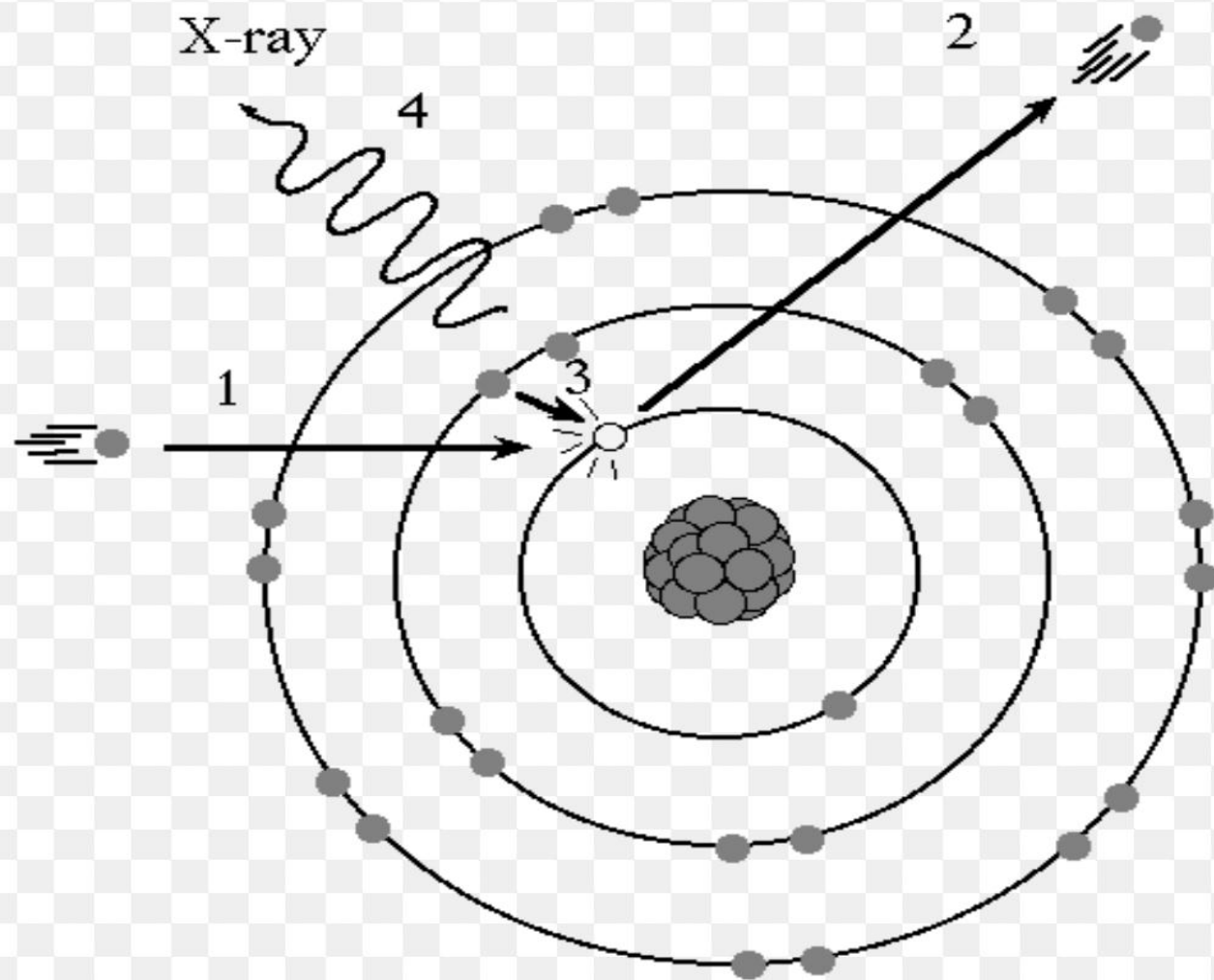


X-ray

Definition:

X rays are a type of radiation used in imaging and therapy that uses short wavelength energy beams capable of penetrating most substances except heavy .metals

X-rays are produced when fast-moving electrons with sufficient energy strike a target. Most of the electron energy is converted to heat, but a very minute amount—less than 1 per cent—is converted to x-rays



Spectrum of Electromagnetic Radiations. X-rays resemble visible light rays very closely but have the distinguishing feature that their wave lengths are very short

x-ray:

