Radiation physics-Theoretical

Lec.6:

Factors affecting X-ray beam quality and quantity

Asst.Lec.Dumoaa Haider Shakir

Quality

- **The quality of an x-ray beam** refers to its ability to penetrate matter. A highly penetrating x-ray beam consists of photons which ,on the average, have high energy, high frequency, and shorter wavelength.
- **Quality** refers to the overall energy of the beam. As the X-ray beam is polyenergetic, any factors that increase or decrease the average energy of photons in the beam affect x-ray beam quality.
- **Wavelength of x-rays range 0.01 to 10 nm**

Factors affecting X-ray beam quality

Quality Is Directly Affected By,

- Changes in kVp
- Changes in the material(atomic number Z) of the target material.
- Changes in the filtration.
- The type of waveform used

Quantity

- **The quantity of radiation in an X-ray beam is a measure of the number of photons in the beam.**

As the number of photons increases, the beam intensity increases & any factors that affect the number of x-ray photons in the beam influence x-ray beam quantity.

Factors affecting X-ray beam quantity

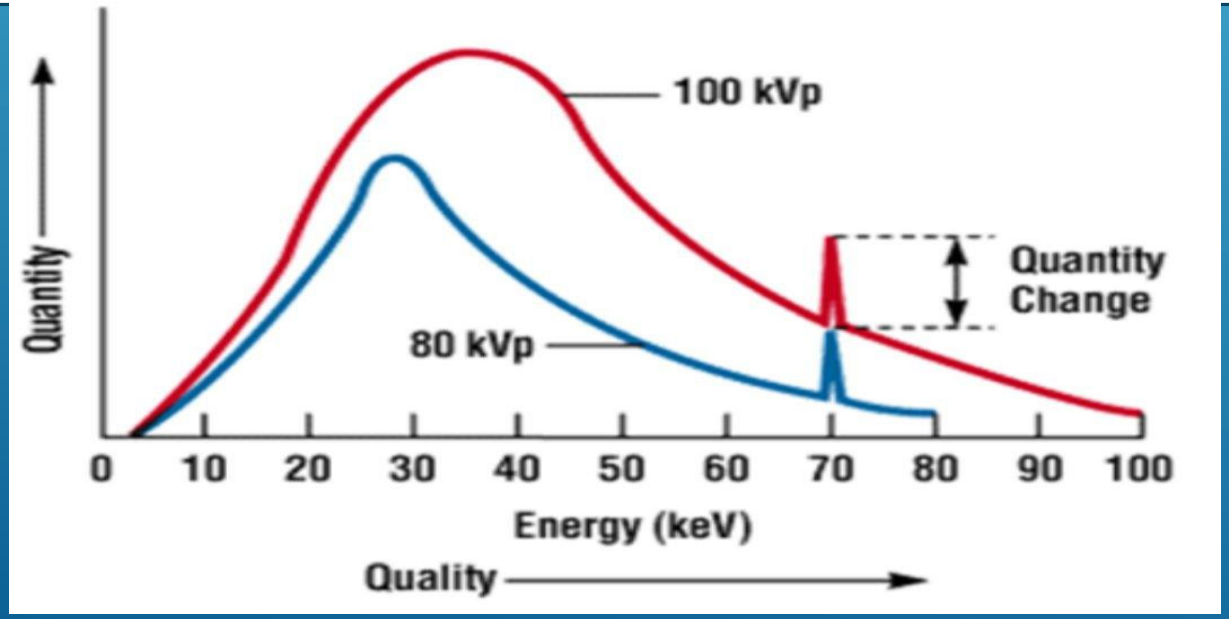
Quantity is affected by,

- **Changes in mA (tube current).**
- **Changes in the filtration..**
- **Changes in the material (Z number) of target.**
- **Changes in kVp**
- **Changes in type of waveform used.**
- **Changes in distance from the tube .**

Effects of changes in kVp:

Peak kilo voltage (kVp) is the maximum voltage applied across an X-ray tube, it determines the kinetic energy of the electrons accelerated in the X-ray tube and the peak energy of the X-ray spectrum.

