A KURSUS 2014

Diagnostisk Radiologi : ” Fysik og Radiobiologi ”

STRÅLINGSKVALITET

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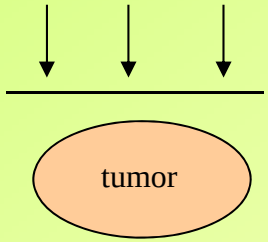
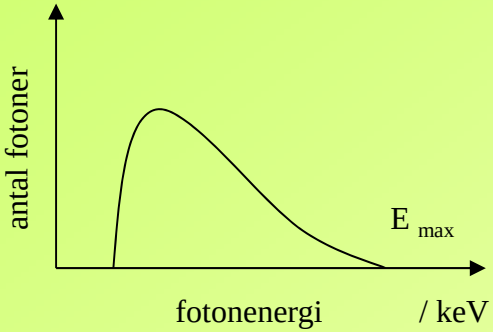
”Definition” af strålingskvalitet :

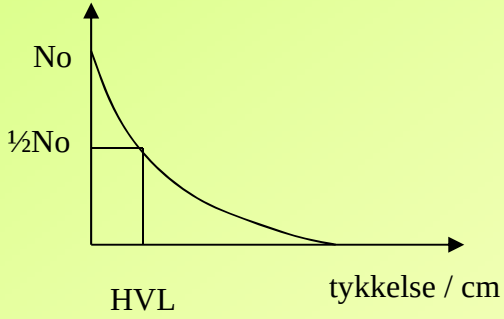
- Røntgenstrålingens ”gennemtrængningsevne” :



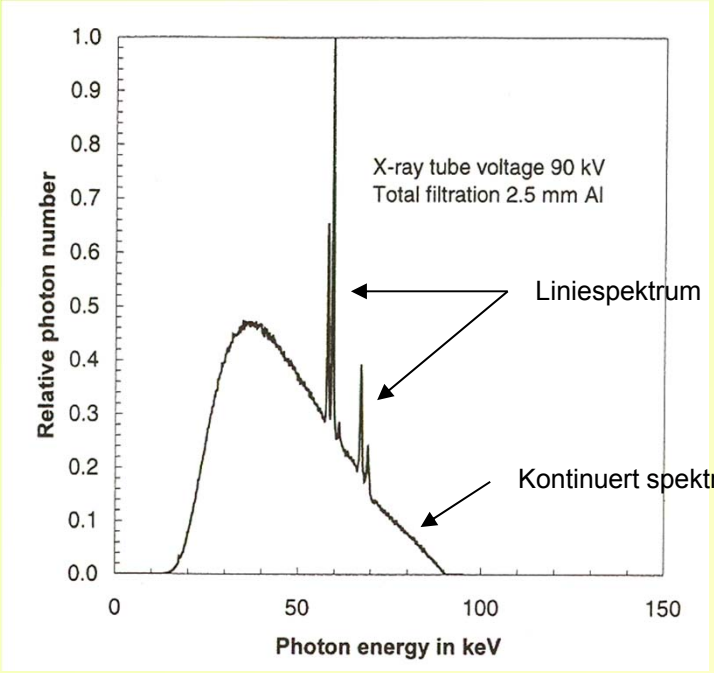
- Røntgenstrålingens spektrale Energifordeling :



- HVL halvværdilag :

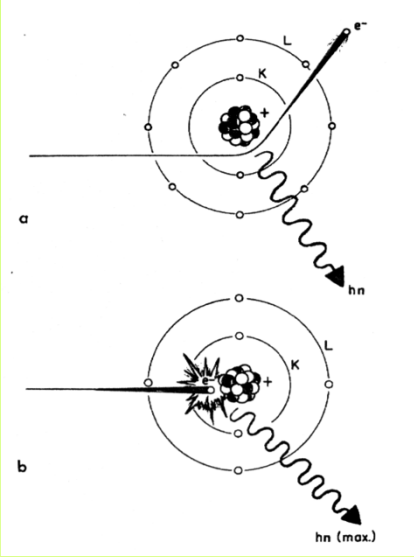


Røntgenspektrum :



Dannelse af røntgenspektret :

