



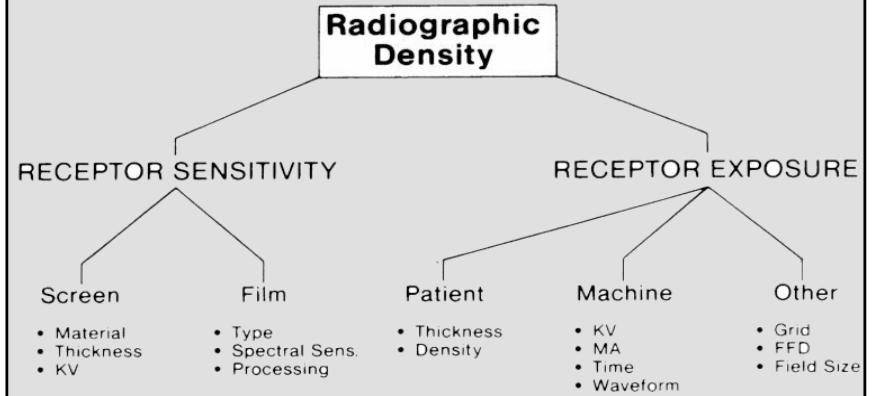
Radiographic Density Control



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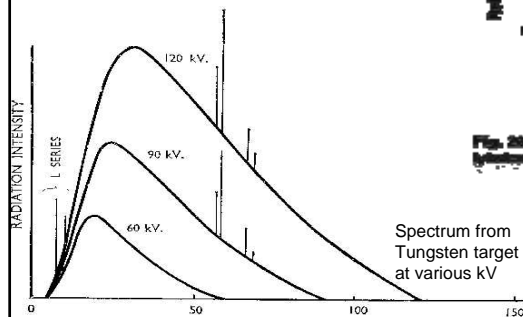
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What influences Radiographic Density?



Factors influencing the X-ray spectrum

- kV (accelerating *anode* voltage)
- Filtration material
- Target material
- mA (tube *anode* current) or mAs
- kV Rectification (type of generator)



Spectrum from Tungsten target at various kV

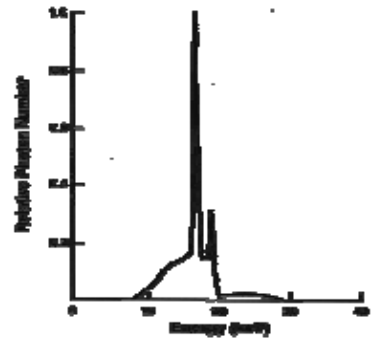


Fig. 20-6. X-ray emission spectrum for a tungsten target at 30 kVp.

Images from Johns and Cunningham "The Physics of Radiology"

Exposure Kilovolts (kVp)

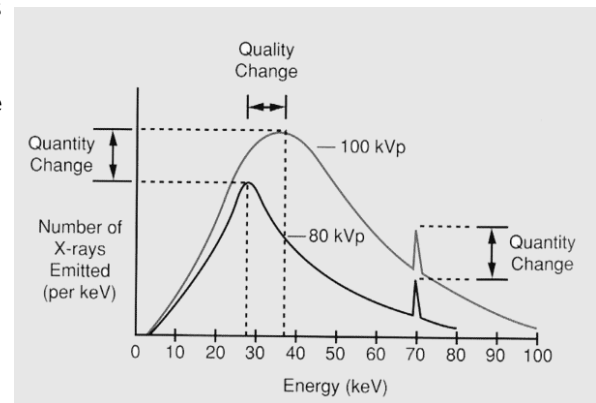
X-ray spectrum – quality and quantity change

Change of kV leads to change of X-ray energy, Anode effectiveness, Dose and spectrum

$$X \sim Z \cdot kV^2 \cdot mAs$$

$$\eta \sim Z \cdot U_a$$

Photographic analogue: none



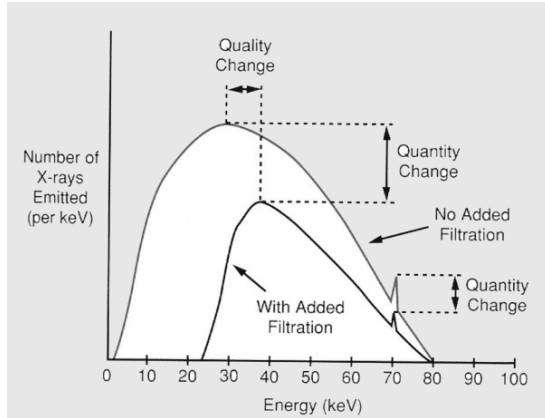
Effective increase of kV, but with decrease of Dose.

