

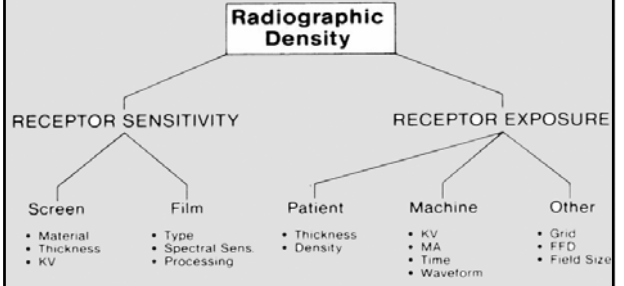


# Radiographic Density Control



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## What influences Radiographic Density ?



## Exposure Kilovolts (kVp)

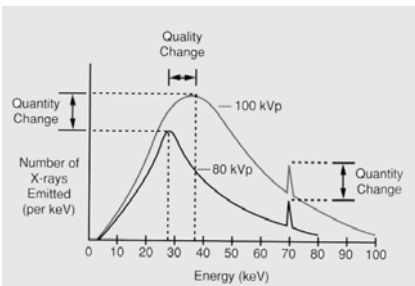
X-ray spectrum – quality and quantity change

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

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

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

Photographic analogue: none



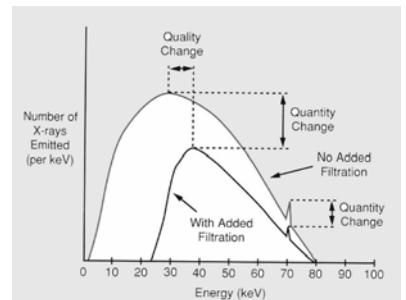
Effective increase of kV, but with decrease of Dose.

## Added Filtration (Al) influence

X-ray spectrum – quality and quantity change

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

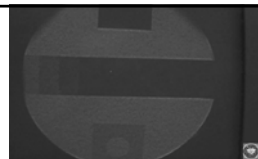
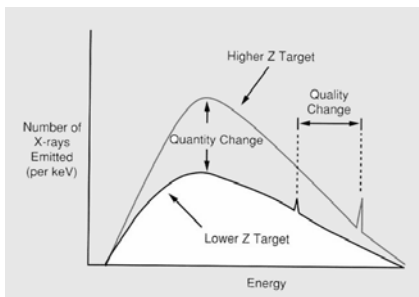
$$Al \uparrow = C \downarrow$$



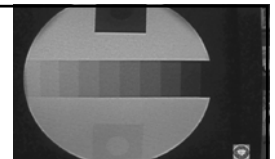
## Type of Anode material influence

X-ray spectrum – quality and quantity change

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



60 kV

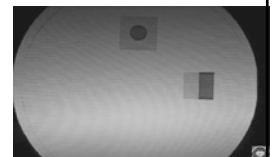
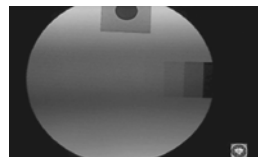