electromagnetic radiation

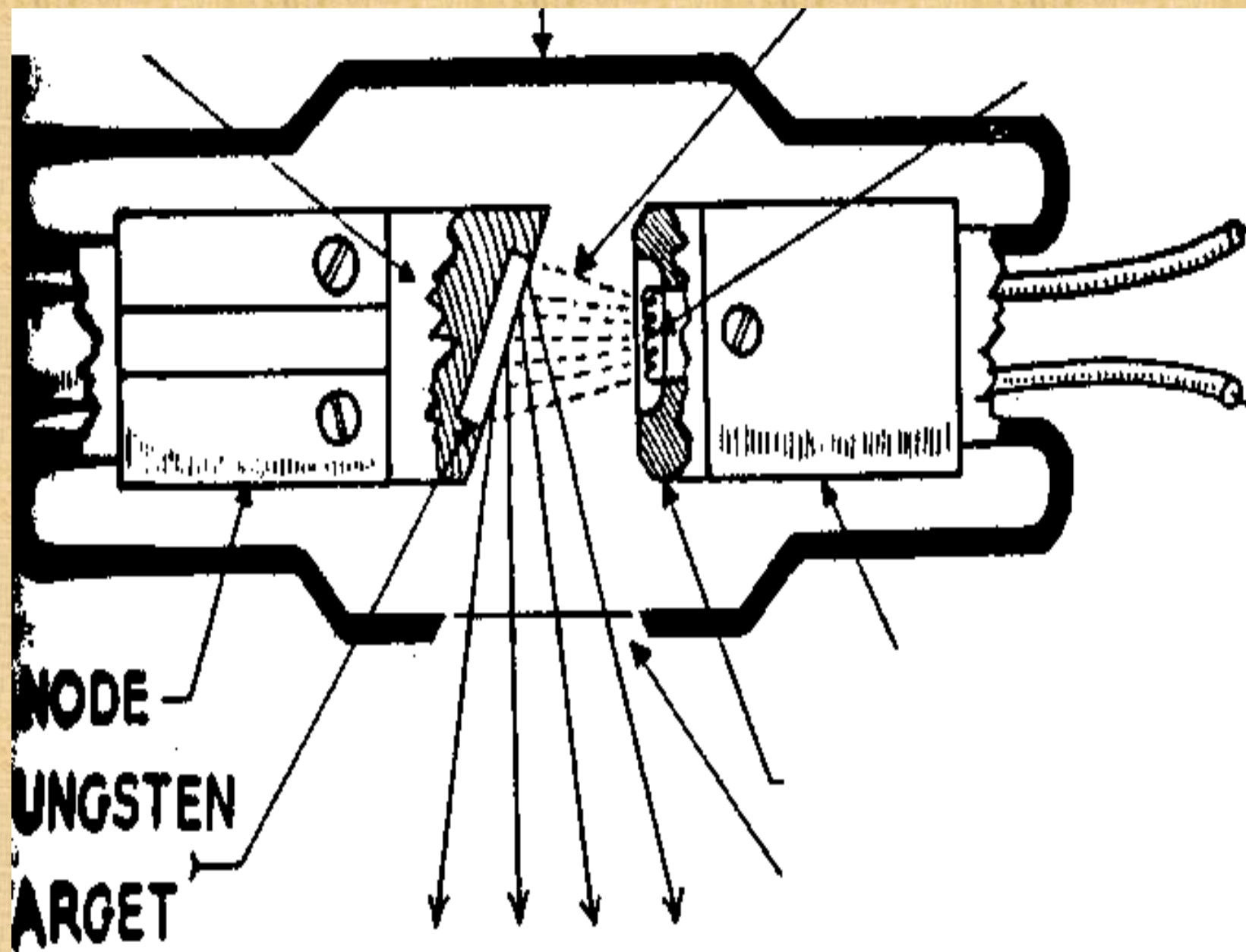
- No mass
- No charge
- Travel at the speed of light
- Short wave length
- High energy
- Source of x-ray from the electron shells

X-ray production:

- X-rays are generated by an x-ray tube, a vacuum tube that uses a high voltage to accelerate electrons released by a hot cathode to a high velocity. The high velocity electrons collide with a metal target, the anode, creating the x-rays. In medical x-ray tubes the target is usually tungsten

X-ray tube :

- the insert is evacuated from air because :
 1. Prevent oxidation of the cathode filament
 2. Decrease resistance against electron movement
- Advantage of oil in x-ray tube :
 1. Shock absorber
 2. Heat absorber



X-ray Tube Components

The cathode acts to excite electrons to the point where they become free from their parent atom and are then able to become part of the electron beam. The cathode acts as a negative electrode and propels the free electrons, in the form of an electron beam, towards the positive electrode (the anode)

.

.The anode acts as a positive electrode, attracting the free electrons and accelerating the electrons through the electromagnetic field that exists between the anode and cathode.

. This acts to increase the velocity of the electrons, building potential energy.

. The electrons then impact a target (most commonly made of tungsten, but this target can also be molybdenum, palladium, silver or other material). This causes the release of the potential energy built up by the acceleration of the electrons comprising the electron beam.

.The most of this energy is converted to heat and is radiated by the copper portions of the anode.

**.The remainder is refracted off of the target in the form of
 .high energy photons, or x-rays, forming the x-ray beam**

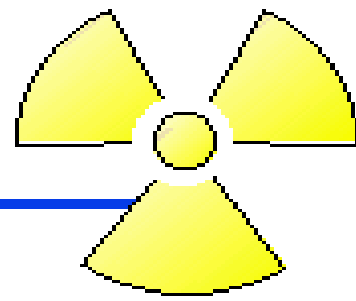
X-ray

X-Rays are produced either when electrons • change orbits within an atom, or electrons from an external source are deflected around the nucleus of an atom. Both are forms of high energy electromagnetic radiation which interact lightly with matter. X-rays and gamma rays are best shielded by thick layers of lead or other dense material and are hazardous to people when they are external to the body.

Radiation is energy traveling in the form of particles or waves in bundles of energy called photons. Some everyday examples are microwaves used to cook food, radio waves for radio and television, light, and x-rays used in medicine

Ionization is a particular characteristic of the radiation produced when radioactive elements decay. These radiations are of such high energy that when they interact with materials, they can remove electrons from the atoms in the material. This effect is the reason why ionizing radiation is hazardous to health, and provides the means by which radiation can be detected.

Radiation Units



- ◆ Roentgen: A unit for measuring the amount of gamma or X rays in air
- ◆ Rad: A unit for measuring absorbed energy from radiation
- ◆ Rem: A unit for measuring biological damage from radiation

•The gray (Gy) which has units of (J/kg), is the SI unit of absorbed dose which is the amount of radiation required to deposit 1 joule of energy in 1 kilogram of any kind of matter.

The rad is the (obsolete) corresponding traditional unit, equal to 0.01 J deposited per kg. $100 \text{ rad} = 1 \text{ Gy}$.

The equivalent dose is the measure of the biological effect of radiation on human tissue. For X-rays it is equal to the absorbed dose.

The sievert (Sv) is the SI unit of equivalent dose, which for X-rays is equal to the gray (Gy).

The rem is the traditional unit of equivalent dose. For X-rays it is equal to the rad or 0.01 J of energy deposited per kg. $1 \text{ sievert} = 100 \text{ rem}$

Glass envelope

The above components are sealed into a glass envelope. This allows for gases and other impurities to be pumped out of the tube, creating the vacuum necessary for proper performance. The x-ray creation process must occur in a vacuum so as not to disrupt the electron beam, and also to allow for proper filament performance and durability

CT scan

Definition

Computed tomography (CT) an imaging method that uses x-rays to create cross-sectional pictures of the body.

Alternative Names

CAT scan; Computed axial tomography (CAT) scan

What is computed tomography?

Computed tomography, commonly known as a CT scan, uses X-rays and computers to produce images of a cross-section of the body. The patient must lie as still as possible as the table moves through the large, donut-shaped scanning device. Movement could blur the images produced by the scanner.