Soft energy quanta increase the contrast (mammography use), but also increase the patient absorbed dose.

$$Al \uparrow = C \downarrow$$

Added Filtration (Al) influence

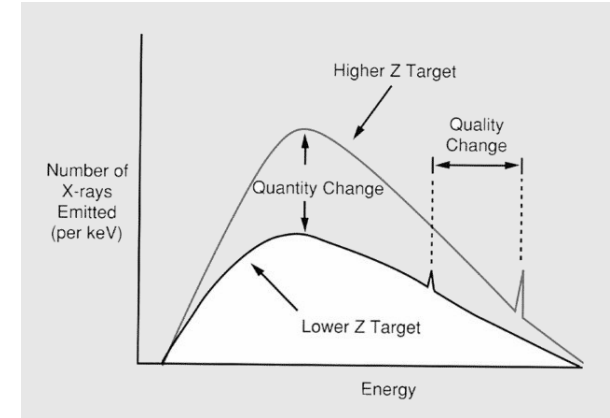
X-ray spectrum – quality and quantity change



Type of Anode material influence

X-ray spectrum – quality and quantity change

The X-ray anode efficiency
 $\eta \sim Z \cdot U_a$



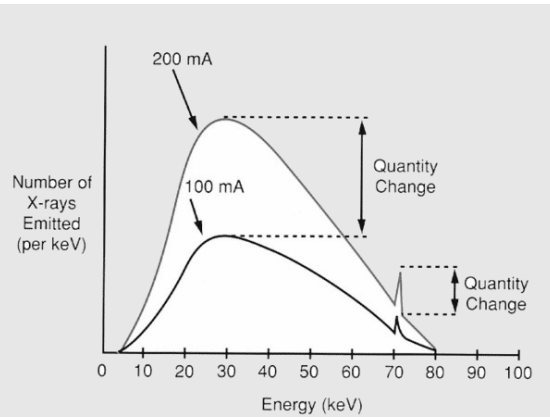
Exposure milli Amperes (mA)

X-ray spectrum – quantity change

Change of mA leads to change of X-ray intensity (with no spectrum change)

Energy in a single exposure
 $X \sim Z \cdot kV^2 \cdot mAs$

Photographic analogue:
 -speed



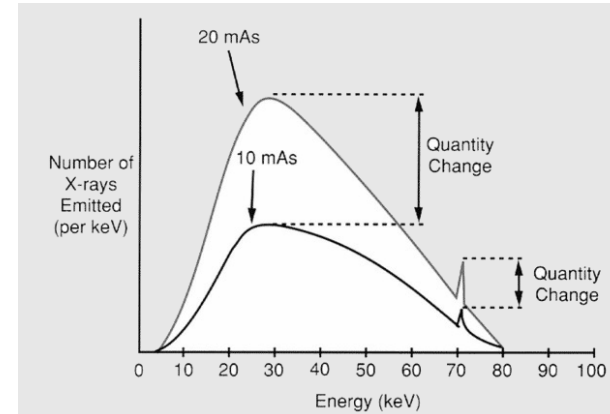
Exposure Time (mAs)

