# التصوير الطبي

# *Medical Imaging*

## *LECTURE TWO*

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# *LECTURE Two*
# X-Ray

## 2.1 Introduction

In 1895, Wilhelm Roentgen, a German physicist, discovered radiation, which he called X-rays that could be used to look into the human body. This discovery heralded the medical uses of radiation, which have been expanding ever since. Roentgen was awarded the first Nobel Prize in physics in 1901.

Marie Curie shared the Nobel Prize in physics in 1903 with Pierre Curie and Henri Becquerel. She was the first woman to win the Nobel Prize a second time in 1911 for her discoveries in radiation chemistry.

The first use of X rays was in medical diagnosis, within six months of their discovery in 1895. So a benefit from the use of radiation was established very early on, but equally some of the potential dangers of radiation became apparent in the doctors and surgeons who unwittingly overexposed themselves to X rays

Dr. FORAT HAMZAH

in the early 1900s. Since then, many different applications of radiation and radioactive materials have been developed.

**Roentgen (1845–1923)**

**Marie Curie (1867–1934)**

**Henri Becquerel (1852–1908)**

## 2.2 Properties of X-Ray

There are many properties of x-ray such as;

(i) X-ray is a type of electromagnetic radiation with frequency of $10^{18}$ Hz and wavelength of $10^{-10}$ m (high frequency and very short wavelength).

(ii) X-ray has the ability to pass through liquids, solids, gases and many materials.

(iii) X-ray is traveling in a straight line.

(iv) X-ray is invisible to the eye.

Dr. FORAT HAMID

(v) Long x-ray exposure can be harmful to living organisms, and short exposure to x-rays is not harmful.

(vi) X-rays can be a very dangerous type of radiation because they have a high frequency and high energy.

(vii) When x-rays hit the material, electrons of this material will be ejected from the atom leaving behind a positive charge. For this reason, x-ray radiation is sometimes known as ionizing radiation.

## 2.3 Uses of X-Ray

X-ray beam is used in different field such as;

- **Medical image:** X-rays are used to view images of the different parts in the human body because that the X-rays penetrate different objects more or less according to their density
- **Radiation therapy:** X-rays play an important role in the fight cancer, with high energy radiation used to kill cancer cells.
- **Airport security:** x-ray security system that scans baggage to check for dangerous items and full body x-ray scans.

Dr FORAT HAMZAH

# 2.4 X-ray production (X-ray tube)

X-radiation is created by taking energy from electrons and converting it into photons. This energy conversion takes place within the **x-ray tube**. The quantity (exposure) and quality (spectrum) of the x-radiation produced can be controlled by adjusting the electrical quantities (KV, MA) and exposure time S, applied to the tube.

The **x-ray tube** is an electrical device used for generation of X-ray , which constant from many parts: a (i) glass tube, (ii) cathode, and (iii) anode. As the electrical current flows through the tube from cathode to anode, the electrons exposed an energy loss, which results in the generation of x-radiation. x-ray tube is an energy converter. It receives electrical energy and converts it into two other forms: x-radiation and heat. The heat is an undesirable by-product. X-ray tubes are designed and constructed to maximize x-ray production and to dissipate heat as rapidly as possible.

## (i) Glass Tube

- The X-ray tube evacuated consists of glass envelope containing an anode and cathode (Figure 3.1).
- The glass envelope is surrounded by oil to help with the electrical insulation and to absorb the heat.

Dr FORAT HAMZAH

- The X-ray tube has a small window close to the anode to allow X-rays to leave the tube in the required direction.