In conventional x-rays, a beam of energy is aimed at the body part being studied. A plate behind the body part captures the variations of the energy beam after it passes through skin, bone, muscle, and other tissue. While much information can be obtained from a regular x-ray, specific detail about internal organs and other structures is not available

With computed tomography scan (also called CT or CAT scan), the x-ray beam moves in a circle around the body. This allows for many different views of the same organ or structure, and provides much greater detail. The x-ray information is sent to a computer which interprets the x-ray data and displays it in two-dimensional form on a monitor

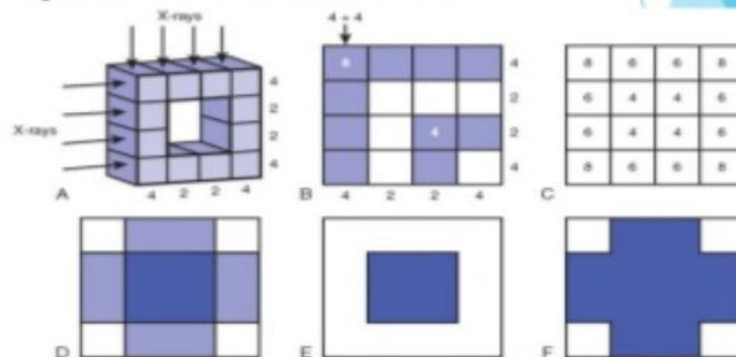


Basic principle

- ▶ CT image is a display of the anatomy of a thin slice of the body developed from multiple x-ray absorption measurements made around the body's periphery.
- ▶ Image in conventional tomography → blurring out the information from unwanted regions
- ▶ In CT → constructed using data arising only from section of interest.
- ▶ Routine CT generated axial image → image is reformatted to coronal / sagittal.

▶ CONCEPT:

- ▶ Internal structure of an object can be reconstructed from multiple projections of the object.



► **X-ray Tubes:**

rotating anodes, unique cooling methods

2 MHU with 300kHU/min → 7 MHU with 1 MHU/min

enhance system's ability to cover large areas of anatomy at diagnostic levels of x-ray output.

► **Double tube designs:**

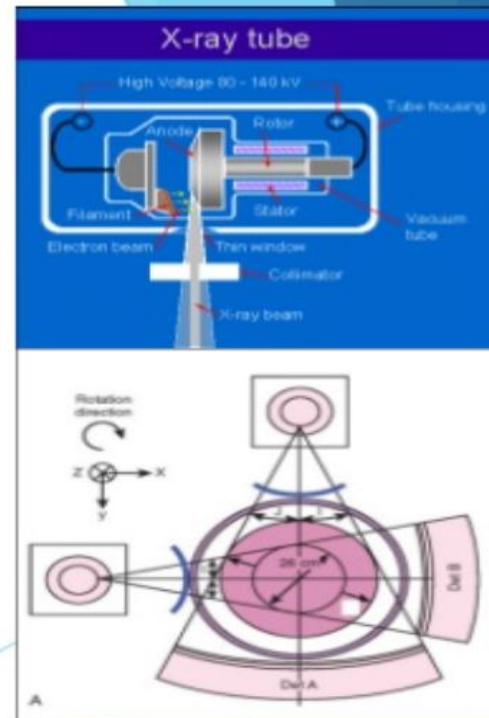
increase x-ray source, faster acquisition time

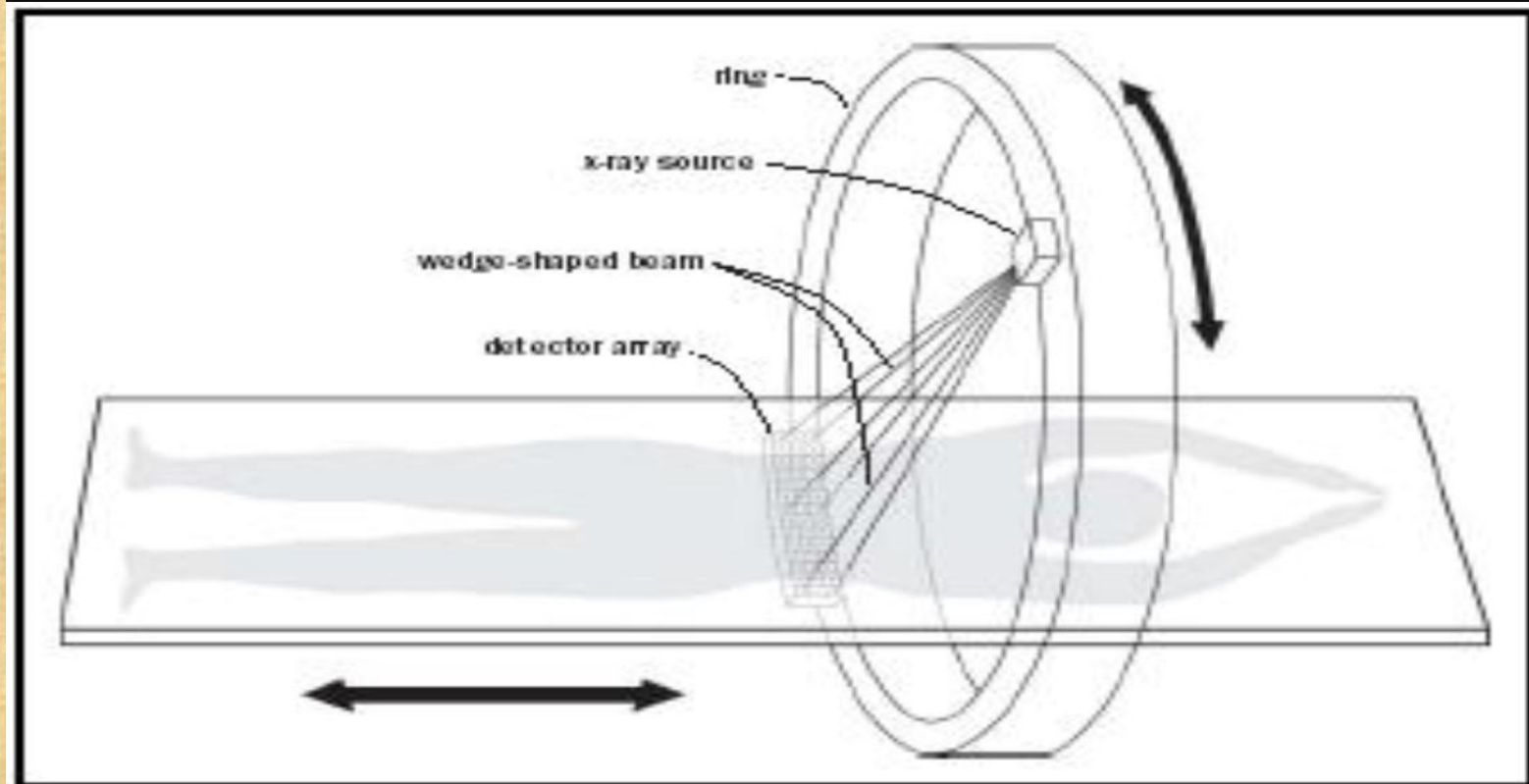
spectral absorption differences of tissues