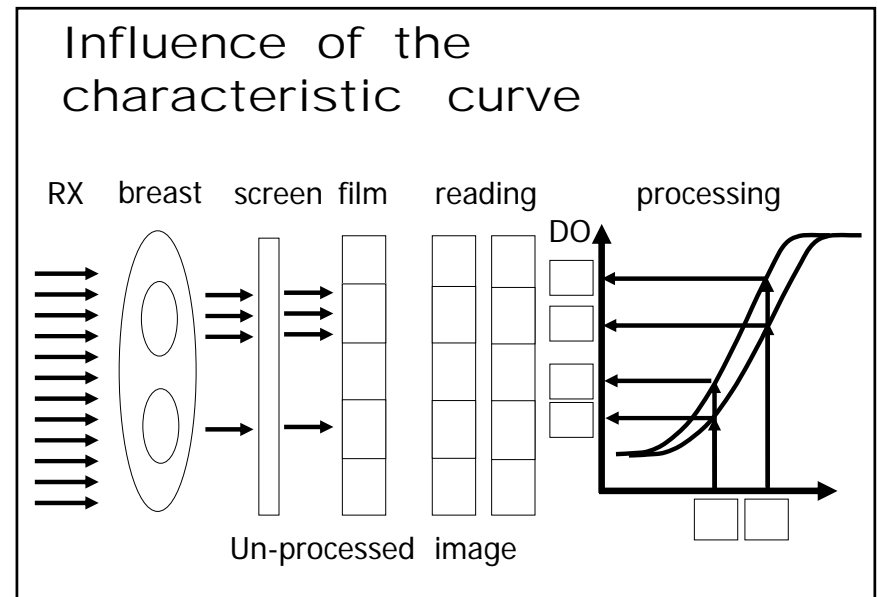
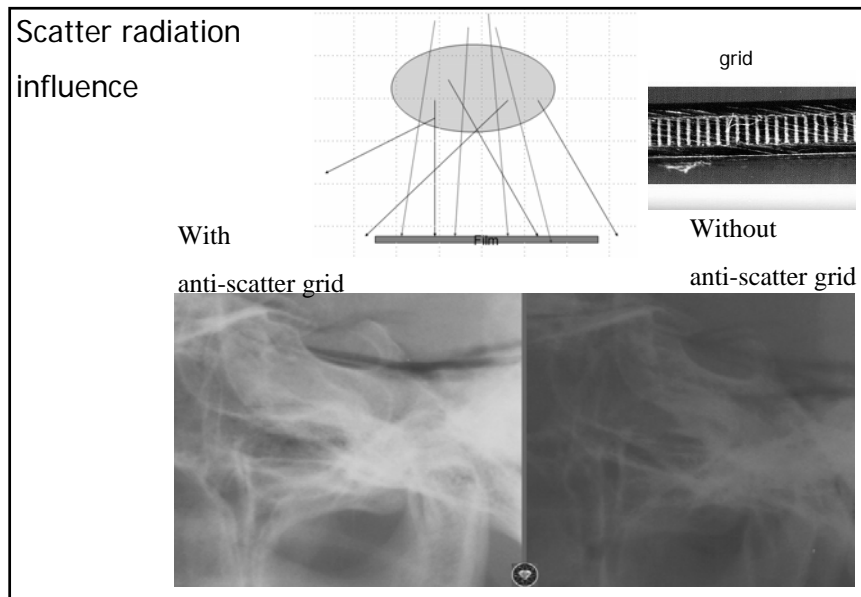
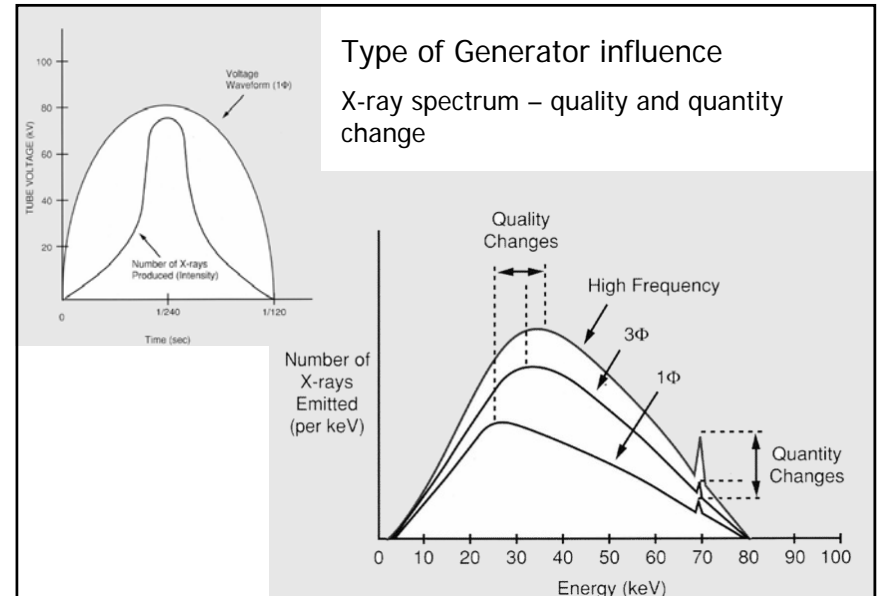
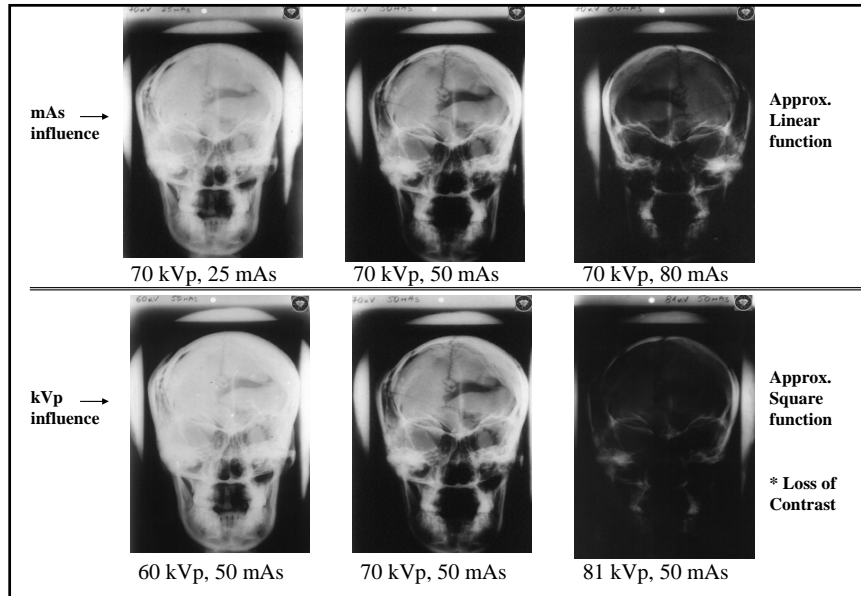
X-ray spectrum – quantity change

