

Radiation physics - 1

Lecture 1

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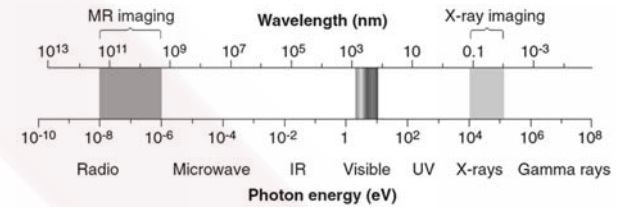
1

Radiation

Particulates

Electromagnetic

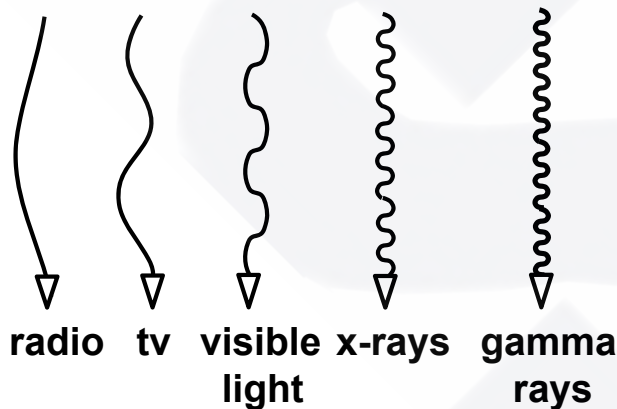
Alpha	α
Beta ⁺ (positron)	β^+
Beta ⁻ (electron)	β^-
Electron	e^-
Neutron	n^0
Proton	p



X-ray: 0.1 to 0.01 nm/ 10⁴-10⁵ ev.

2

Electromagnetic Spectrum



3

ENERGY

Ability to penetrate

Shorter wavelength, higher energy

Higher frequency, higher energy

$$f = c \cdot \lambda$$

4

X-ray Characteristics

- Travel in straight line
- Differentially absorbed
- Cause fluorescence
- Harmful to living tissue

