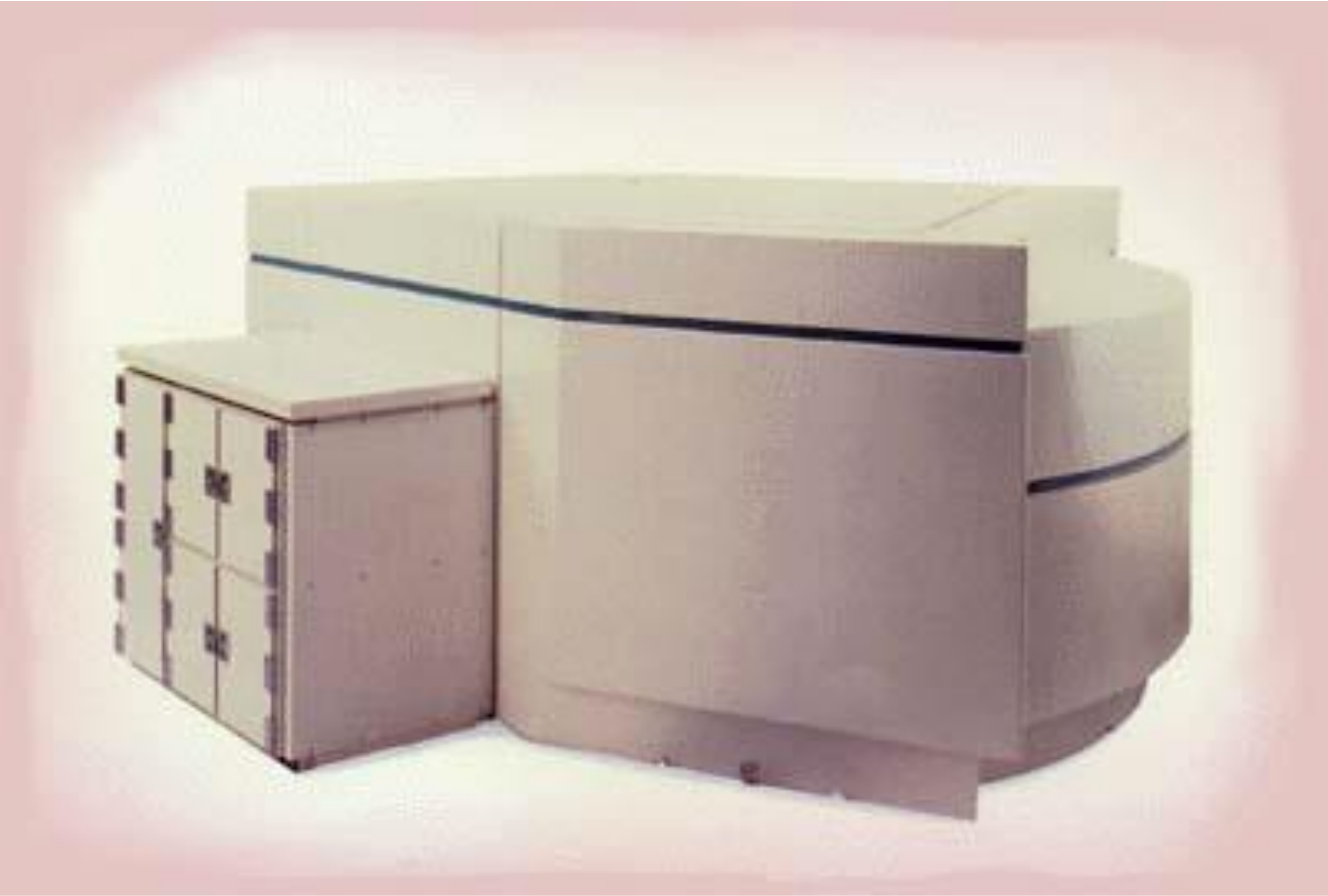


Cyclotron

The cyclotron was one of the earliest types of particle accelerators, and is still used as the first stage of some large multi-stage particle accelerators. It makes use of the magnetic force on a moving charge to bend moving charges into a semicircular path between accelerations by an applied electric field. The applied electric field accelerates electrons between the "dees" of the magnetic field region. The field is reversed at the cyclotron frequency to accelerate the electrons back across the gap.



Cyclotron for PET



Cyclotoron

Often the synthesis box is placed inside a minicell to minimize radiation exposure. An automated multi-synthesis module (FASTlab2) for the synthesis of different PET radiopharmaceuticals marketed by GE Healthcare is shown in Fig. 8.2. Other vendors include Siemens Medical Solutions, Inc. (Explora), IBA (Synthera), and Eckert & Ziegler (FDG-Plus).

Fig. 8.2 Automated synthesis box, FASTlab2, from GE Healthcare (Courtesy of GE Healthcare)

Fig. 10.2 Lead syringe shield (Photo courtesy of Biodex Medical Systems, Inc., NY)