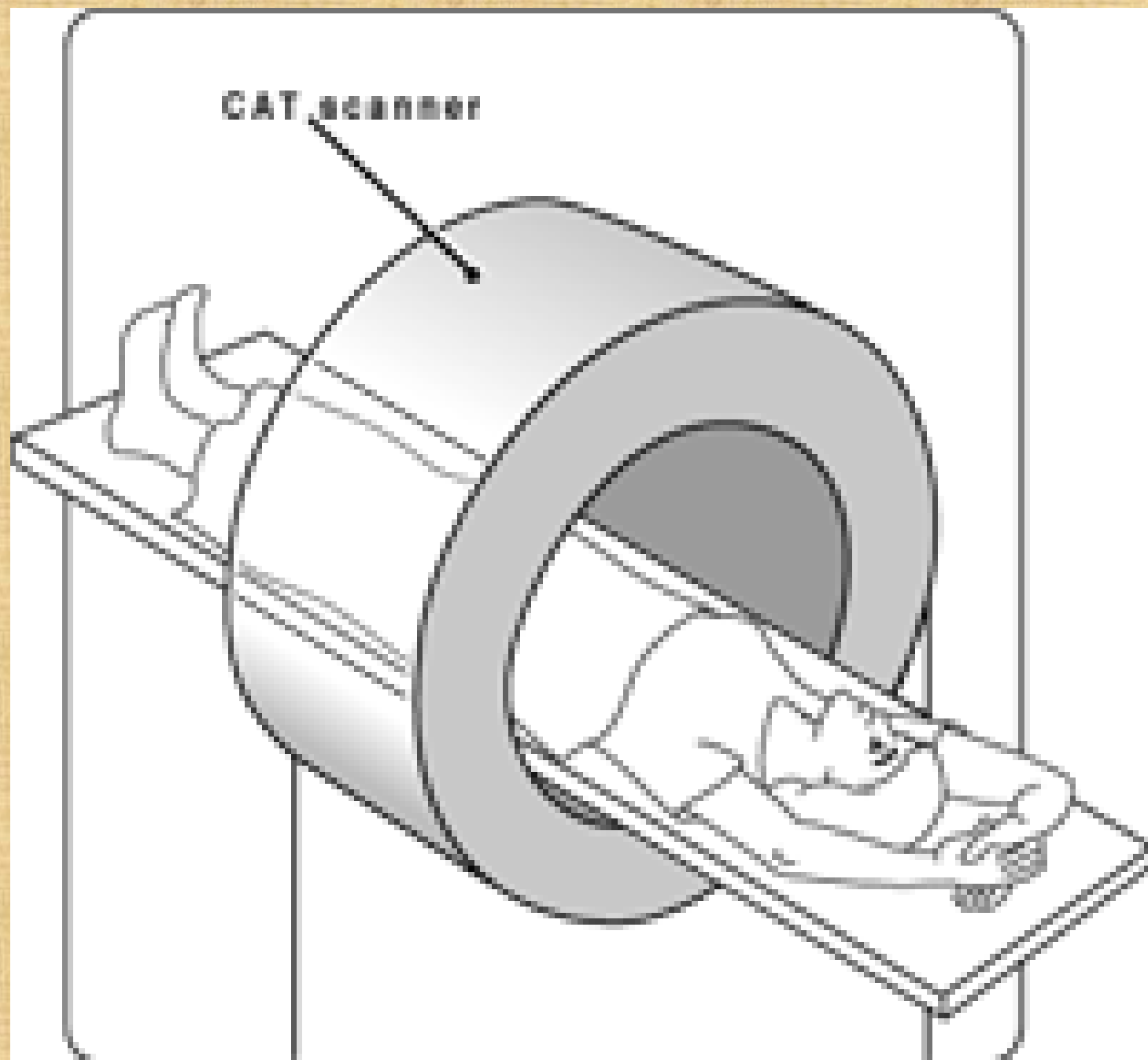
characterising tissues and abnormalities - fat content, stones.