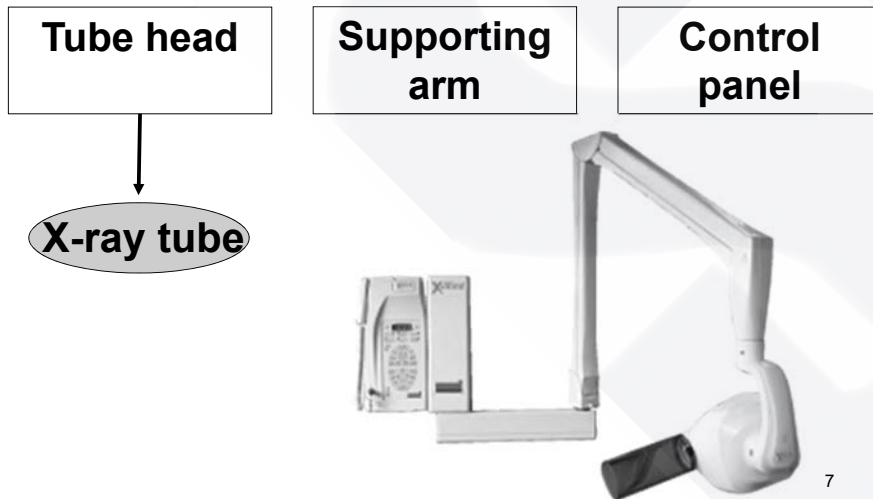
5

X-ray Characteristics

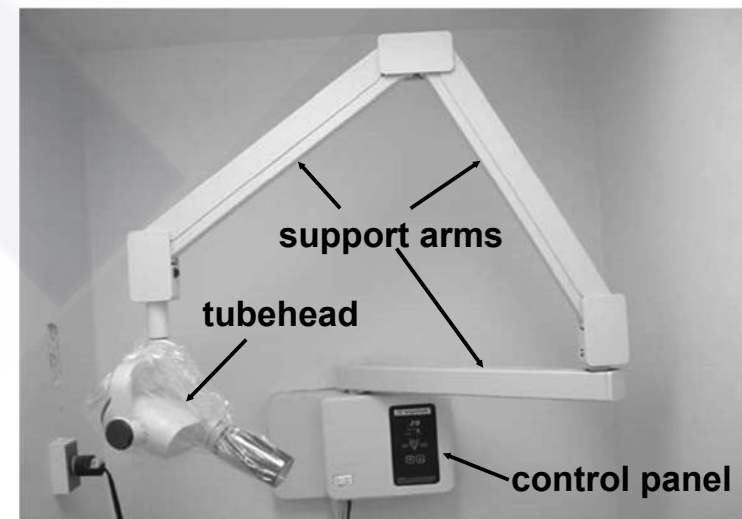
- High energy waves
- No charge (neutral)
- Travel at speed of light
- Invisible

6

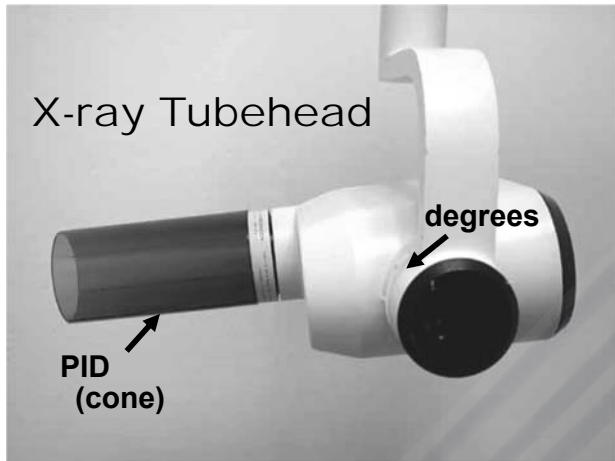
X-ray machine



7



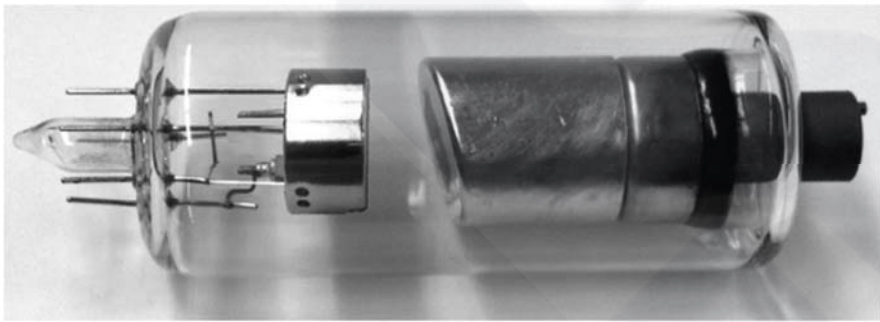
8



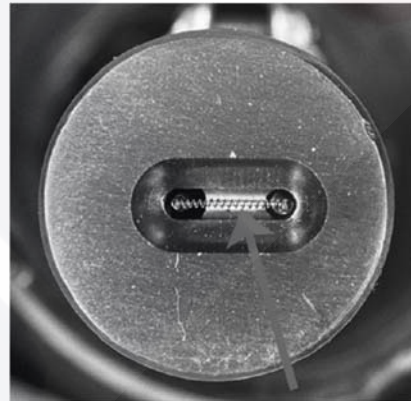
PID = position indicating device



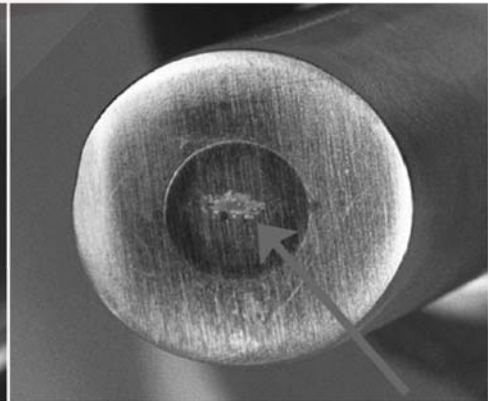
X-ray Tube



It is indicated within the tube head
?