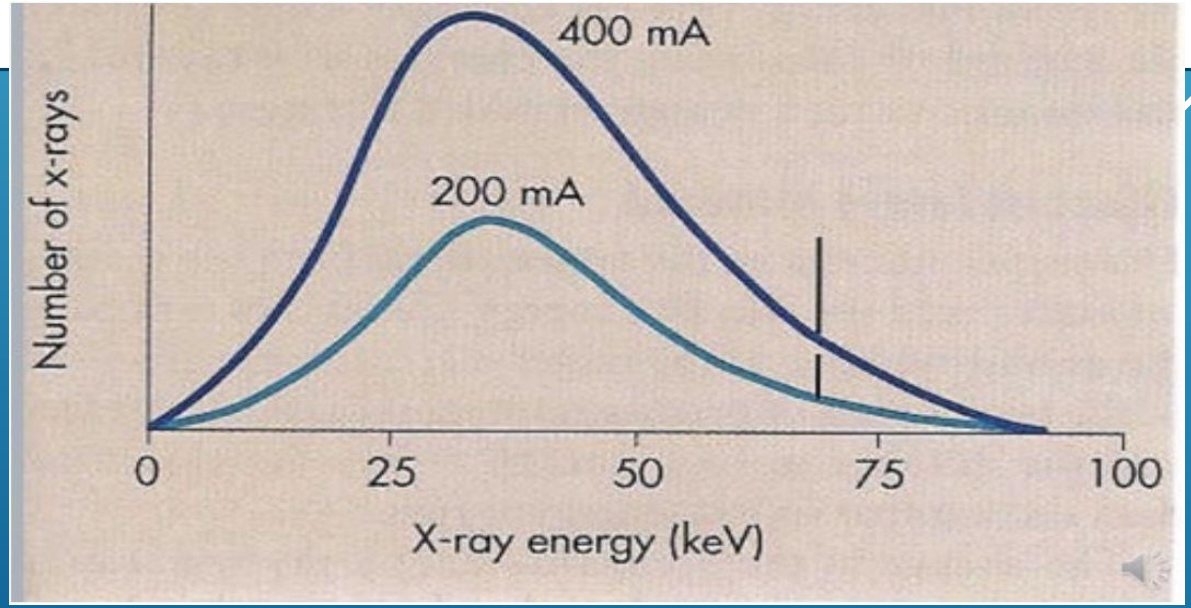
An increase in kVp increases the efficiency of x-ray production and the quantity and quality of the x-ray beam.



Effect of changes in mA

Tube current (mA) is the rate of electron flow from filament to target (electron/sec) and measured in miliamperes.

The relationship between the mA and number of photons produced **directly** affects the amplitude of the x-ray emission spectrum.
Changes in mA do not affect quality.

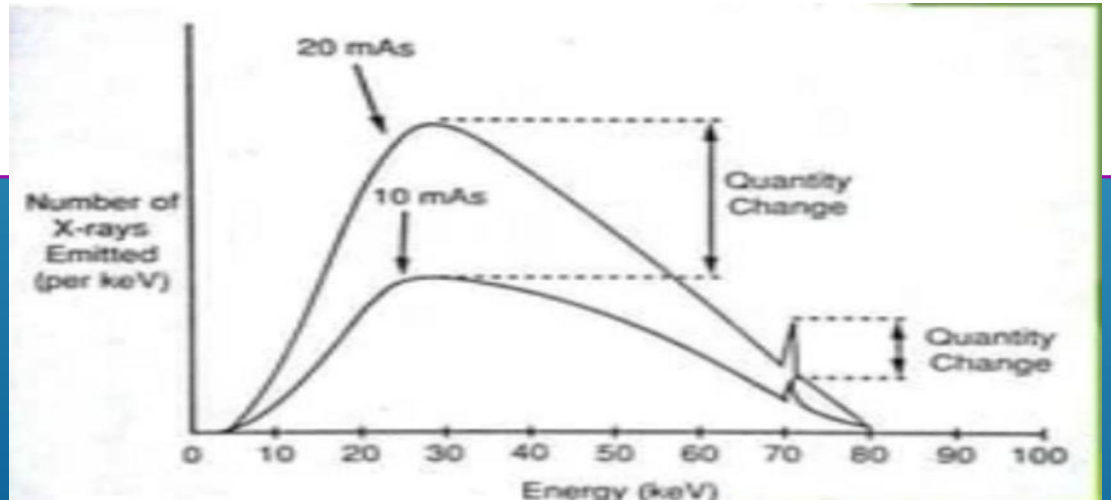


Effects of changes in mAs

The exposure is the duration of x-ray production. The quantity of x-rays is directly proportional to the product of tube current and exposure time (mAs).