► **Data acquisition system (heart of CT system):**

1. Detector system
2. Analogue to digital conversion
3. Data processing

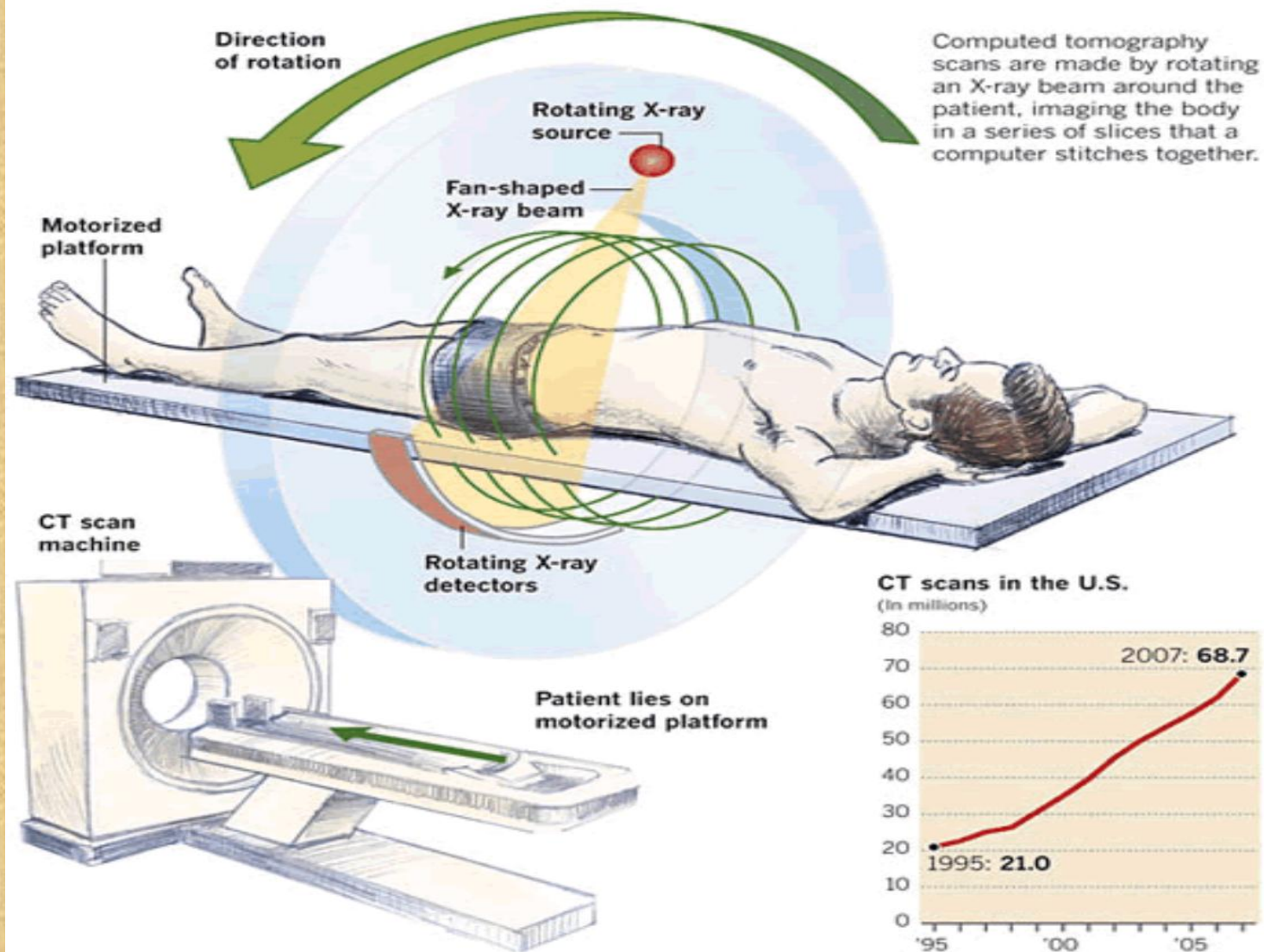