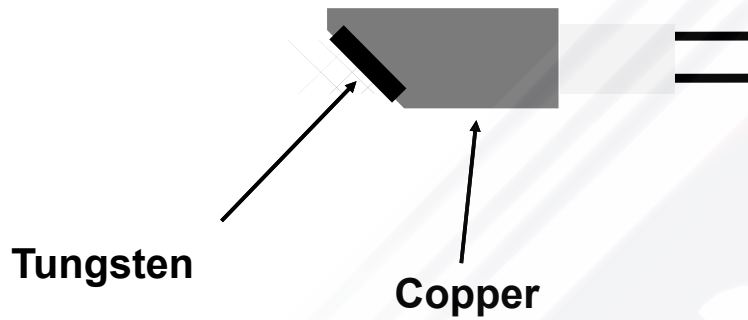
Cathode



Anode

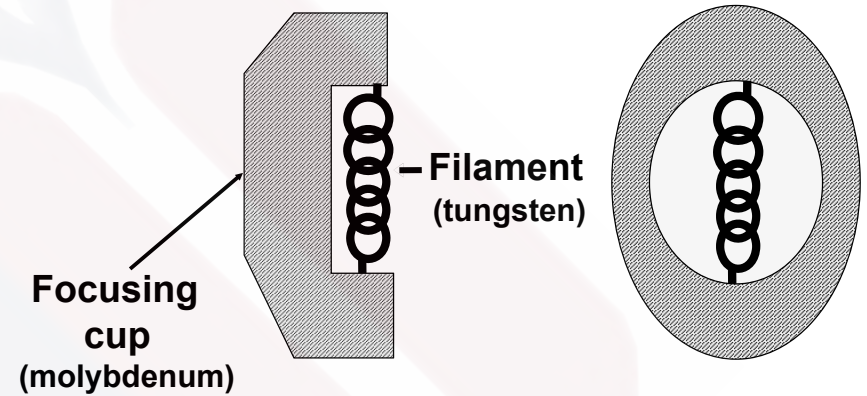
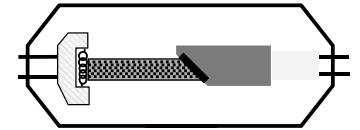
Focal spot

X-ray Tube

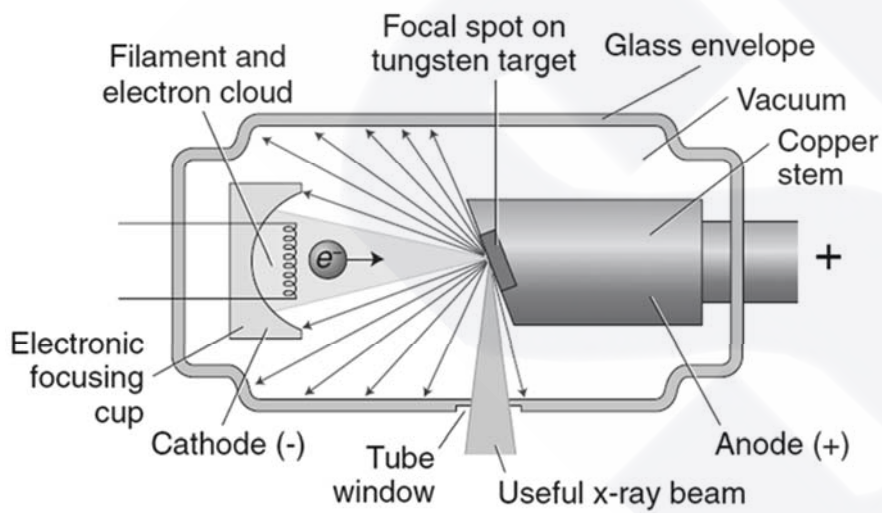


13

Cathode



14



X-ray is produced in all directions.