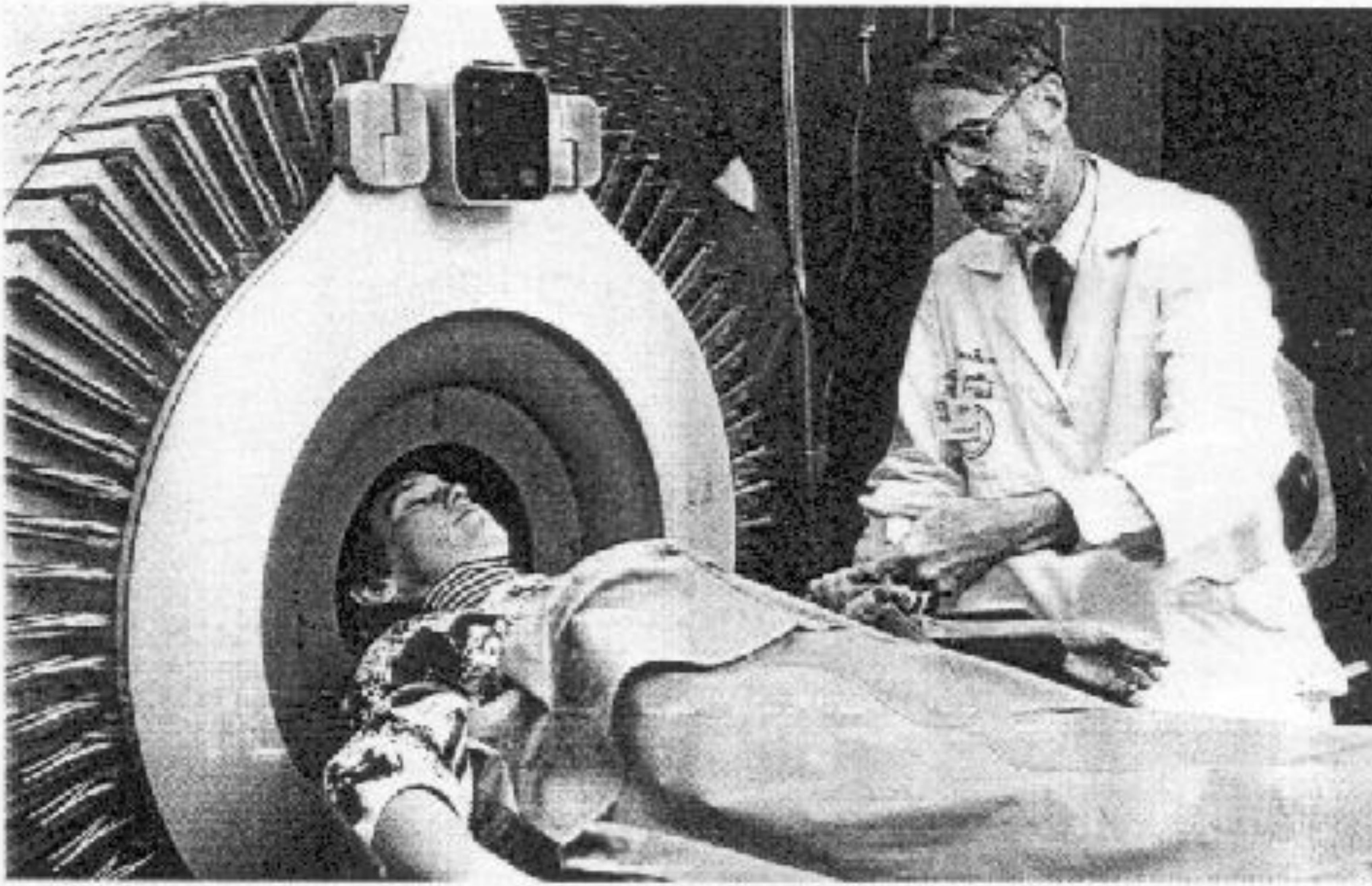
Book: Basics of PET imaging P= 204

Fig. 10.3 A PET syringe holder (Photo courtesy of Biodex Medical Systems, Inc., NY)

Book: Basics of PET imaging P= 205

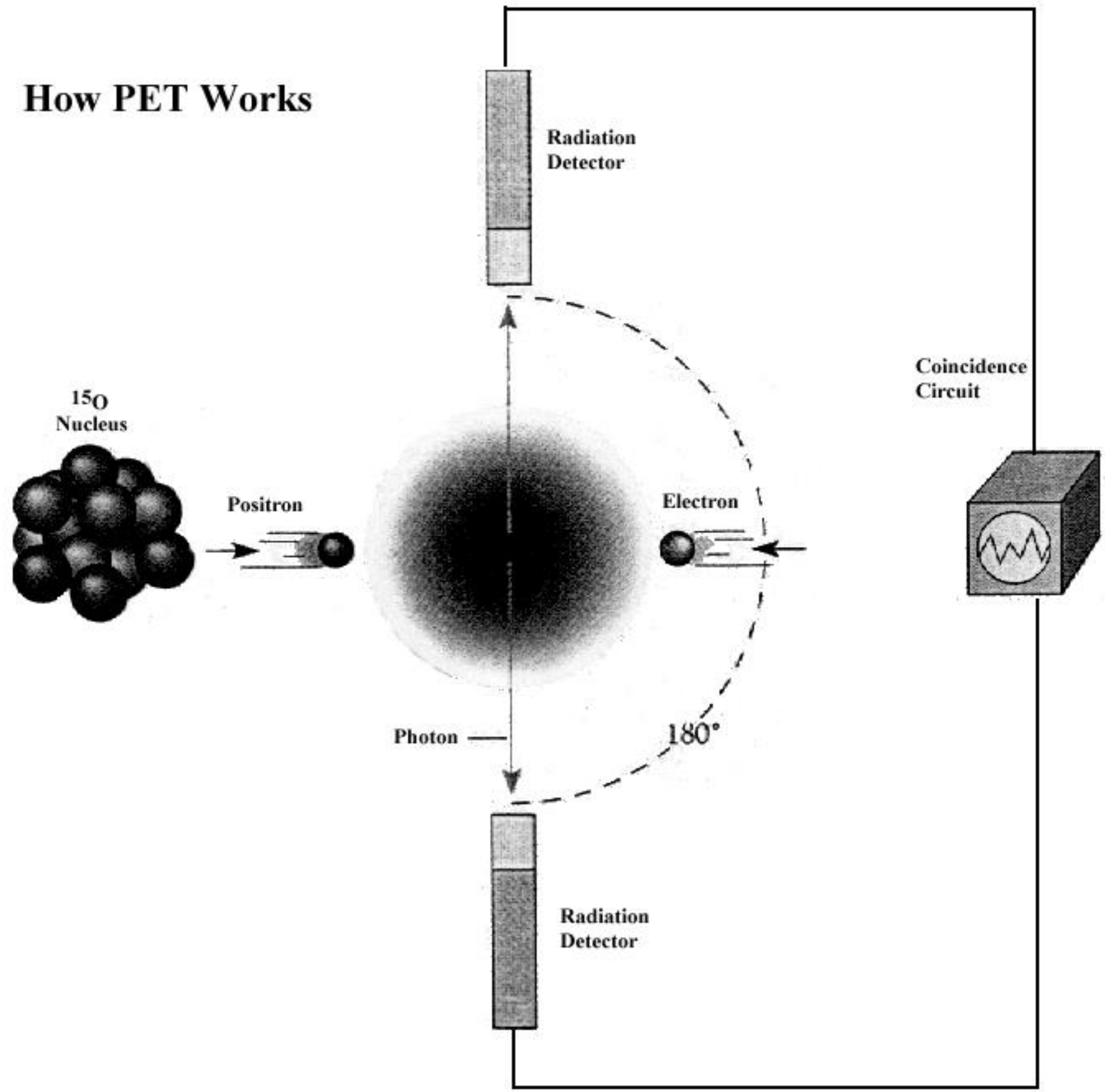
Fig. 10.5 Special shipping containers made of lead that can ship 3 unit dosages of PET radiopharmaceuticals (Photo courtesy of Biodex Medical Systems, Inc., NY)