Hence as mAs is increased the number of electrons striking the target increases, the more electrons hit the target, the more x-ray are produced in both complete &discrete portions of x-ray spectrum.

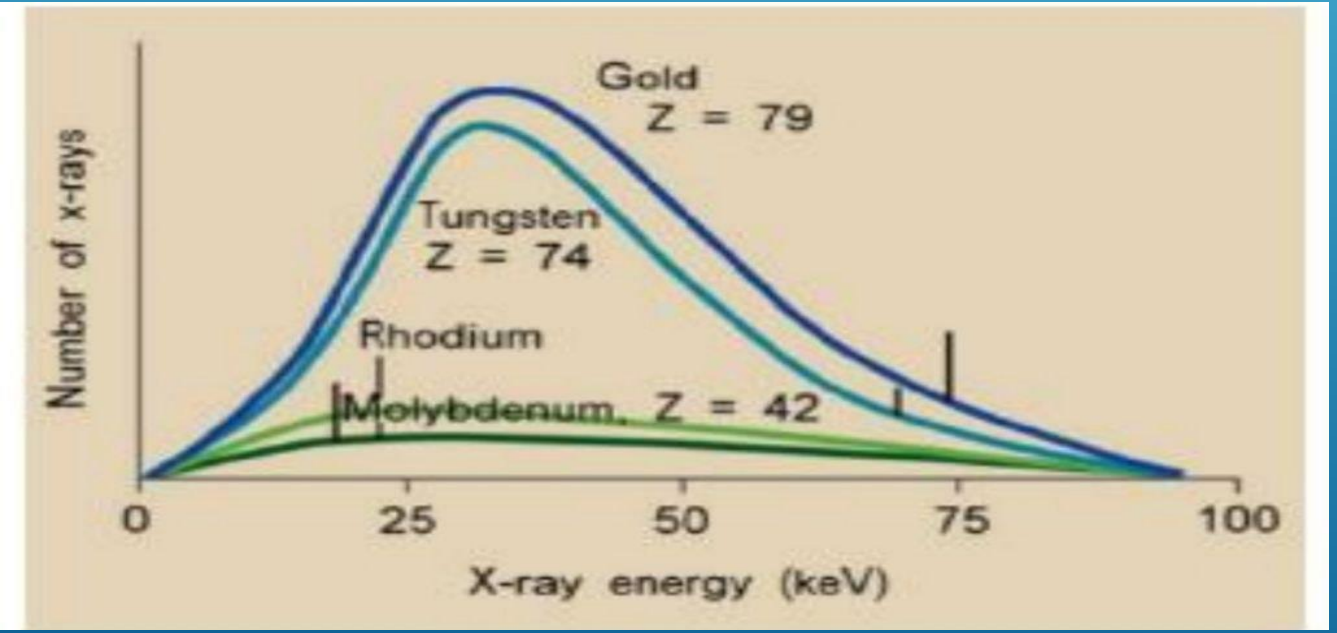
Changes in mAs do not affect quality.



Effect Of Changes In The Target A Materials:

The target (anode) material affects the efficiency of Bremsstrahlung radiation production, without put exposure roughly proportional to atomic number.

As the Z number of target increases the amount of Bremsstrahlung radiation produced also increases.



Effects of changes in added filtration

Added filtration consists of addition Al filters placed in the path of emerging beam to absorb low-energy photons results in **reduced x ray quantity but increased in quality** (as these low energy photons contribute radiation dose only to the patient) .