15

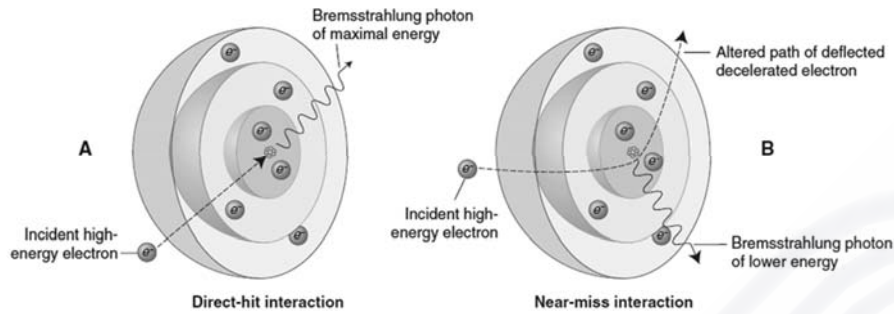
Most energy (more than 99%) as heat.

2 interactions between e⁻ with anode

Braking radiation (Bremsstrahlung)

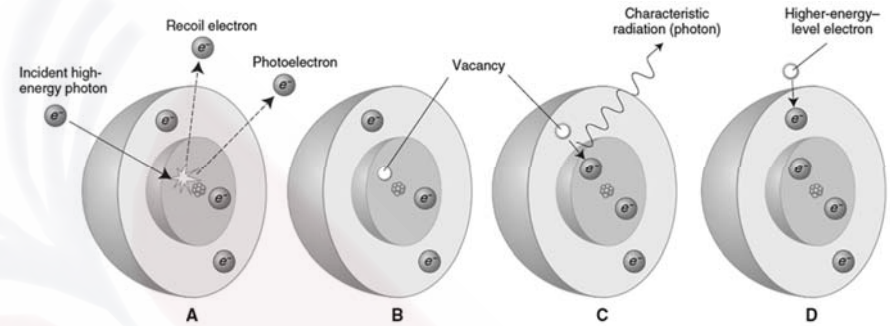
Characteristic radiation

16



Bremsstrahlung radiation is produced by the direct hit of an electron on a nucleus in the target (A) or, much more frequently, by the passage of an electron near a nucleus, which results in electrons being deflected and decelerated (B).

17



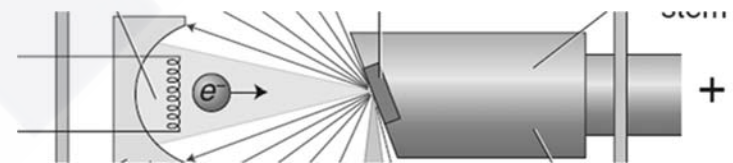
An incident electron (A) ejects an electron from an inner orbital creating a photoelectron, a recoil electron, and an electron vacancy (B). C, An electron from an outer orbital fills this vacancy, and a photon is emitted with energy equal to the difference in energy levels between the two orbitals. D, Electrons from various orbitals may be involved, giving rise to other characteristic photons. The energies of the photons released are characteristic of the target atom.

Why anode is made of tungsten?

- High atomic number (74).
- High melting point (3422°C).
- High thermal conductivity.
- Low vapor pressure at the working temperatures of an x-ray tube.

19

The target is placed at an angle to the electron beam.



WHY?