Kontinuert spektrum :
Bremsestråling



Linie spektrum :
Karakteristisk stråling

$$E_{foton} = E_n - E_m = h \cdot f$$

K_α , K_β linier

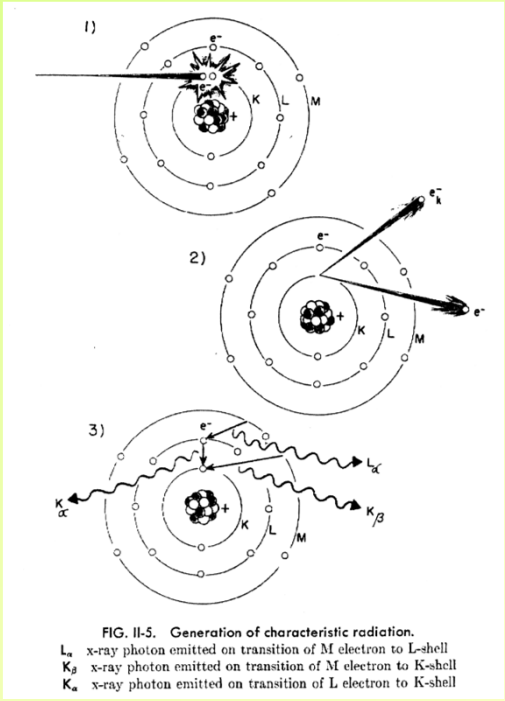
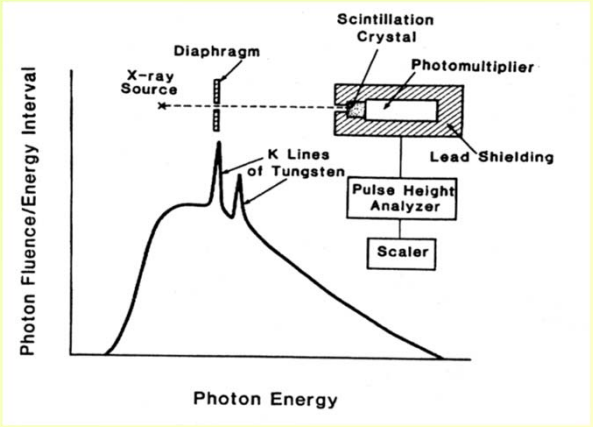


FIG. II-5. Generation of characteristic radiation.
L_α x-ray photon emitted on transition of M electron to L-shell
K_β x-ray photon emitted on transition of M electron to K-shell
K_α x-ray photon emitted on transition of L electron to K-shell

Fotonens energi : $E_{foton} = h \cdot f$

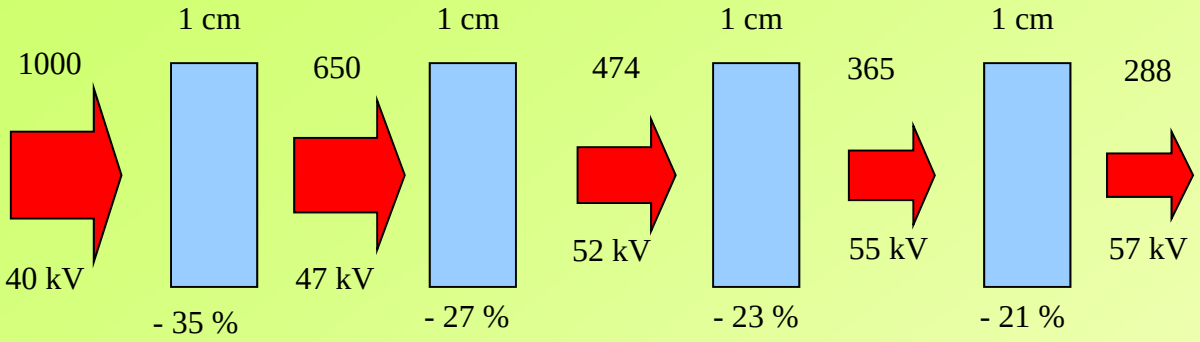
h = Plancks konstant = $6{,}63 \cdot 10^{-34}$ J·s
f = frekvensen

"Måling" af røntgenspektret :



Attenuation af røntgenstråling / røntgenspektrum:

Eks.: 100 kVp ~ ca. 40 keV i middelenergi af røntgenstrålingen.