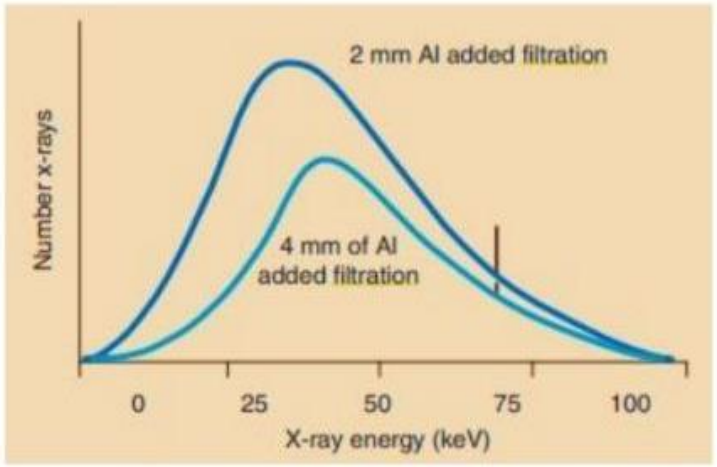
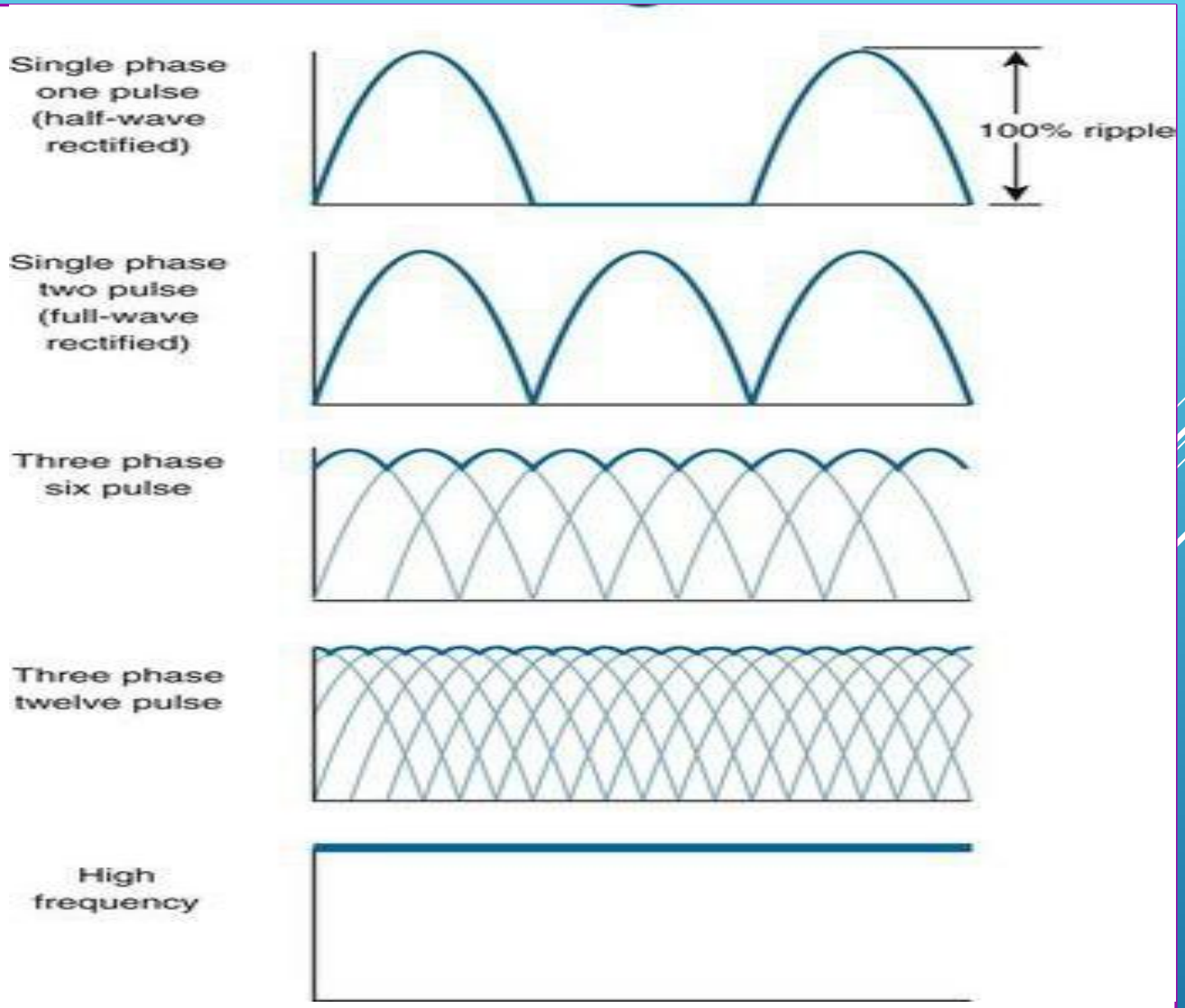


Figure 1:Adding filtration to an x-ray tube results in reduced x-ray intensity but increased effective energy.