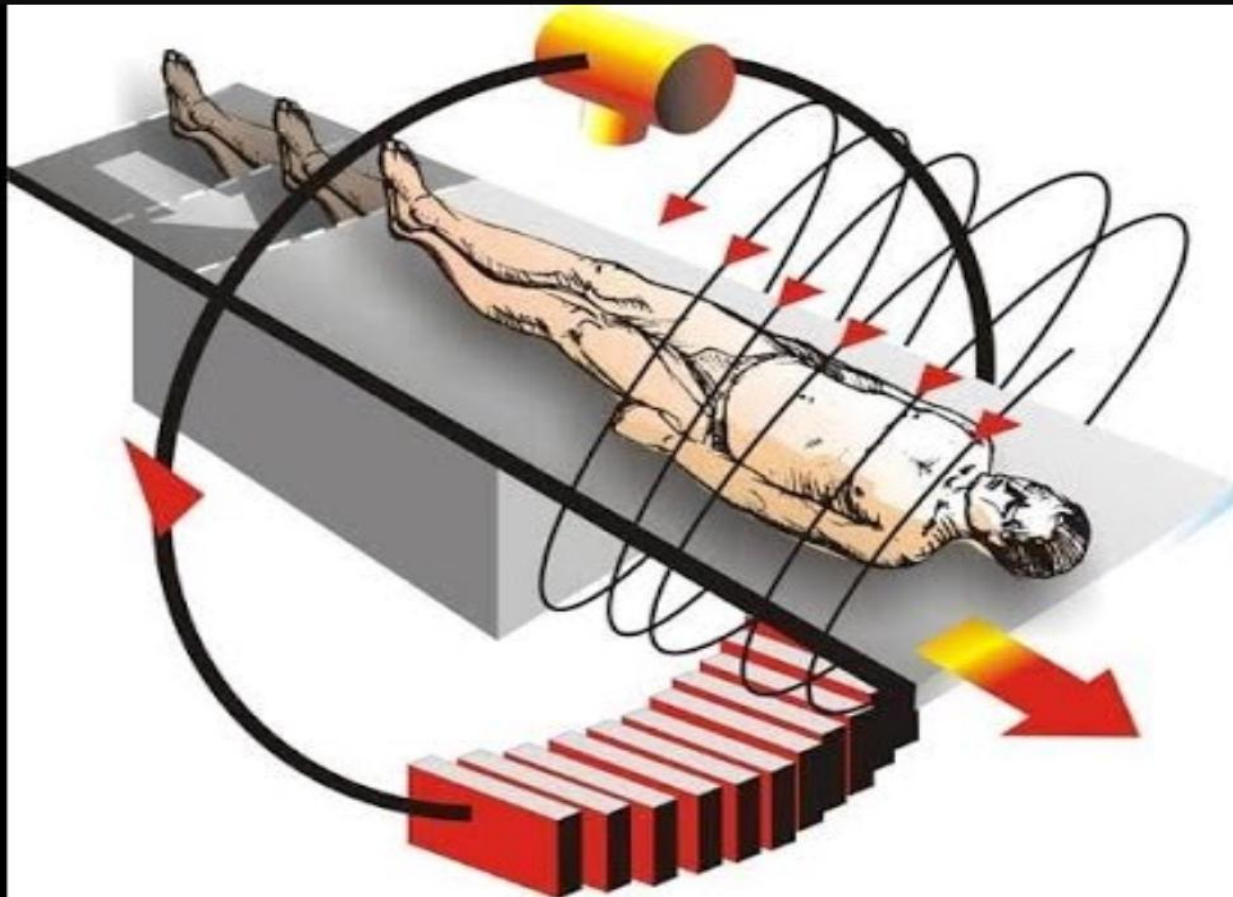


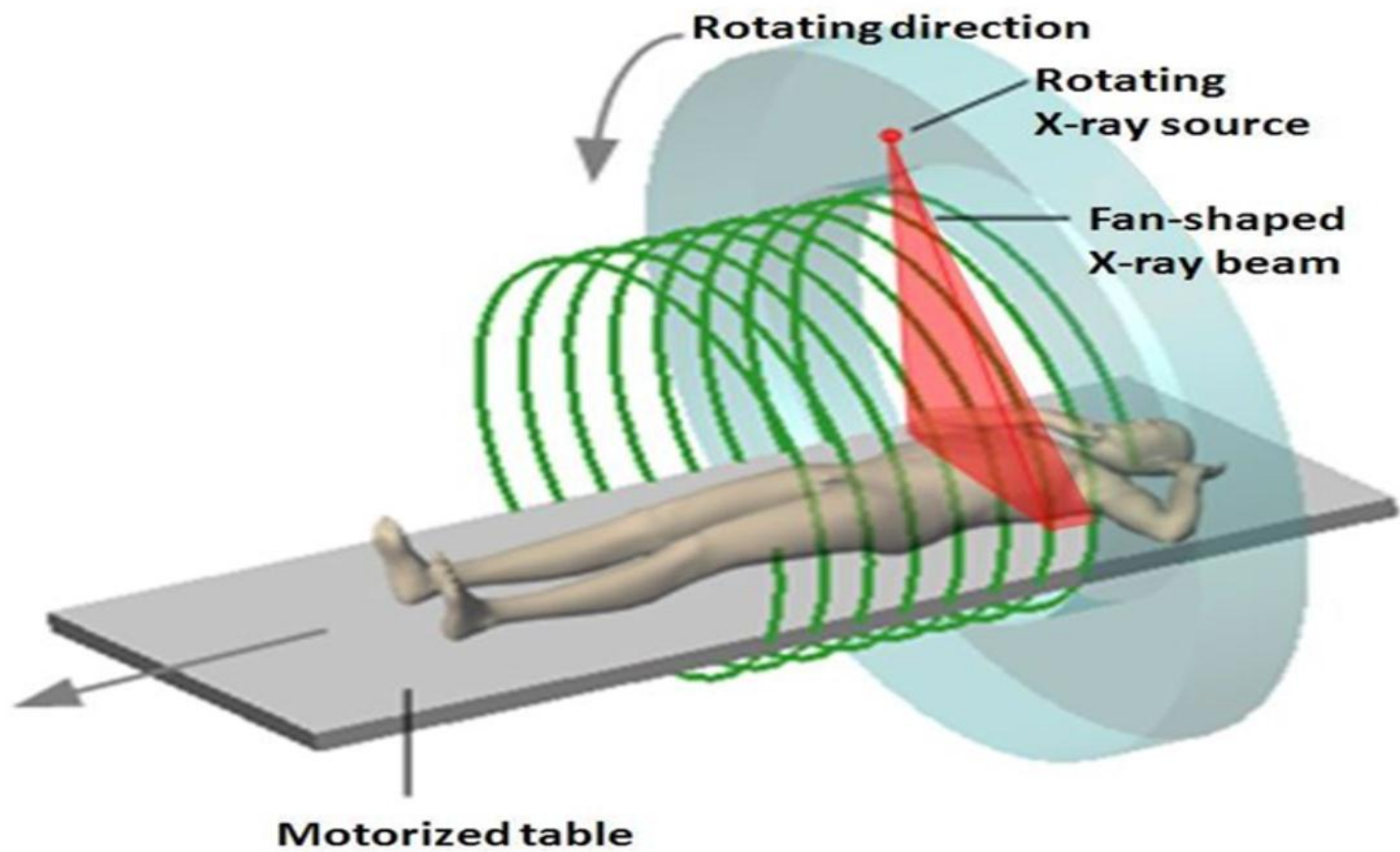


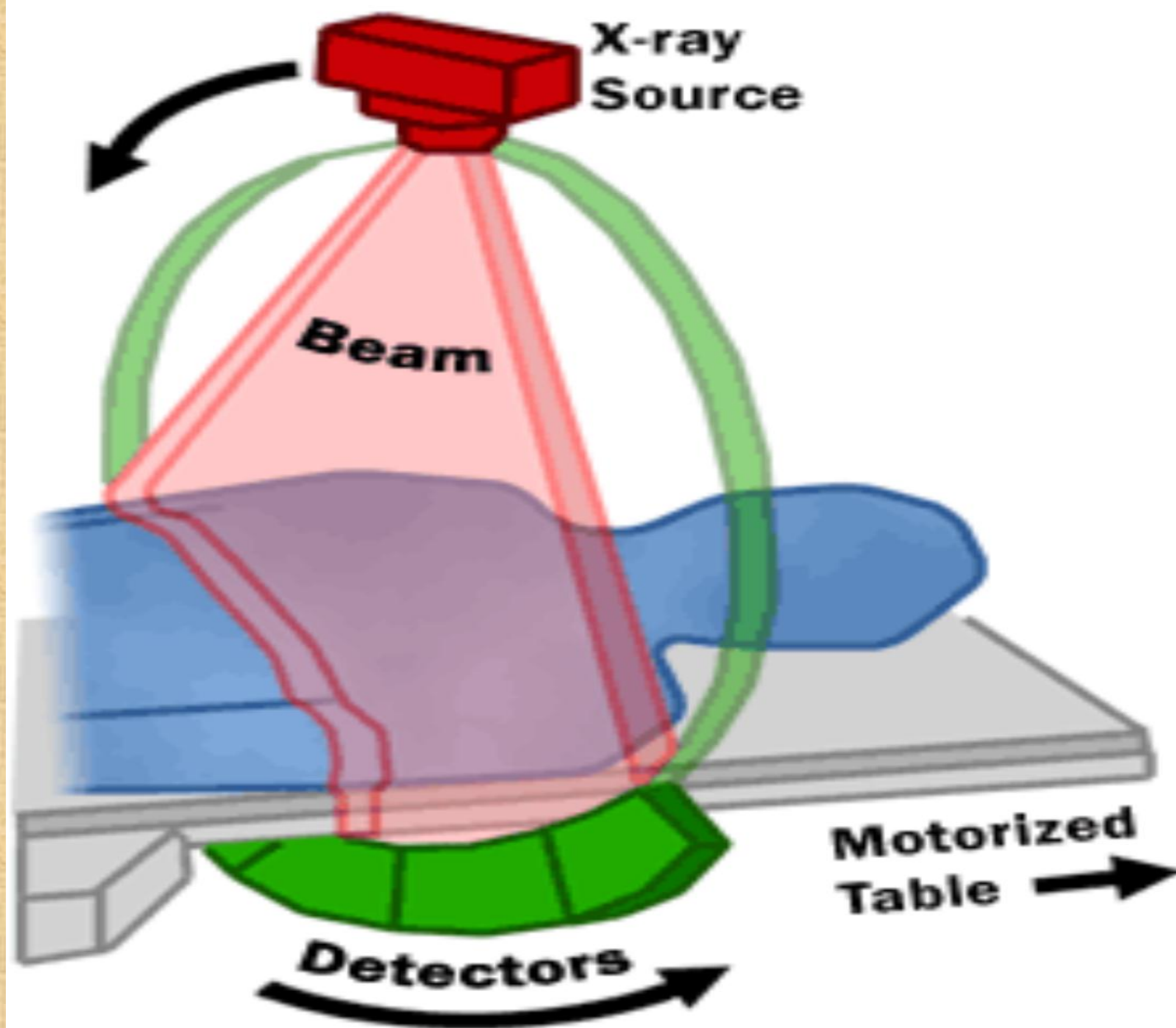
Anatomy of a CT scan

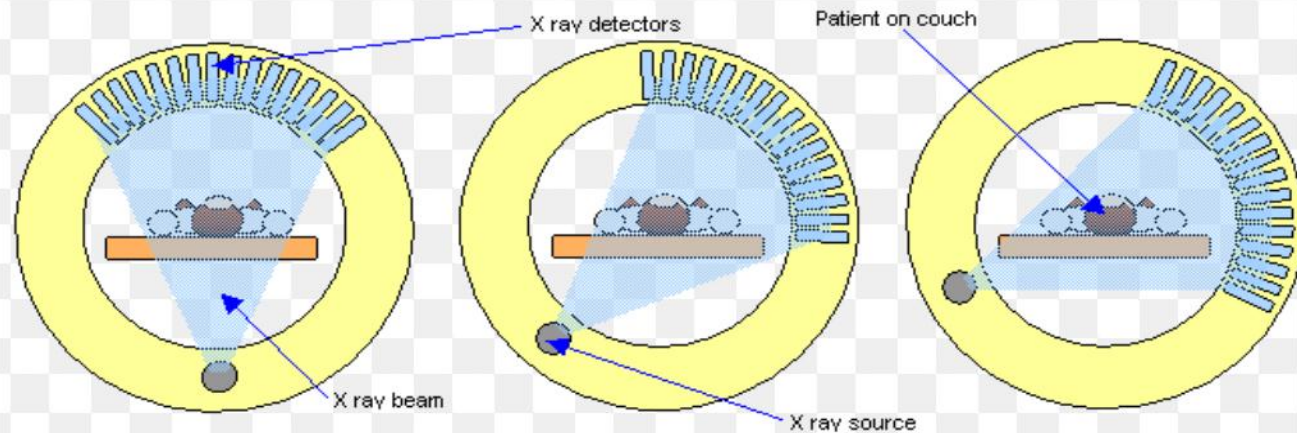
CT scanners give doctors a 3-D view of the body. The images are exquisitely detailed but require a dose of radiation that can be 100 times that of a standard X-ray.