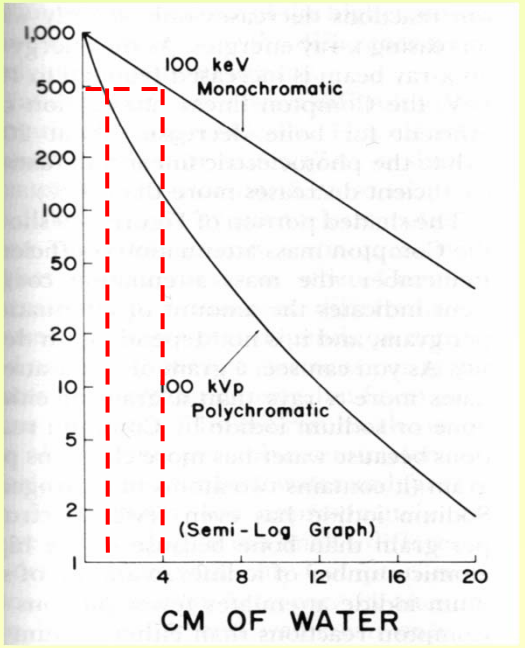


NB: Beam hardening !

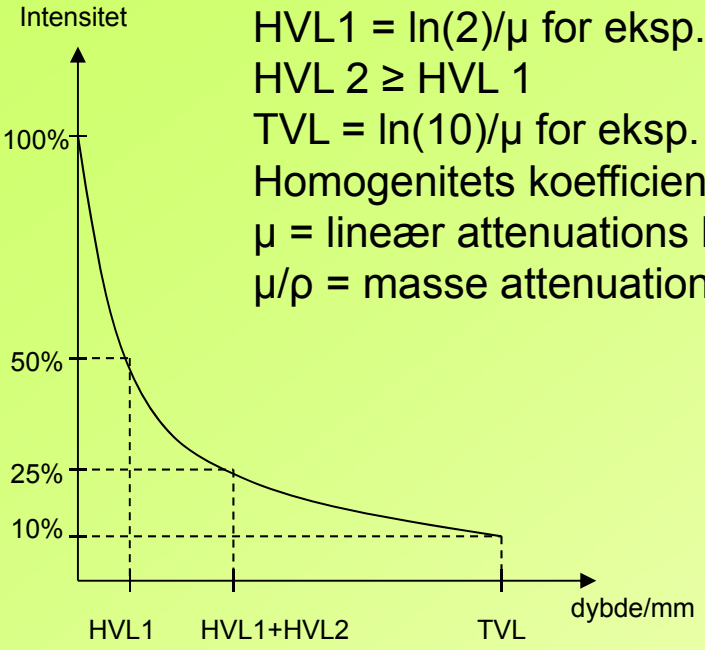
NB: Kun for monoenergetisk stråling er attenuationen i stof eksponentielt aftagende (dvs. en ret linie i semi-log. koordinatsystem)

HVL_{poly} er mindre end HVL_{mono} inden for de første cm.

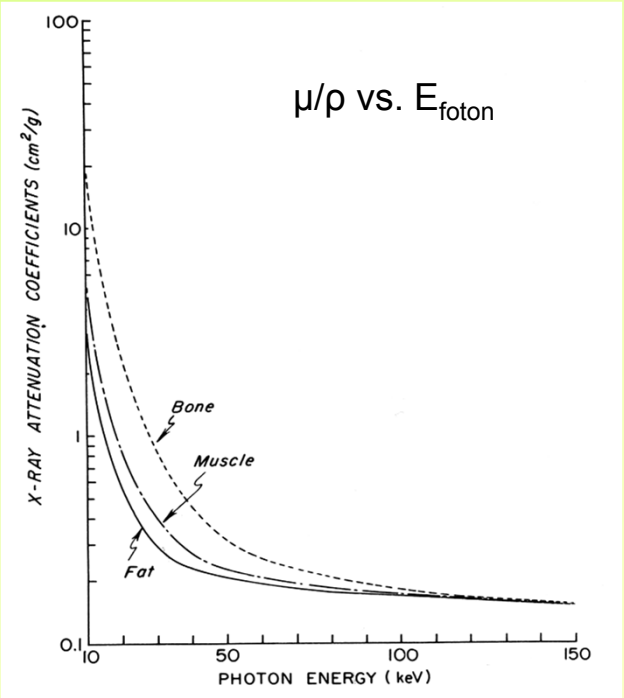
For større dybder er HVL_{poly} næsten lig med HVL_{mono}