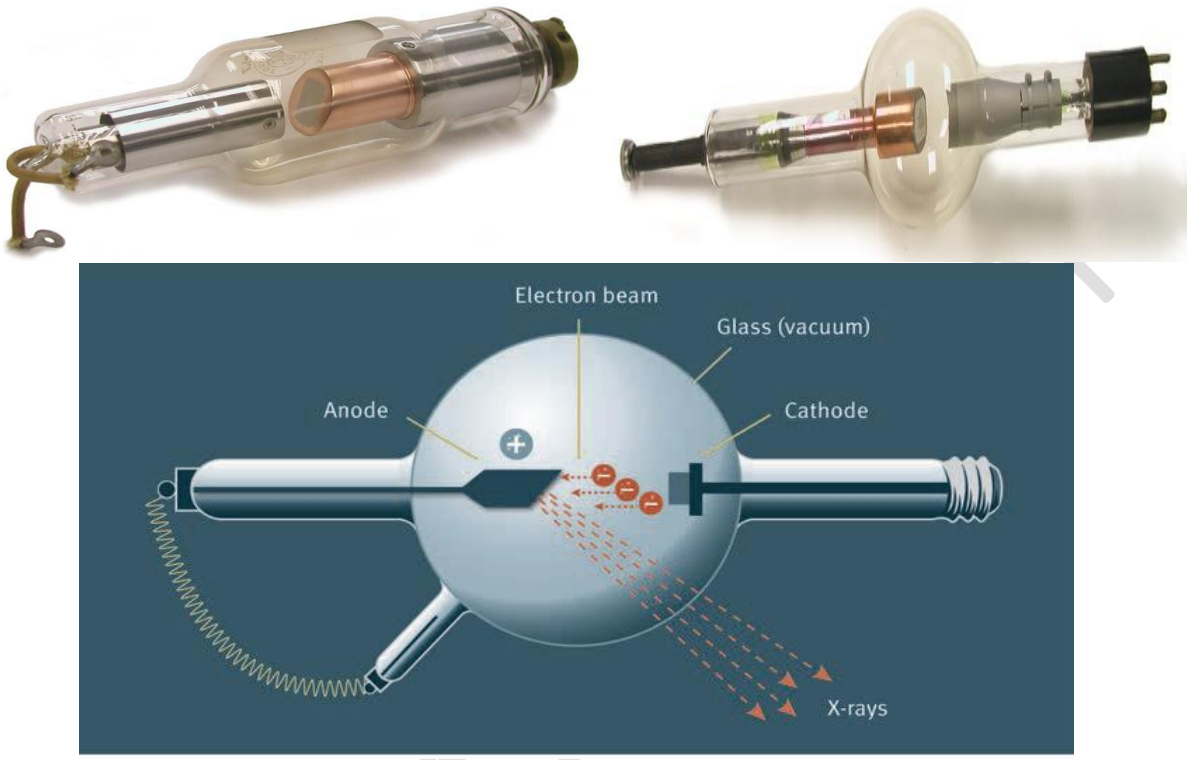



Figure 3.1:The X-Ray Tubes.

## (ii) Cathode

- The cathode of an X-ray tube contains a filament of tungsten wire (as found in the lamp). When the current passes through tungsten wire, the temperature rises until it reaches a certain temperature enabling the electrons of the tungsten wire to emit from its surface.

- Tungsten is used because it has a high and stable thermal emission, a high melting point (3410°C)

- Electrons are released from the surface of the filament (tungsten wire) by thermionic emission and are accelerated towards the anode

- The high voltage between the cathode and the anode helped accelerate the electrons to release strongly in the direction of the anode.

## (iii) Anode

- The anode is usually constructed from tungsten although molybdenum or rhodium is used for special applications where a low-energy X-ray beam is required.

- When the electrons interact with the anode of the X-ray tube, they slow down and stop. Most of the energy absorbed by the anode from the electrons appears in the form of heat and X-ray.

- Electrons emitted from the cathode are accelerated across the vacuum within the tube by an electric field and hit the anode (also called the target)

Therefore, X-rays are generated from the interaction of the high-energy electrons that come from the cathode and then absorbed by the anode through X-ray tube evacuated , according to the excited states of energy of an atom (LECTURE ONE- page 3-5).