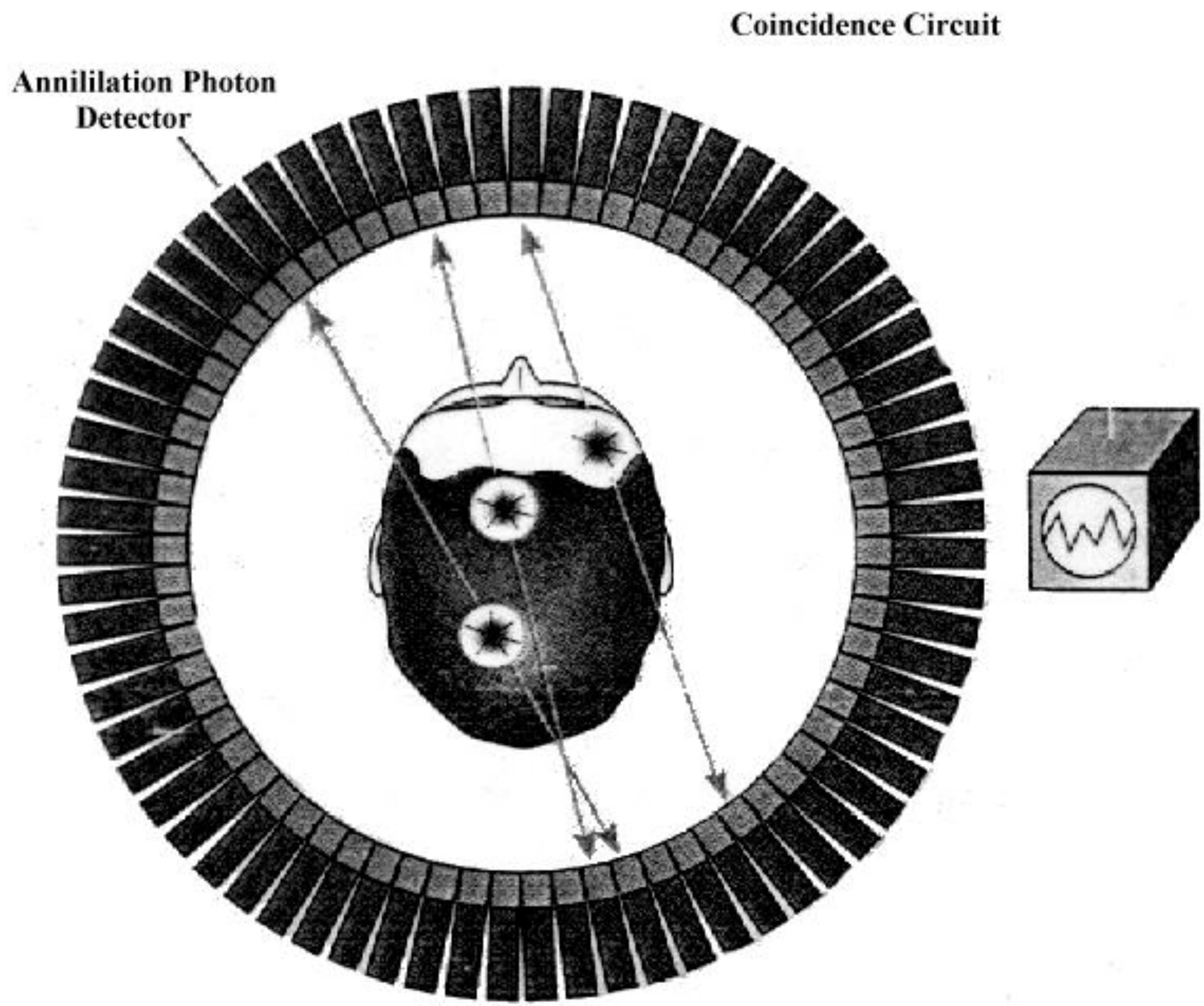
Book: Basics of PET imaging P= 210



Radioactive water is injected into the arm of a subject lying in the PETscanner.

How PET Works





Multiple radiation detectors arranged around the subject's head are connected by coincidence circuits.