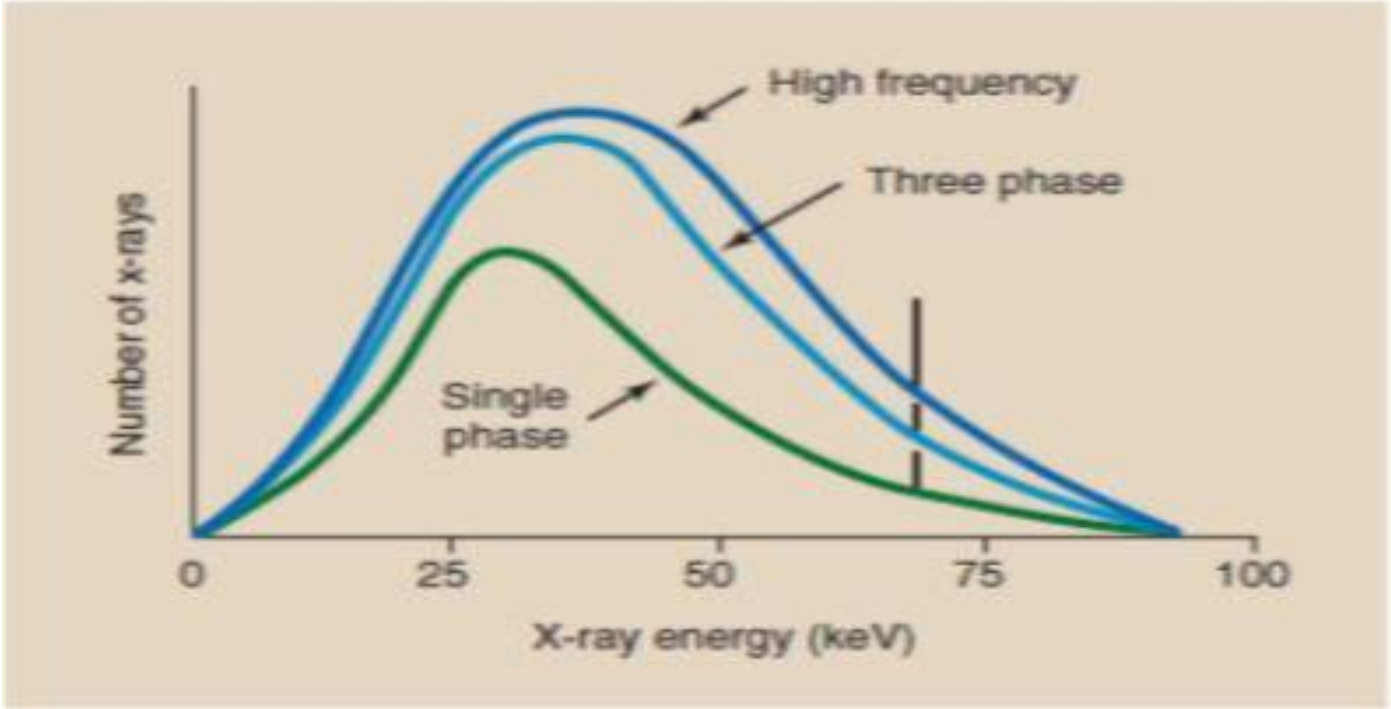
Effect Of Ripple Voltage Waveform

There are five voltage waveforms:

- **half-wave-rectified,**
- **full wave-rectified,**
- **three-phase/six-pulse**
- **three-phase/12-pulse**
- **high-frequency waveforms**



Both quantity and quality decrease by ripple. Because of reduced ripple, operation with three-phase power or high frequency is equivalent to an approximate 12% Increase in kVp, or almost a doubling of mAs over single phase power.



Effect of increasing	X-ray quantity	X-ray quality
KVp	Increased	Increased
mA, mAs	Increased	None
Target material	Increased	Increased
Added filtration	Reduced	Increased
Ripple voltage	Reduced	Reduced
distance	Reduced	none