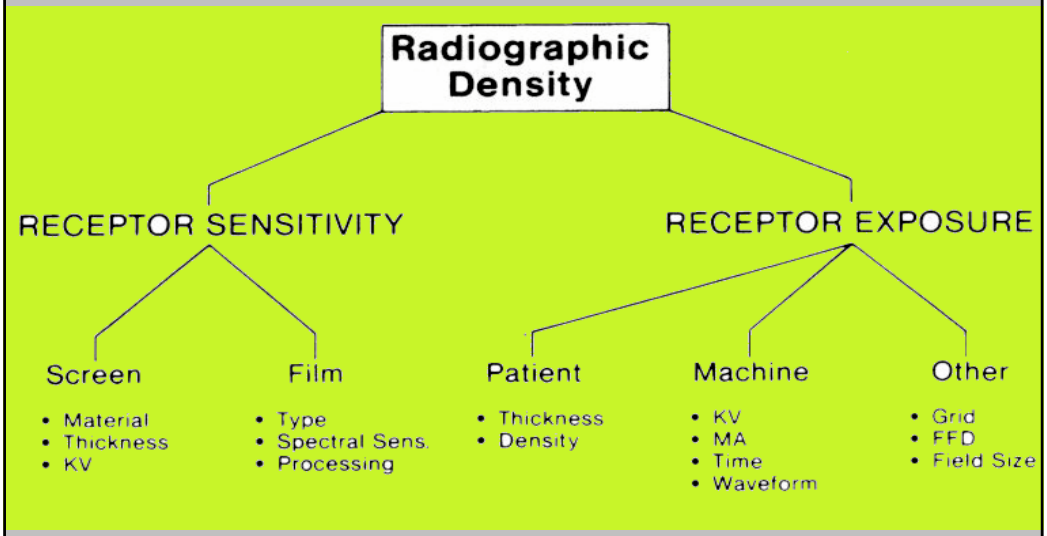
Radiographic Density Control

Dr Slavik Tabakov, FIPEM,

Dept. Medical Eng. and Physics, King's College London, UK
slavik.tabakov@kcl.ac.uk