Change of mAs (msec) leads to change of X-ray intensity (with no spectrum change)

Energy in a single exposure
 $X \sim Z \cdot kV^2 \cdot mAs$

Photographic analogue:
 -exposure time



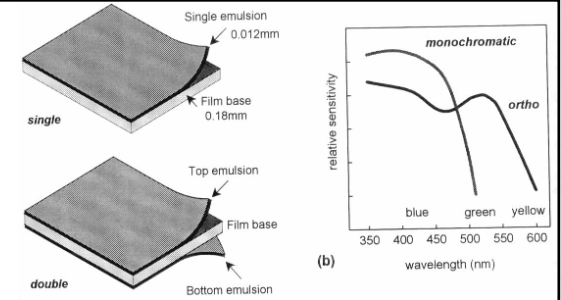


X-ray film processing influence – temperature of the developer

27 C

33 C

36 C



Influence of:

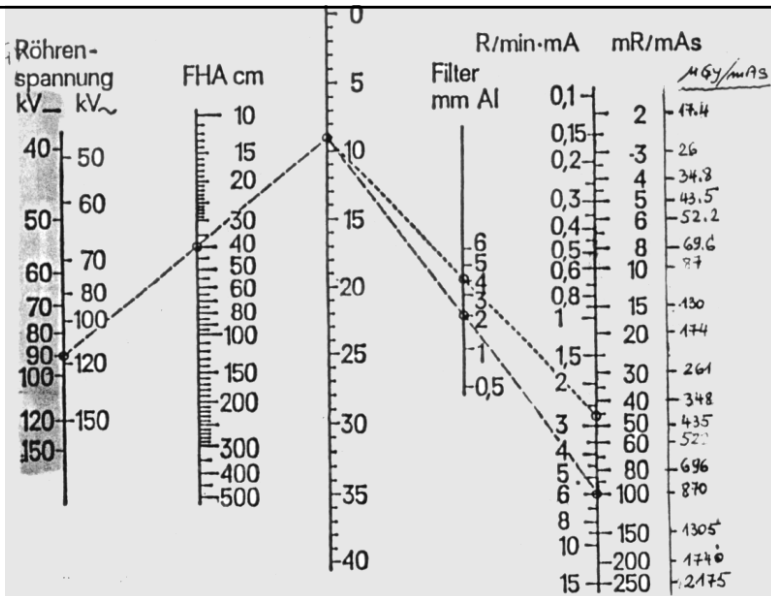
- Material of the screen
- Thickness of the screen
- Energy Sensitivity of the screen

$$I_x = I_o \cdot e^{-(\mu \cdot d)}$$

- Patient (tissue composition and thickness ($\mu \cdot d$))



Radiographic Table ~ 1960



Digital Imaging Density control:

- Optical Density is less influenced due to very large dynamic, but still depends on:
- All X-ray spectrum parameters
- Window technique
- Image processing