Halvværdilag HVL :

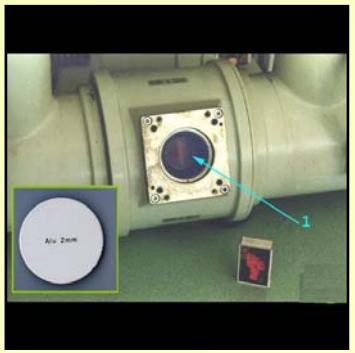


HVL1 = ln(2)/μ for eksp. udv.
HVL 2 ≥ HVL 1
TVL = ln(10)/μ for eksp. udv.
Homogenitets koefficient : HVL1 / HVL2
μ = lineær attenuations koefficient
μ/ρ = masse attenuations koefficienten



Filtrering af røntgenstrålingen :

Røntgenspektrets form ændres ved filtrering med f.eks. Al og Cu.
- mindsker strålingsintensiteten i den lavenergetiske del af spektret
- beamhardening (spektrets middelenergi E_{mid} øges)
- mindsker derved huddosis til patienten
- ændrer kontrasten i røntgenbilledet



Filtrering af røntgenstrålingen :

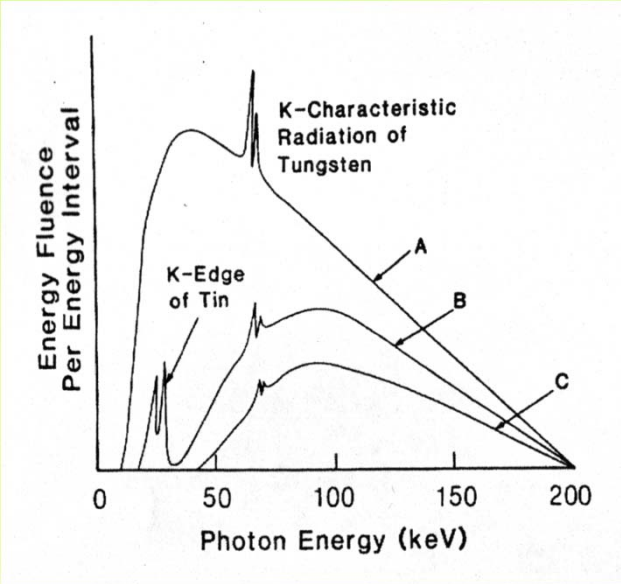
Indre filtre : ~ 0,5 – 1,0 mm Al
Be vindue, olie, glaskappe m.m.

Ydre filtre :

kurve A : Al
kurve B : Sn + Al
kurve C : Sn + Cu + Al

Røntgenspektrets middelenergi øges
A → B → C. (*Beamhardening).*

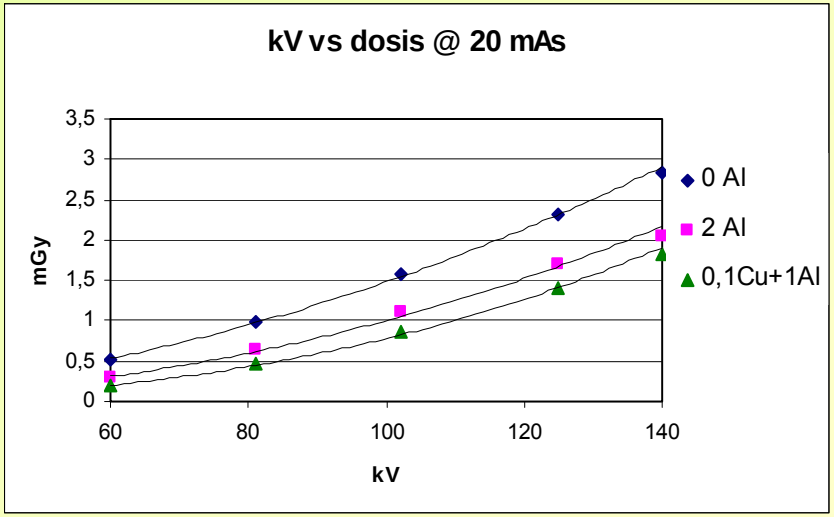
Krav : Totalfiltrering i røret ≥ 2,5 mm Al