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

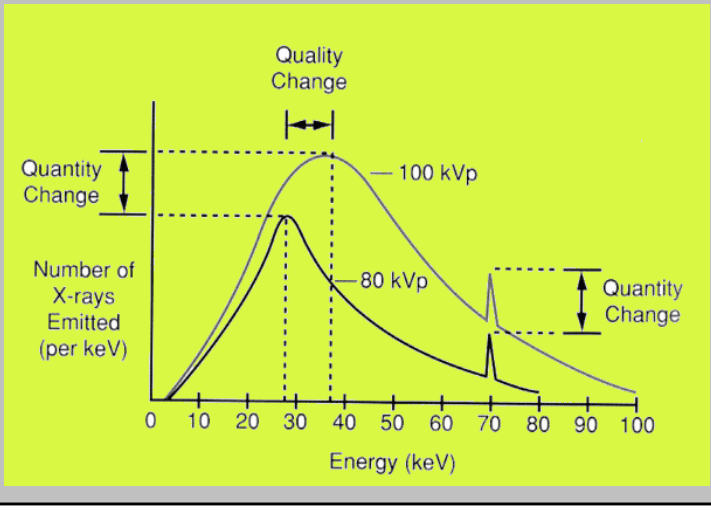
Energy in a single exposure

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

The X-ray anode efficiency

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

Photographic analogue: none



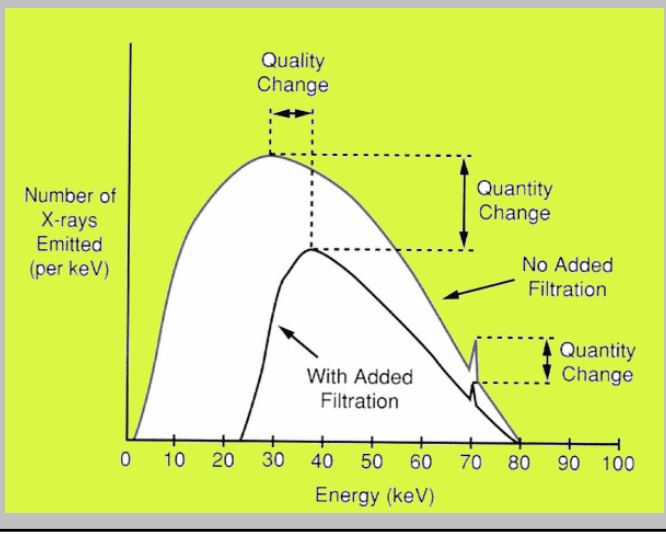
Added Filtration (Al) influence

X-ray spectrum – quality and quantity change

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↑ = C↓

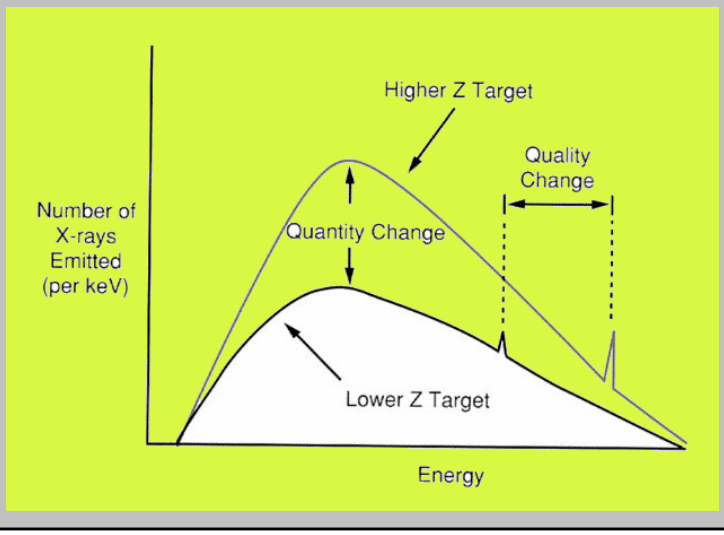


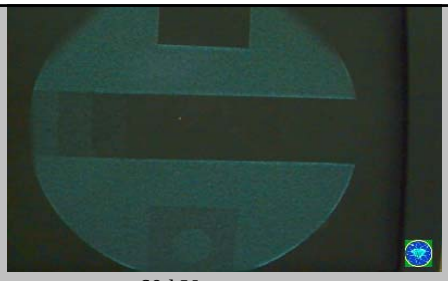
Type of Anode material influence

X-ray spectrum – quality and quantity change

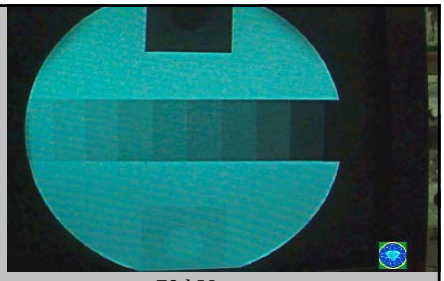
The X-ray anode efficiency

$$\eta \sim Z.U_a$$





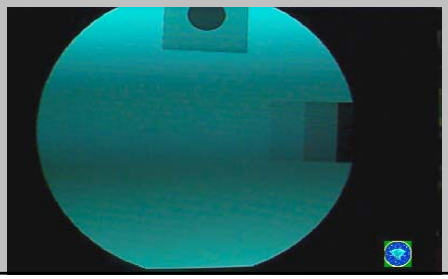
60 kV



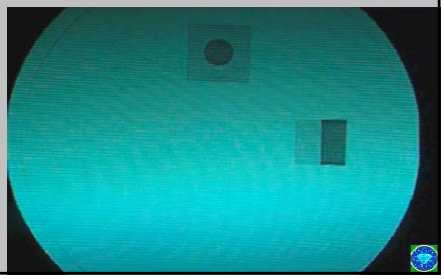
70 kV

II contrast with different kV (constant mA)

90 kV



100 kV



Exposure milli Ampers (mA)

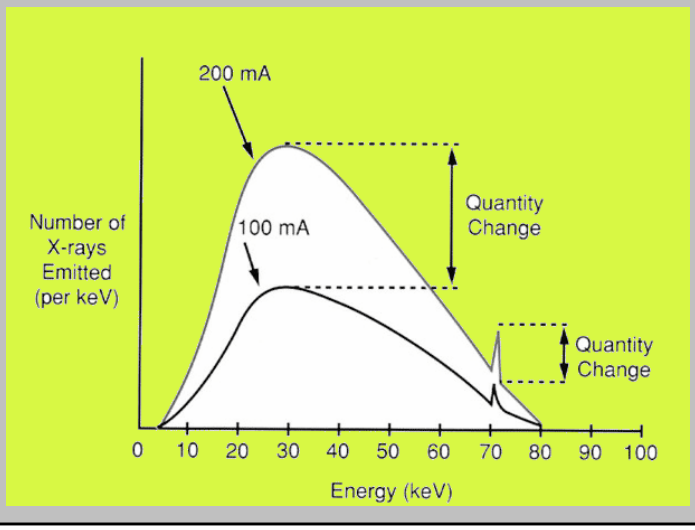
X-ray spectrum – quantity change

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

Energy in a single exposure

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

Photographic analogue:
-speed



Exposure Time (mAs)