Dr. FORAT HAMZAH

## 2.5 Types of radiography using X-rays

### (1) Radiography (Plain X-rays)

Plain X-rays are the (i) simplest medical images created using X-radiation, (ii) provides fast, (iii) high-resolution images (v) low-cost, and the most common plain X-rays are pictures of the chest and pictures of the arms, legs or spine in patients who have problems in the bones, joints or back.

Figure 3.2: Photograph of plain X-rays system.

### (2) Computed Tomography (CT)

(i) Computed tomography (CT) images of the body by using complex x-ray and computer, (ii) CT imaging systems generate cross-sectional image of internal body from a virtual images, (iii) CT scans can be performed on every region of the body for a different of reasons, and (iv) most CT scans are performed as outpatient procedures.

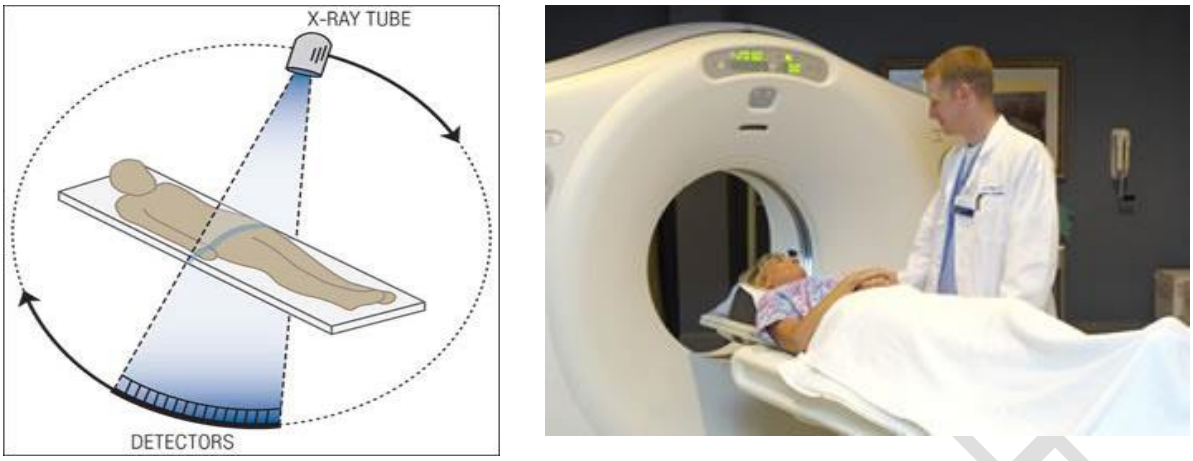



Figure 3.3: Schematic Diagram of an Computed Tomography (CT).

## (3) Fluoroscopy

Fluoroscopy is a type of medical imaging that produces a continuous live' X-ray image of the patient's internal structures on a monitor.

Figure 3.4: Photograph of fluoroscopy imaging and system .

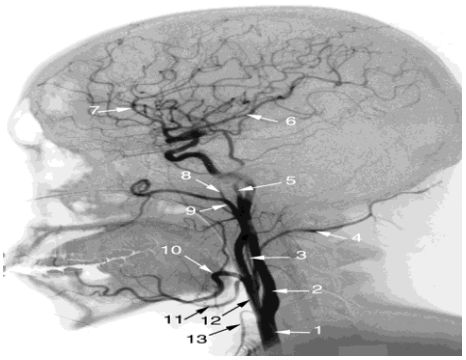
## (4) Mammography

Mammography is a special type of X-ray imaging used to create detailed images of the breast and is commonly used in screening for breast cancer.

Figure 3.5: Photograph of mammography imaging and system .

## (5) Angiography

Angiography is a specific type of X-ray technique for viewing blood vessels and organs, especially the heart, by injecting a contrast agent into the blood that enhances its visibility on the X-ray image.

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