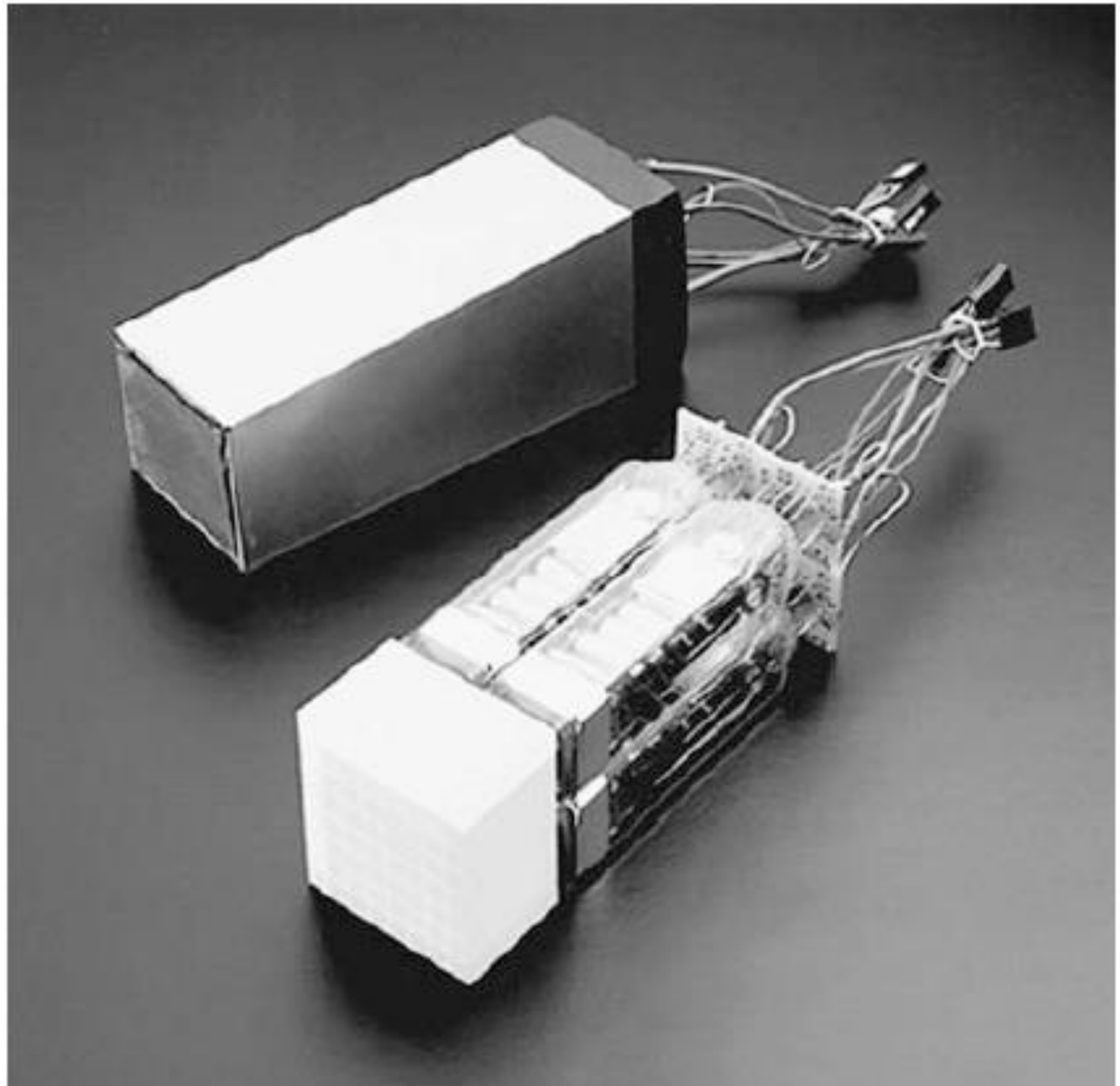


Fig. 2.6 A typical commercial block detector (8×8) attached to four square PM tubes (*bottom*) and a packaged module (*top*), developed and manufactured by Siemens Medical Solutions USA (Courtesy of CPS Innovations, Knoxville, TN, USA, currently Siemens Medical Solutions USA, Inc.)

PET

- **Two gamma rays** (photons) **detected simultaneously** (in coincidence) by opposing radiation detectors which are arranged in a ring around the patient.

- Scanning consists of either a **dynamic** series of images or a **static** image obtained after an interval during which the radiopharmaceutical enters the biochemical process of interest.

- The scanner detects the **spatial** and **temporal** distribution of the radiolabel by detecting gamma rays.

- PET is the **gold standard** for quantitative assessment of **cerebral perfusion** and **cerebral vascular disorder**.

PET

- PET can estimate some important **physiological** and **hemodynamic** parameters, such as **CBF (*cerebral blood flow)***, **energy metabolism**. In addition, it is possible to investigate **disease at a molecular level**.

- PET has **moderate spatial resolution** (4*4 mm) and **poor counting statistics.**

- PET also has **low contrast** between **neighboring anatomical** structures.

- However, this method **can not** be applied routinely for many kinds of disease, because it is **expensive** and not commonly **available**, and there are **limits** on the use of radioactive tracers.