X-ray spectrum – quantity change

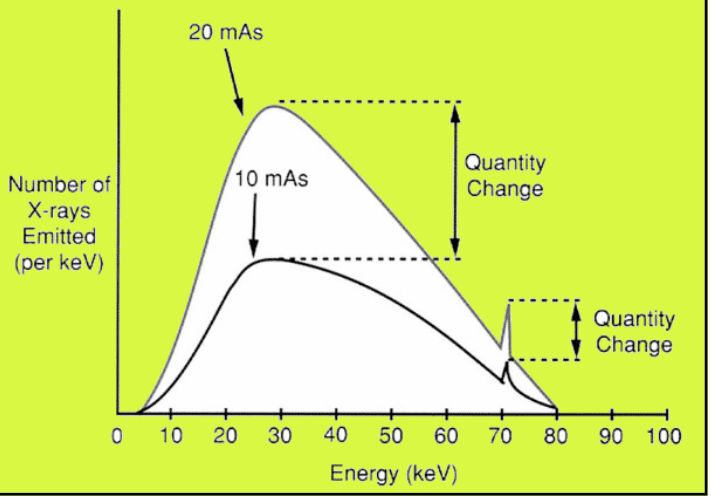
Change of mAs (msec) leads to change of X-ray intensity (with no spectrum change)

Energy in a single exposure

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

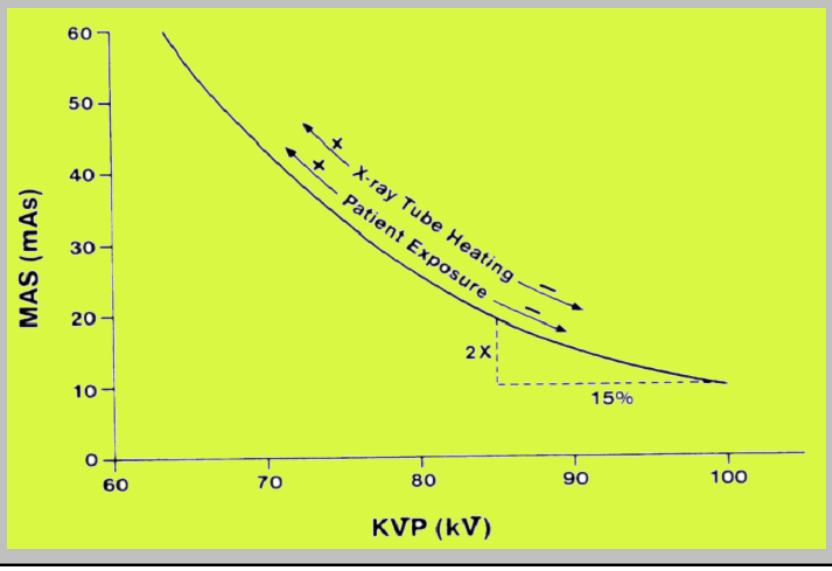
Photographic analogue:

-exposure time



Integral influence of kV and mAs

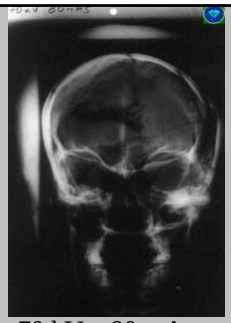
X-ray spectrum – quantity and quality change