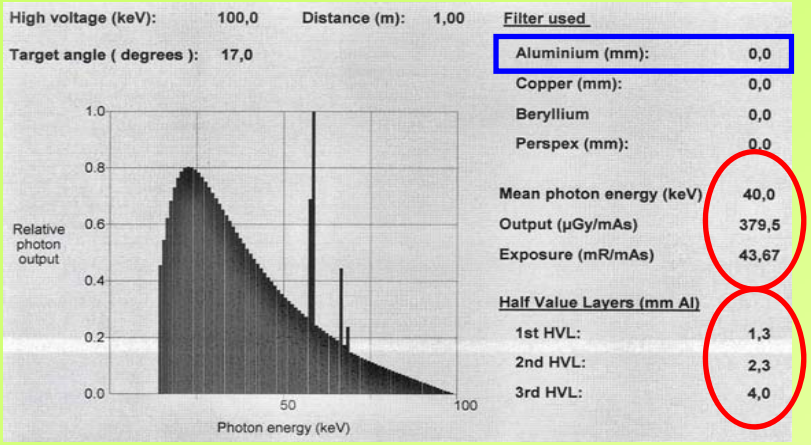
Dosis output fra røntgenrøret :

Høj filtrering :

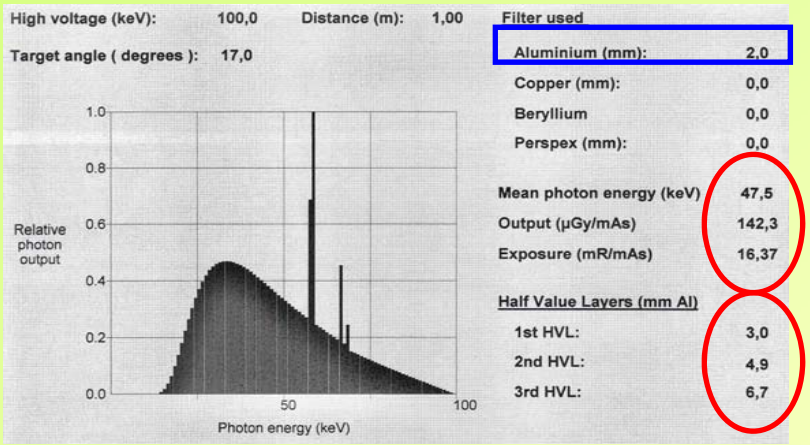
- mindsker dosis output fra røret
- øger belastningen af røret
- mindsker levetiden af røret