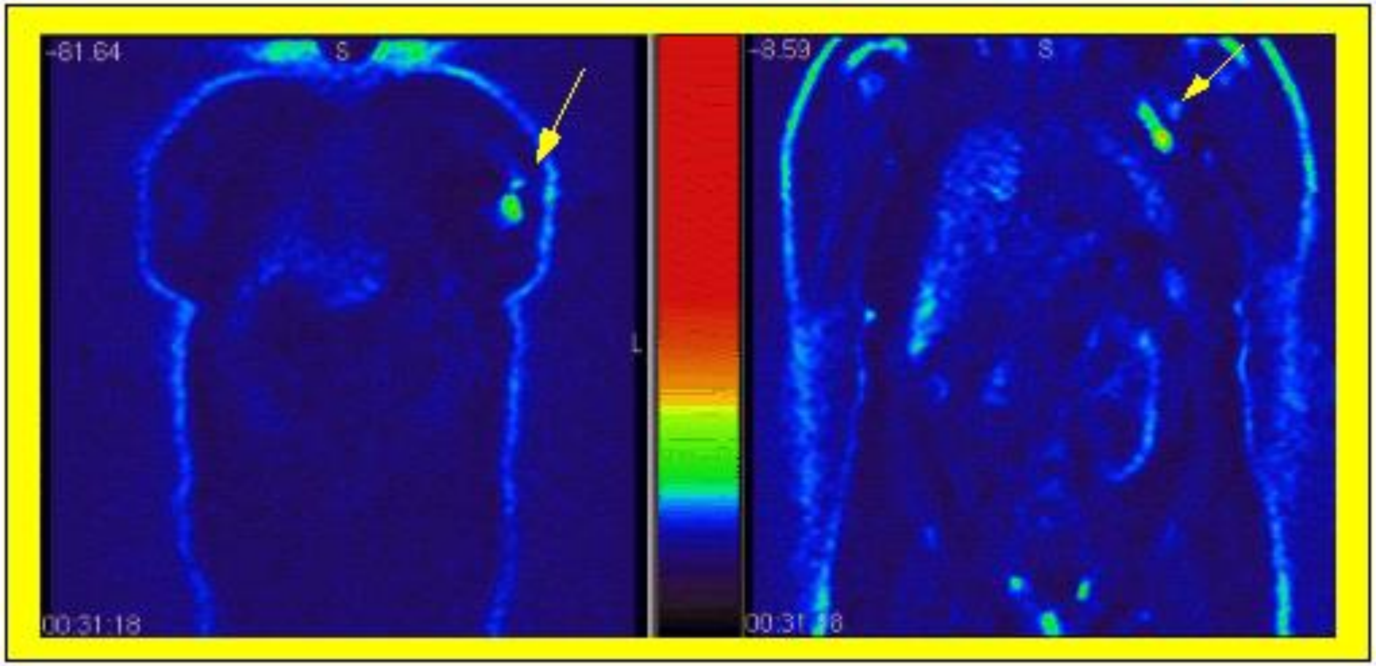


Image showing malignant breast mass that was **not revealed** by conventional imaging techniques such as **CT, MRI, and mammogram.**

Image of same patient with enlarged left axillary lymph nodes (indicated by arrows), which through biopsy were found to be metastatic (spread from another location). The whole body scan reveals a mass in the **left breast** (indicated by arrow), that was malignant and subsequently removed.

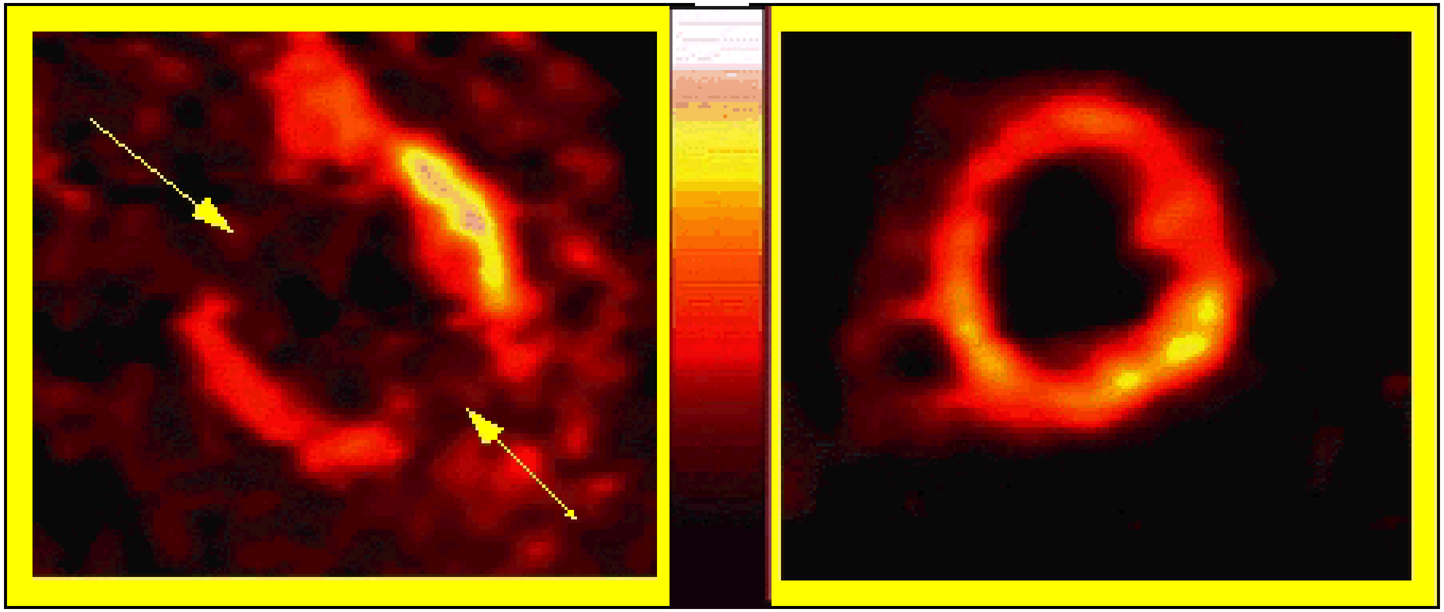
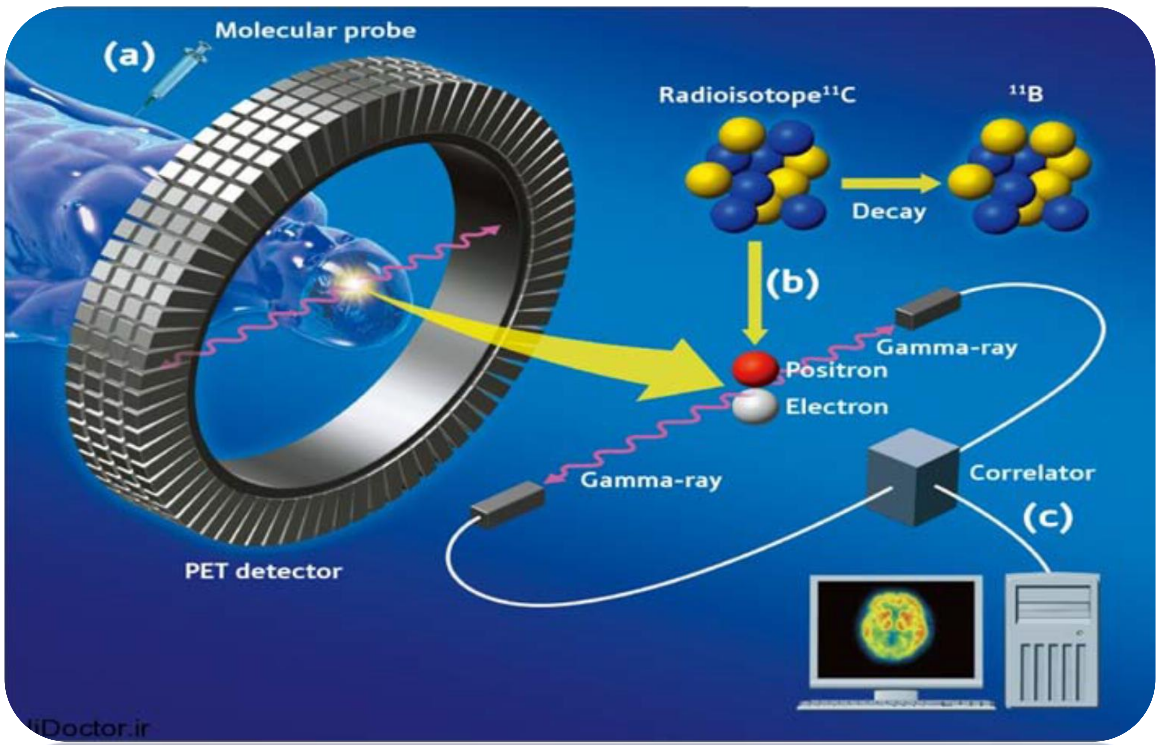