mAs influence →

70 kVp, 25 mAs

70 kVp, 50 mAs



70 kVp, 80 mAs

Approx. Linear function

kVp influence →

60 kVp, 50 mAs

70 kVp, 50 mAs

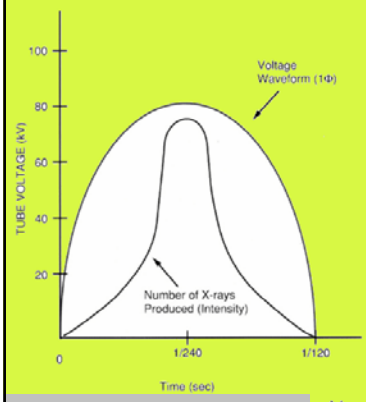
81 kVp, 50 mAs

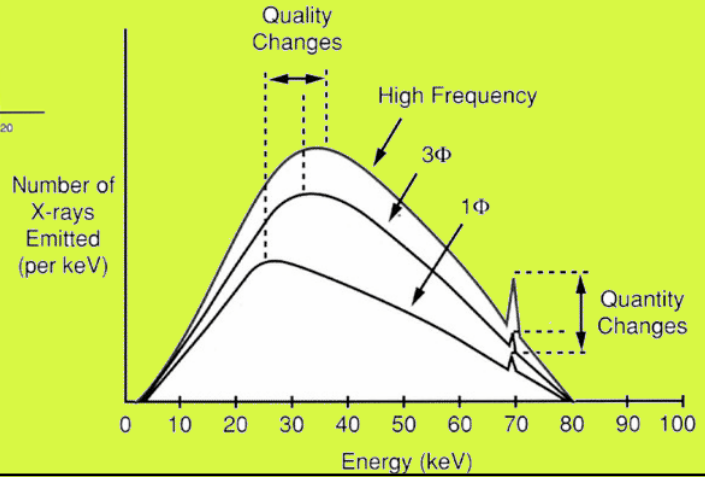
Approx. Square function

*** Loss of Contrast**

Type of Generator influence

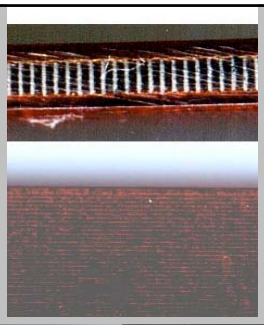
X-ray spectrum – quality and quantity change





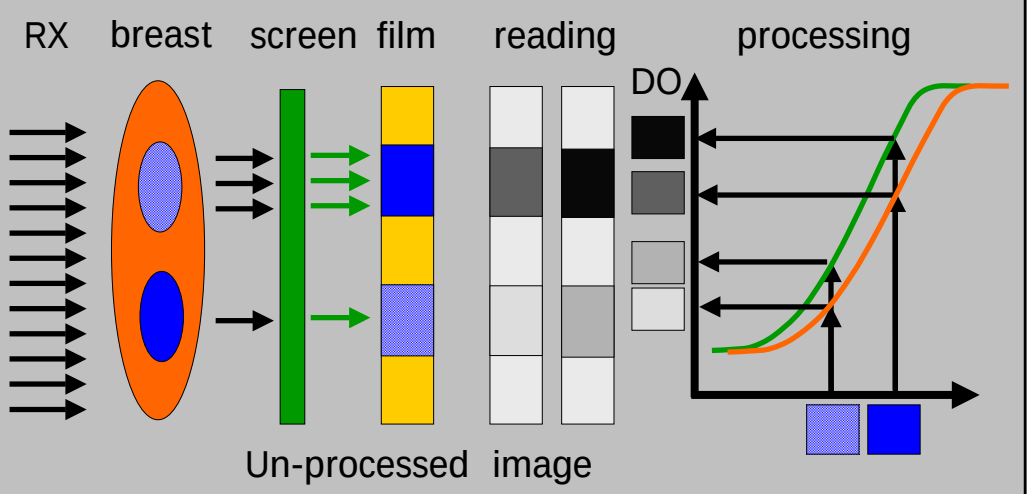
Scatter radiation influence

With anti-scatter grid



Without anti-scatter grid

Influence of the characteristic curve

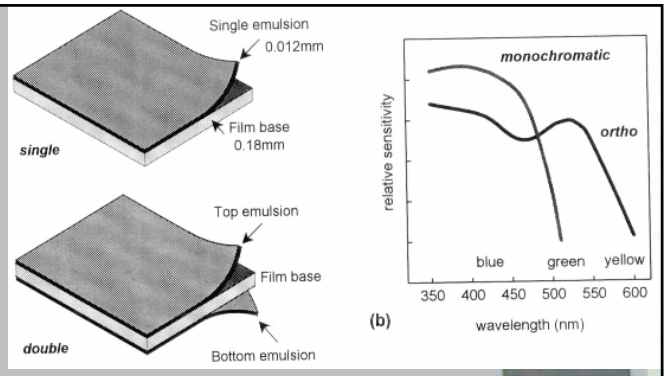


X-ray film processing influence – temperature of the developer

27 C

33 C

36 C



Influence of:

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

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

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