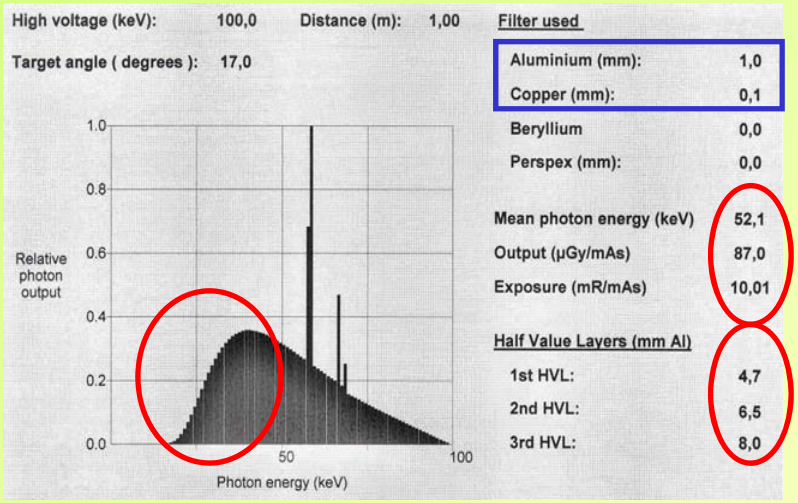
Filtrering : 0 Al



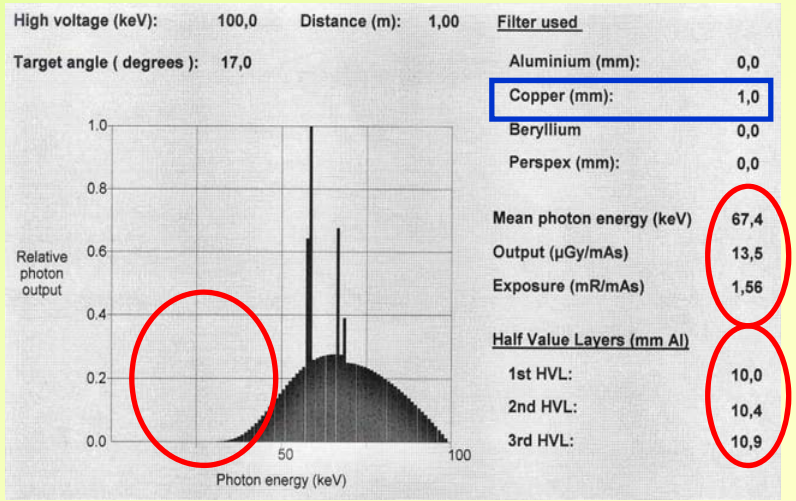
Filtrering : 2 Al



Filtrering : 1 Al + 0,1 Cu

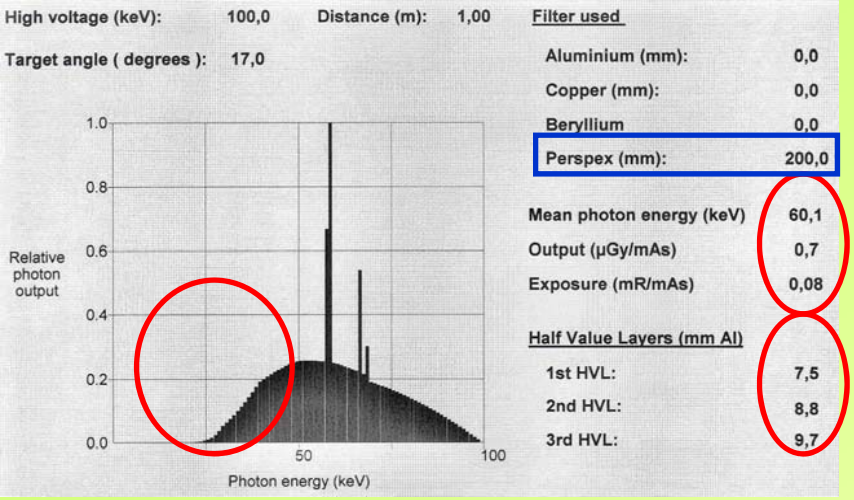


Filtrering : 1 Cu



NB : Reduktion af huddosis til patienten

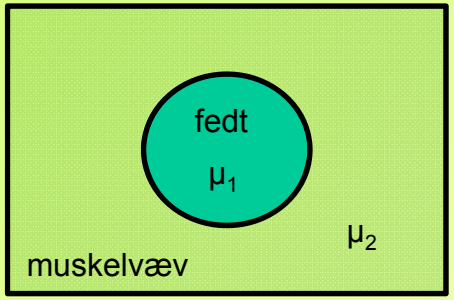
Filtrering : 20 cm PMMA



Typiske filter kombinationer i røntgenrør :

- 0 Al, 2 Al, 0,1Cu+1Al, 0,2Cu+1Al
- 0 Al, 0,1Cu, 0,2Cu, 0,3Cu

Filtrering og kontrast :