Image of heart which has had a mycardial infarction (heart attack). The arrow points to areas that have been damaged by the attack, indicating "dead" myocardial tissue. Therefore, the patient will not benefit from heart surgery, but may have other forms of treatment prescribed.

Normal heart

خلاصه مراحل تصویر برداری PET

قبل از شروع آزمایش , یک ماده رادیواکتیو که درسیکلوترون تولید شده است و با یکی از ترکیبات بدن مثل گلوکز و گاهی هم آب و یا آمونیاک , ترکیب شده به بیمار داده میشود ,تشعشع های منتشره از نقاط ویژه بدن توسط آشکار سازی میشود.



پرستار یا تکنسین بیمار را به اتاق تزریق منتقل میکند , همان مکانی که باید ماده رادیو اکتیو به بیمار تزریق شود (گاهی هم ممکن است یک گاز استنشاقی باشد). پس از ۳۰ تا ۹۰ دقیقه که ماده درسر تاسر بدن انتشار یافته و در بافت مورد نظر جمع می شود.

در این فاصله ممکن است به مریض گفته شود که از حرکت و یا حتی صحبت کردن بپرهیزد تا مبادا باعث اختلال در انتشار ماده شود .بعد از این زمان , اسکن شروع میشود که ممکن است ۳۰ تا ۴۵ دقیقه طول بکشد.

مراجعه کننده محترم

با سلام

مطابق هماهنگی انجام شده با سازمان مربوطه ، برای انجام تصویر برداری PET/CT برای بیماران سرپایی، خواهشمند است :

۱ - **مبلغ ۹/۲۴۰/۰۰۰ ریال بابت هزینه رادیوداروی FDG**

واریزی از طریق دستگاه ATM به شماره ۶۱۰۴۳۳۷۹۶۹۲۷۶۷۰۶

به شماره حساب ۴۲۶۰۸۴۱۲۲۰ بانک ملت شعبه کوی نصر

شماره شناسه ۳۰۰۸۲۴۱۰۹ بنام شرکت پارس ایزوتوپ واریز نمائید

دقت فرمائید نام واریز کننده ، نام بیمار درج شود. از فیش واریزی کپی تهیه فرمائید و تحویل پذیرش دهید.

۲ - هزینه اسکن نیز مبلغ **۱۶/۱۸۴/۰۰۰ ریال** است که در روز انجام اسکن در این مرکز از طریق کارت خوان (سیستم پوز) به حساب بیمارستان دریافت خواهد شد.