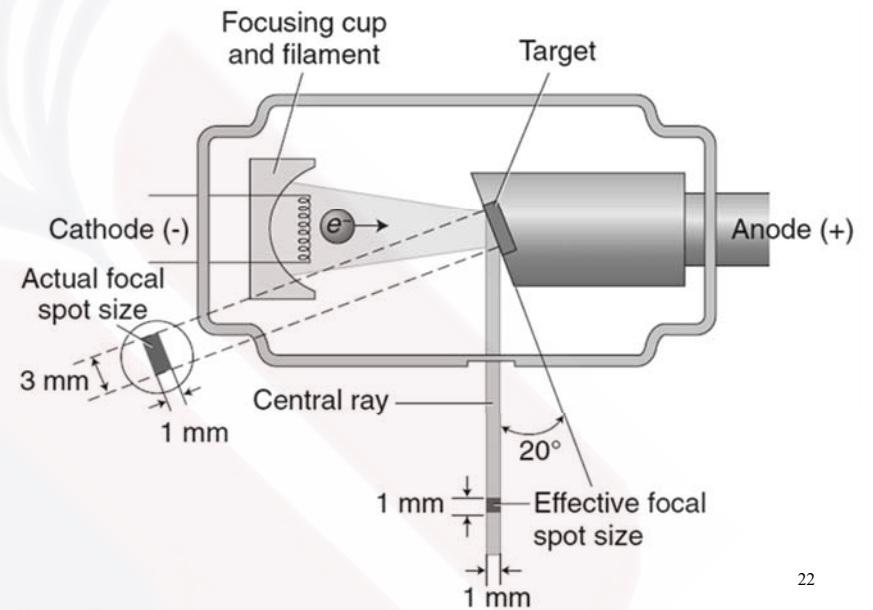
20

The target is placed at an angle to the electron beam

To take advantage of a small focal spot

while

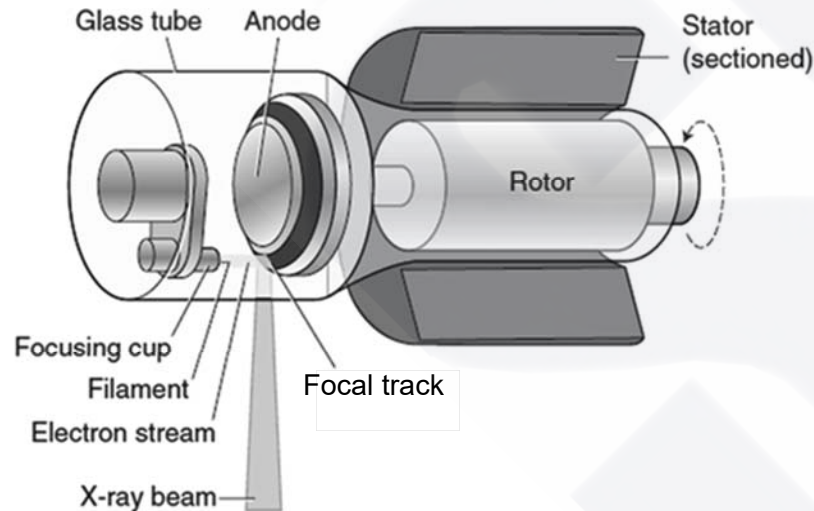
distributing the electrons over a larger area of the target.



* Will be discussed more in the up coming lectures.

21

22



Control Panel



Dental x-ray machines have stationary anode

24

Control Panel

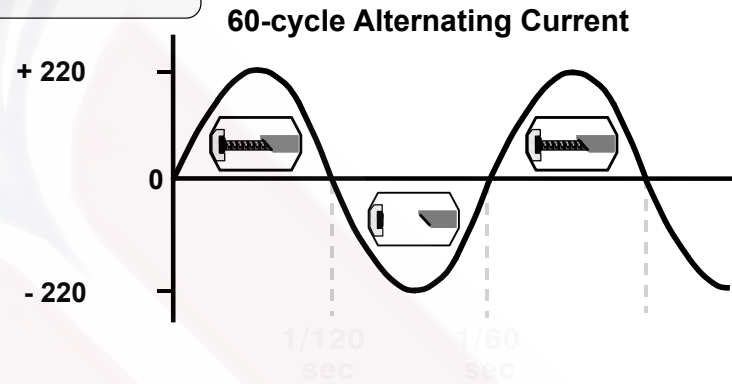
Exposure switch

Timer

mA selector

kV selector

DC / AC

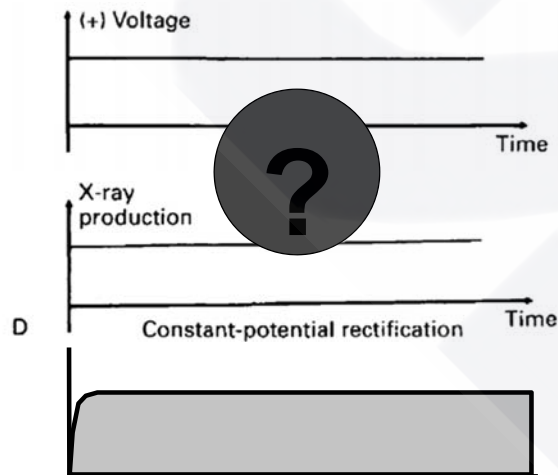


25

26

DC / AC

Direct Current (Constant Potential): 800 cycles/sec.