70 kV

## II contrast with different kV (constant mA)

90 kV

100 kV

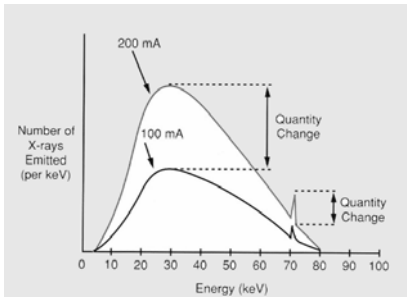


### Exposure milli Ampers (mA) X-ray spectrum – quantity change

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

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

Photographic analogue:  
-speed

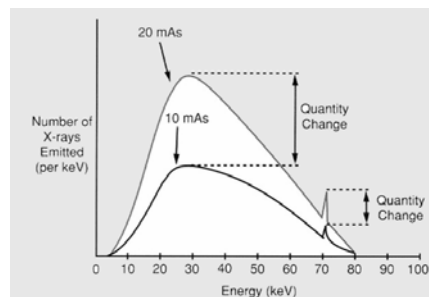


### Exposure Time (mAs) X-ray spectrum – quantity change

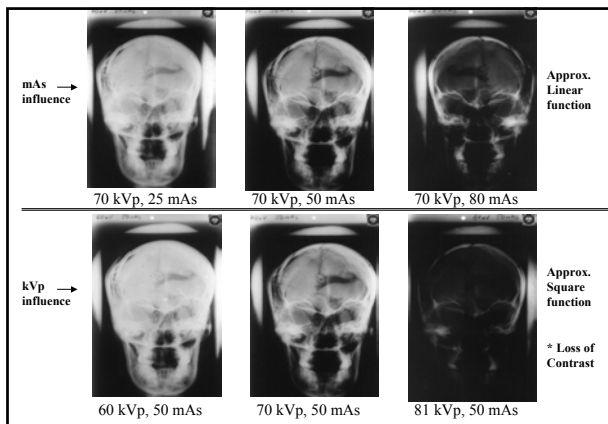
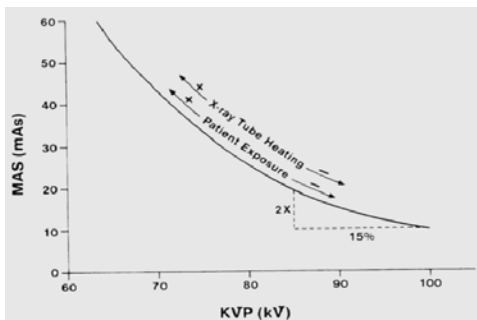
Change of mAs (msec) leads to change of X-ray intensity (with no spectrum change)

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

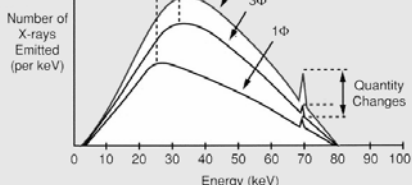
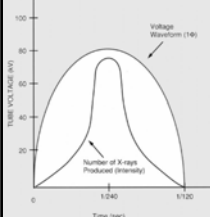
Photographic analogue:  
-exposure time



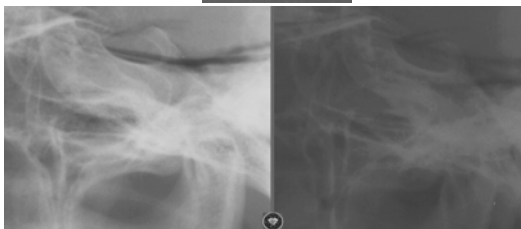
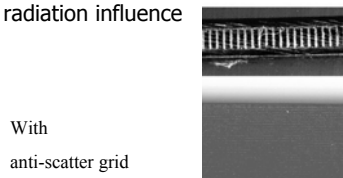
### Integral influence of kV and mAs X-ray spectrum – quantity and quality change



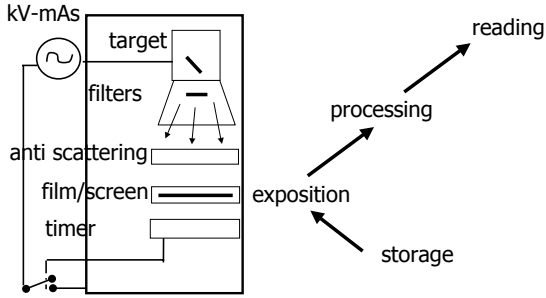
### Type of Generator influence X-ray spectrum – quality and quantity change



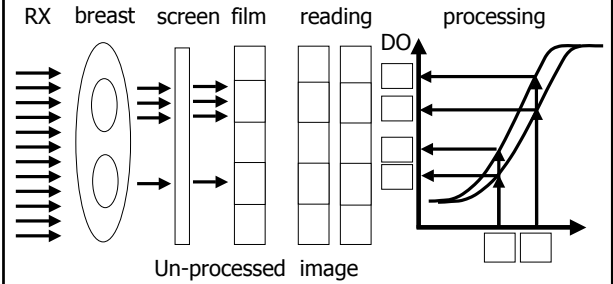
### Scatter radiation influence



### X-ray Film Type influence



### Influence of the characteristic curve



### X-ray film processing influence – temperature of the developer

27 C

33 C

36 C

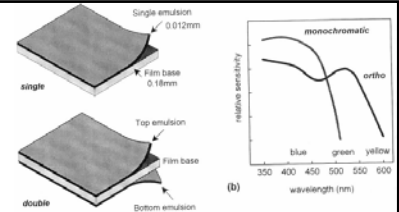


### Influence of:

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

$$I_x = I_0 \cdot e^{-(\mu \cdot d)}$$

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



Radiographic Table ~1960