فکس ۸۸۰۲۶۹۰۵

بدیهی است پذیرش قطعی بیمار منوط به انجام مراحل فوق الذکر می باشد

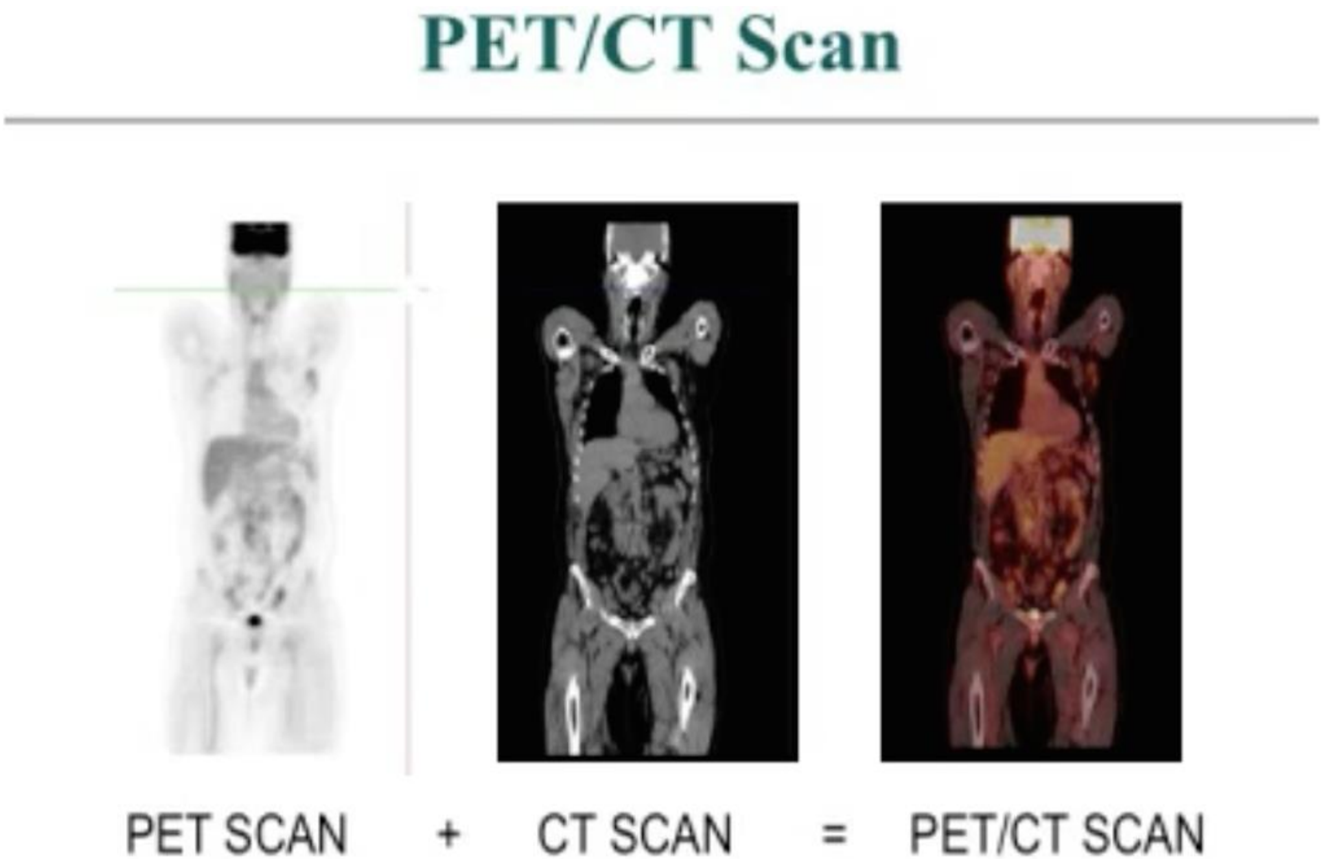
ساعت و تاریخ انجام PET:

قیمت فعلی تصویر پت اسکن حدود 6 میلیون تومان است.
بیمارستان نیکان پت دارد.

لیست دستگاه های PET ایران

1-بیمارستان شریعتی تهران، دولتی ،زیمنس
2-بیمارستان خاتم تهران ، خصوصی، زیمنس
3-بیمارستان محک تهران، خیریه، زیمنس
4-بیمارستان مسیح دانشوری تهران، خصوصی،GE
5- بیمارستان رضوی مشهد، خصوصی، زیمنس
6 -بیمارستان امام رضا تبریز، مرکز امید، خصوصی در دولتی، زیمنس
7-بیمارستان کوثر شیراز، خصوصی، PHILIPS
8-مرکز تصویربرداری پیام کرج، Mediso
9-بیمارستان امام تهران، ,GEدرحال بهره برداری
10- بیمارستان قلب رجایی، زیمنس، درحال راه اندازی

ترکیب تصویر پت اسکن و سی تی اسکن



یک اسکن کامل از بدن، که معمولاً از میانه ران تا به بالای سر است، ۵ تا ۴۰ دقیقه، وابسته به پروتکل‌های تصویربرداری و تکنولوژی تجهیزات به کار رفته، طول می‌کشد.

Process of PET

Radioisotope Production

INFRASTRUCTURE: Vault

EQUIPMENT: Cyclotron

STAFF : Cyclotron Engineer

Radio labelling of PET tracers

Hotlab, hotcells

modules (F18, C11)