27

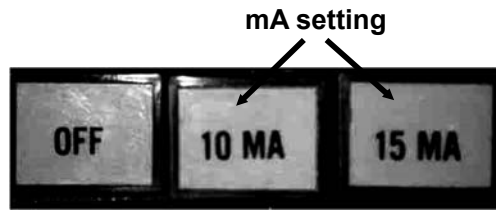
Exposure time

Tooth

Child / adult

Recommended time by the manufacturer

28



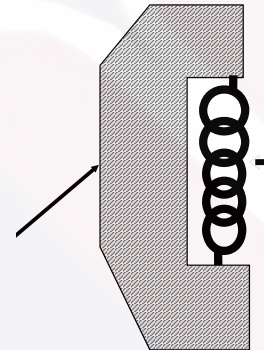
4 or 8

milliAmpere (mA) selector
(Filament current)

29

Step-Down Transformer

220 volt → 10 volts



Filament
Circuit

30

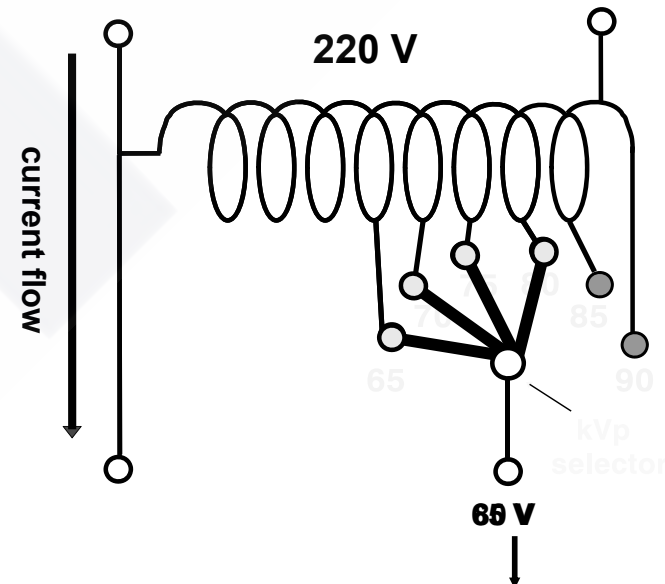
kiloVolt peak (kVp) selector



60 or 70 KV

31

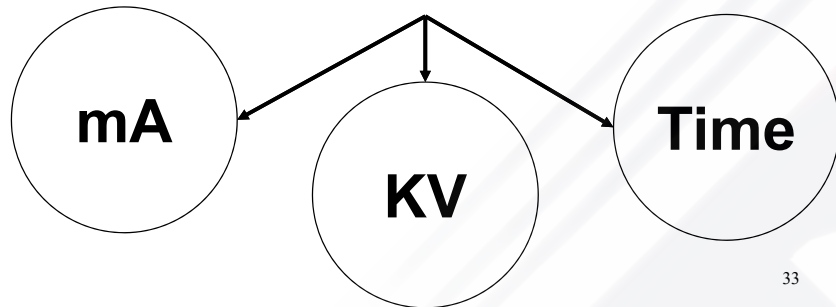
Autotransformer



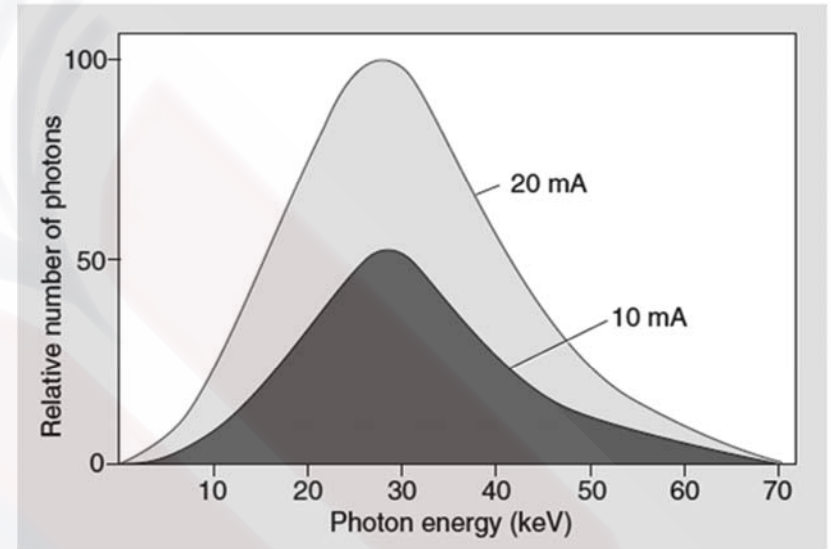
32

Quantity of radiation (Beam intensity)

The number of photons in the X-ray beam.