Attenuation

$I = I_o \cdot \exp(-\mu \cdot x)$

Eks.: 100 kVp , fedtvæv – muskelvæv kontrast

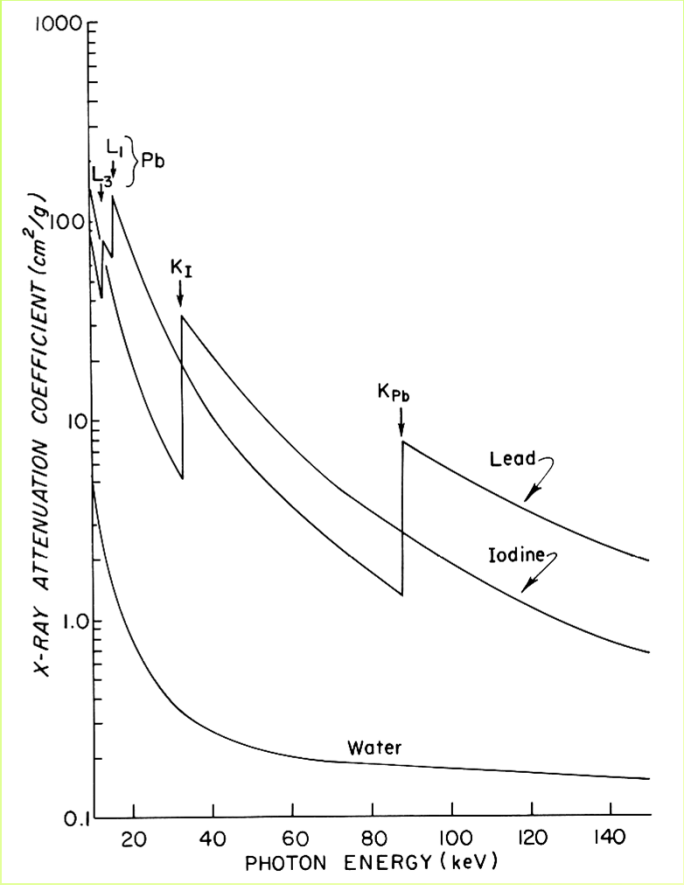
Filter	E_{mean}	μ_1 cm^{-1}	μ_2 cm^{-1}	$C = (I_1 - I_2)/I_2$
0 Al	40 keV	0,2276	0,2819	5,58 %
2 Al	47,5 keV	0,2082	0,2486	4,12 %
0,1Cu+1Al	52,1 keV	0,1987	0,2328	3,47 %
1 Cu	67,4 keV	0,1814	0,2063	2,52 %

Kontrasten C mindskes med øget filtrering

Spredt stråling mindsker kontrasten yderligere

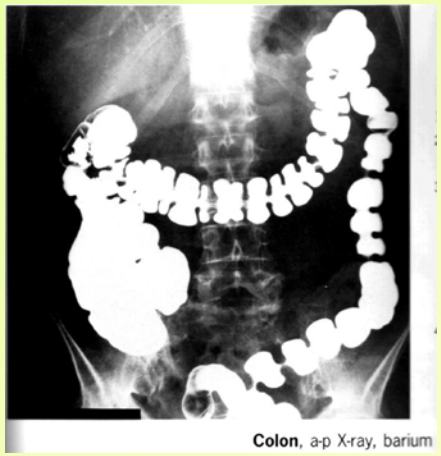
Kontraststoffer :

K – kanter
Masse attenuations koefficienter μ/ρ



Grundstof	Symbol	A	K – kant (keV)
Aluminum	Al	13	1,6
Iod	I	53	33,17
Barium	Ba	56	37,45
Wolfram	W	74	69,5
Bly	Pb	82	88,0

Røntgenbilleder : Barium Ba


Colon, a-p X-ray, barium


Pharynx, lateral X-r

Strålekvalitet og billedkvalitet :