Radiochemist

Quality Control

QC room, laminar flow

HPLC, GC, TLC

Radiopharmacist

Scanning and Imaging

Scanner suite

PET scanner/CT

Nuclear technologist

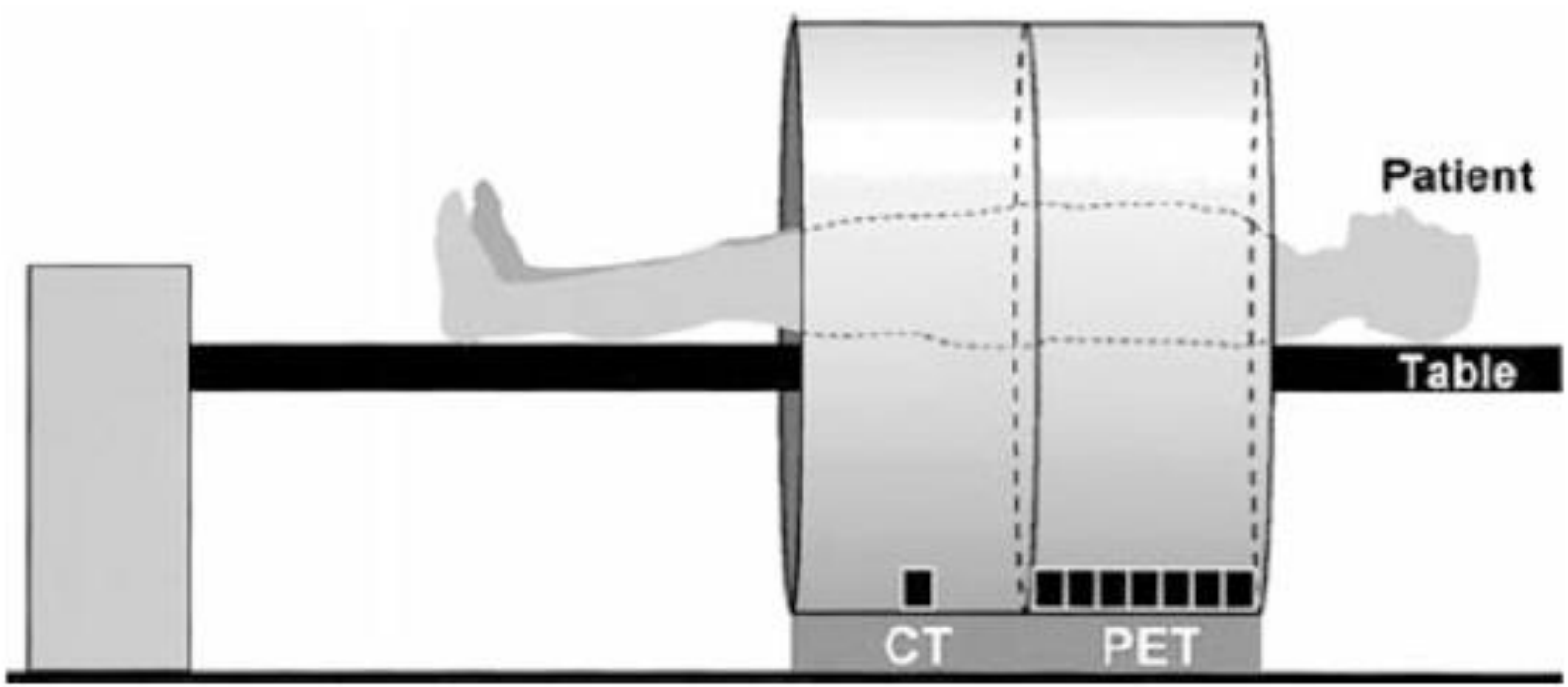


Fig. 2.11 A schematic illustration of a PET/CT system (Reprinted with the permission of the Cleveland Clinic Center for Medical Art and Photography © 2009. All rights reserved)

دستگاه پت-سی تی ۱۶ مقطعی (اسلایس)

https://fa.wikipedia.org/wiki/پت-سی_تی#/media/File:16slicePETCT.jpg

Fig. 2.20 Mediso's small-animal PET/CT scanner, NanoScan PET/CT (Image courtesy of Mediso Medical Imaging Systems at medisousa.com)

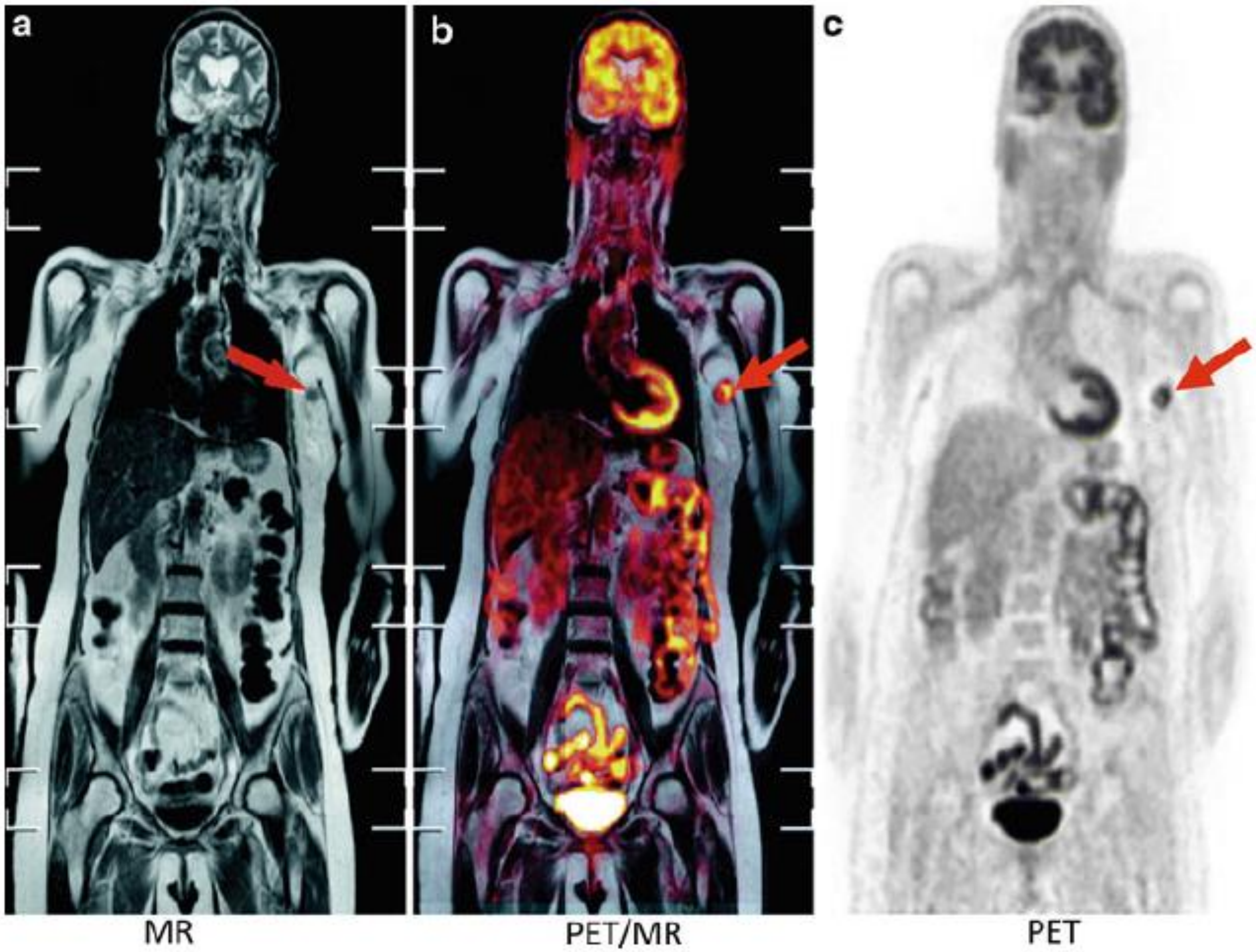


Fig. 3.19 PET/MR image (**b**) obtained by fusion of T2-weighted MR image (**a**) and FDG-PET image (**c**) illustrating the left axillary nodule indicated by *red arrows*. (Fig. 6.5 in Tabouret-Viaud C, Baskin A, Beer AJ et al. Breast cancers. In: Ratib O, Schwaiger M and Beyer T, eds. (2013) *Atlas of PET/MR Imaging in Oncology*. New York, Springer; p. 91. With kind permission from Springer Science and Business Media)