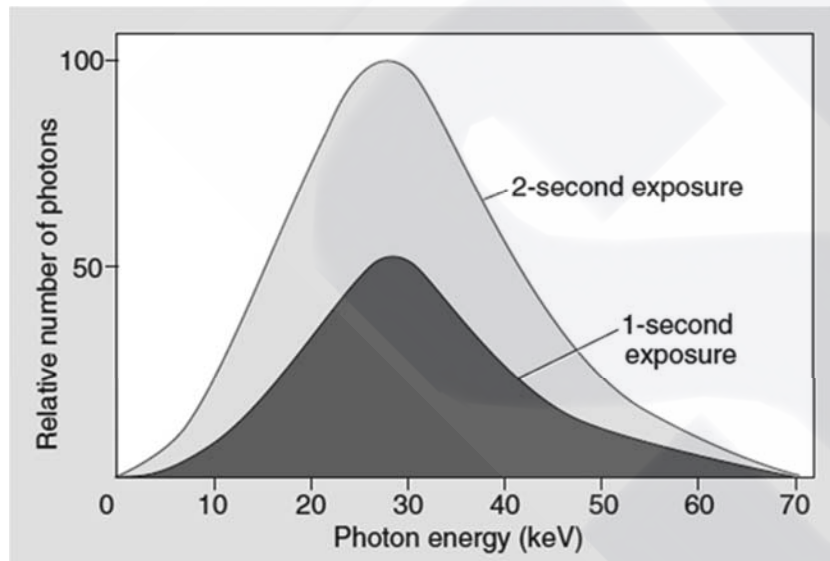


33



Increasing mA increases the amount of photons.

34



Increasing exposure time increases the amount of photons.

35

The quantity of radiation produced is proportional to the product of time and tube current.

$$\begin{aligned} & \mathbf{10 \text{ mA for } 0.5 \text{ second}} \\ & \mathbf{=} \\ & \mathbf{5 \text{ mA for } 1 \text{ second}} \end{aligned}$$

36

Beam Energy

Is controlled by KV.

↑ **KV** →

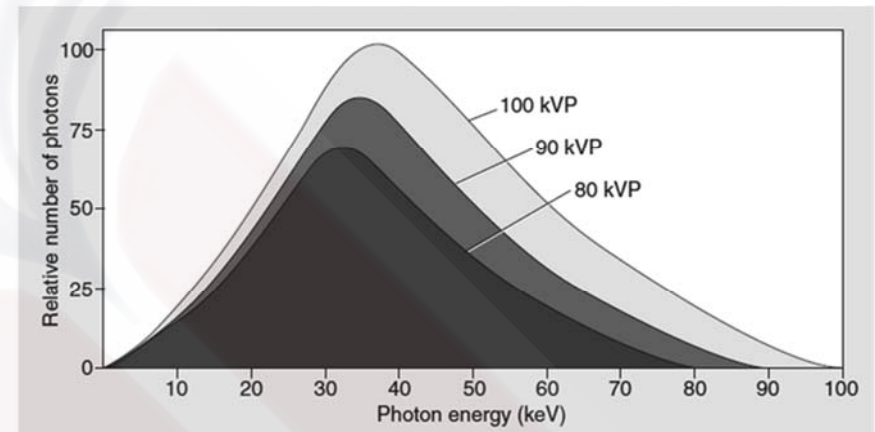
- 1- Number of photons
- 2- Energy of the photons.

37

Supporting arm

**Require tightening
from time to time.**

39



Increasing KV increases the amount of photons & their energy.

38

**THE
END**

40