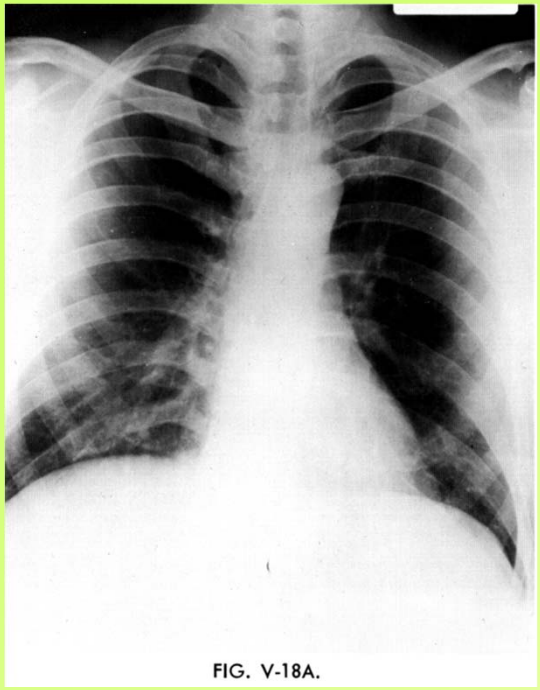


FIG. V-18A.

75 kV, 16mAs

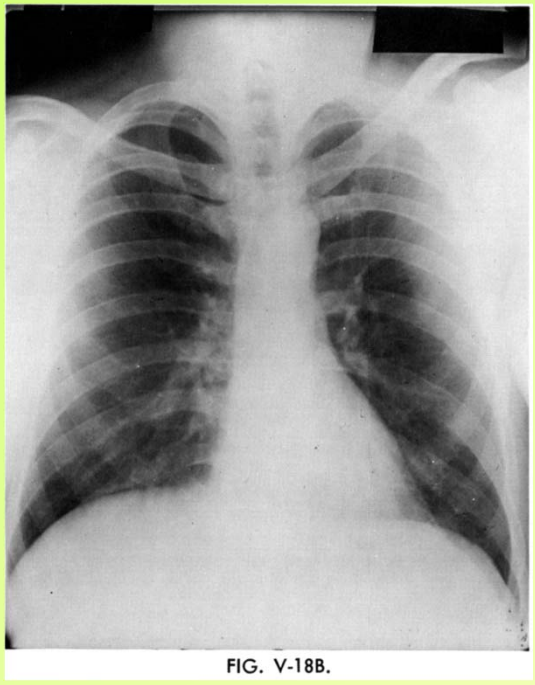


FIG. V-18B.

100 kV, 4,8 mAs

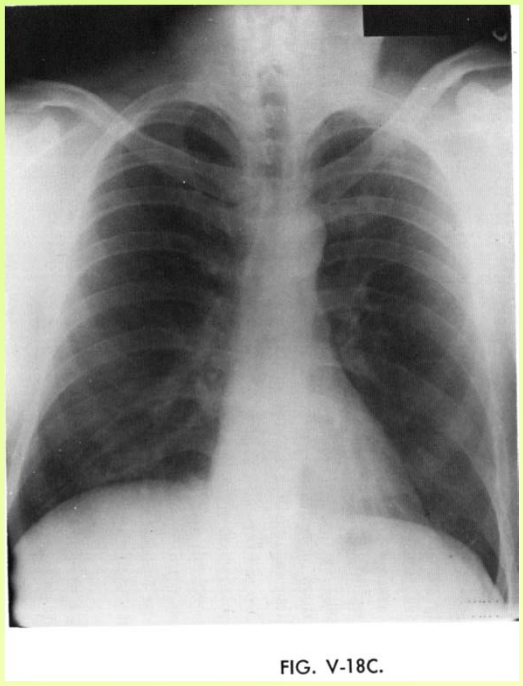
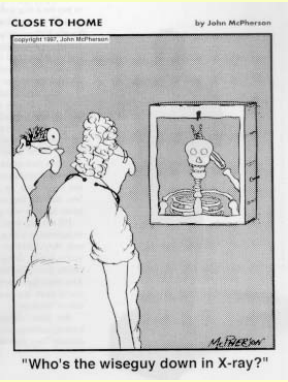


FIG. V-18C.

150 kV, 2,0 mAs

NB : AEC Automatic Exposure Control benyttet !



"Who's the wiseguy down in X-ray?"

The End !