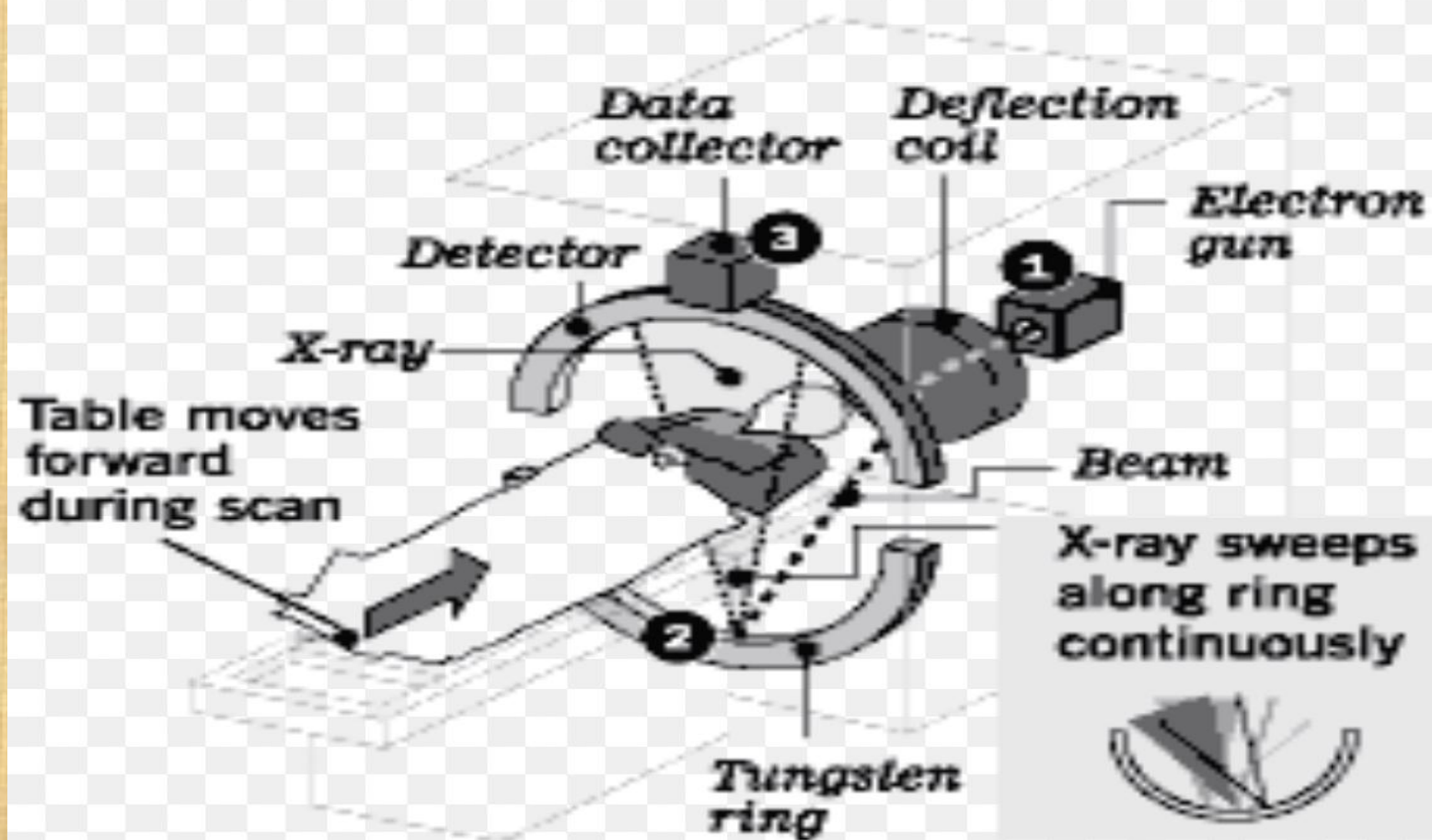




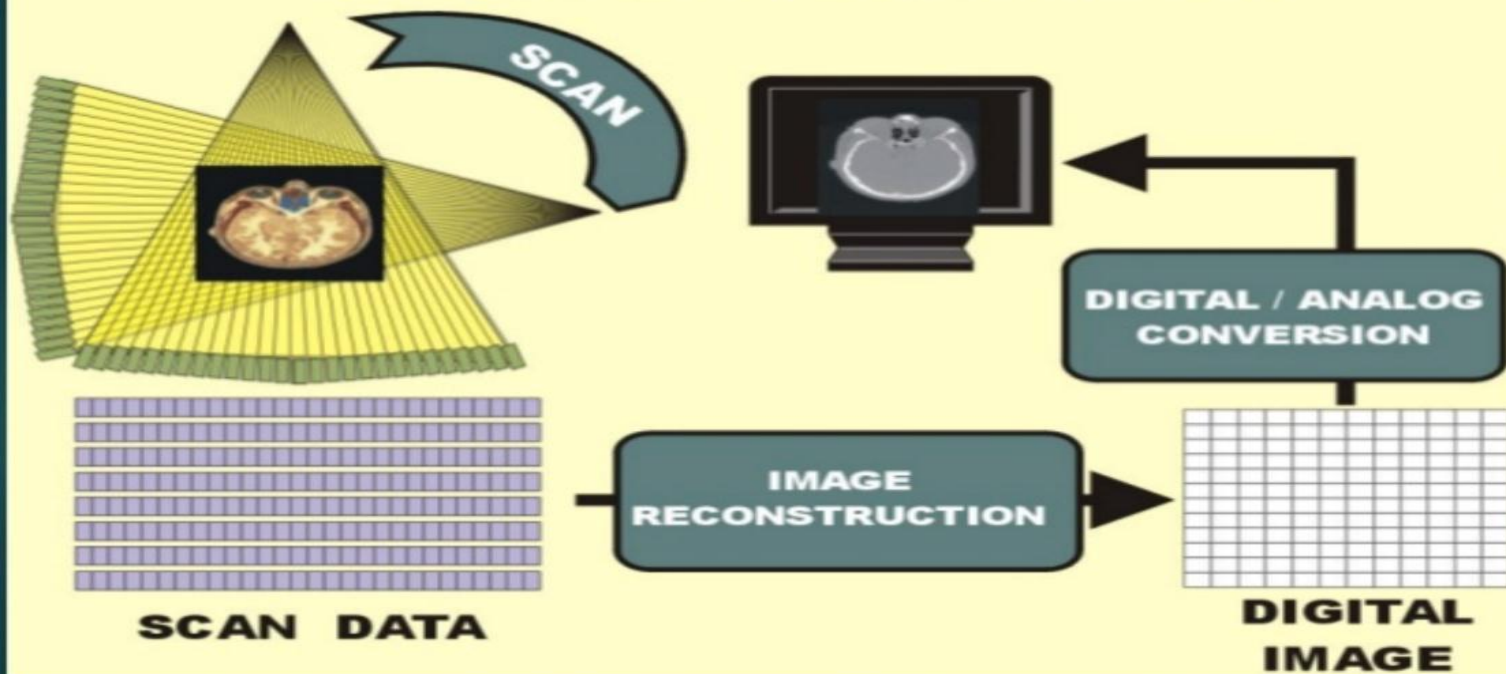




CT scanner with the X ray source and detectors shown in three positions

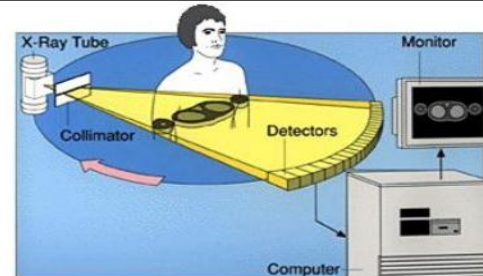


CT IMAGE FORMATION



Medical Physics

Describe the advantages of a CAT scan compared with an x-ray image



Differences:

Simple X-ray is one directional & produces single image

Computer processes data / image constructed from many slices

Advantages: X-ray image is 2D / CT scan produces 3D image

Greater detail / definition / contrast with CT scan / 'soft tissues can be seen'

Image can be rotated

Advantages of CT Scan

- 1- Overcome the superimposition of structure.
- 2- image acquisition in cross-sectional or other planes.
- 3- Soft tissue imaging.
- 4- adjustment of radiographic contrast.

Disadvantages:

- 1- high cost.
- 2- high pt's dose.
- 3- metallic filling produce star artifacts.


Artifacts:

- 1- partial volume artifact at the junction of soft and hard tissue .
- 2- Beam –Hardening artifact .
- 3- Metal artifact.

CT – ADVANTAGES I

COMPARED WITH X-rays, U/S, & MRI

- Better Soft Tissue Contrast Resolution than XR & usually Ultrasound (except reproductive organs, in general)*
- Along with Fluoroscopy using Barium, CT best for Intestinal Tract Evaluation* (though not so “dynamic” as fluoro.)



Advantages

- Cross-sectional imaging
- Superior contrast and resolution
- Geometric accuracy
- Images can be manipulated
- Axial tomographic sections are obtainable
- Images can be enhanced by the use of i.v contrast media, providing additional information.

Examination :

Component of x-ray tube

Feature of x-ray

How the x-ray produced

**Enumerate radiation unit of x-ray
tube**