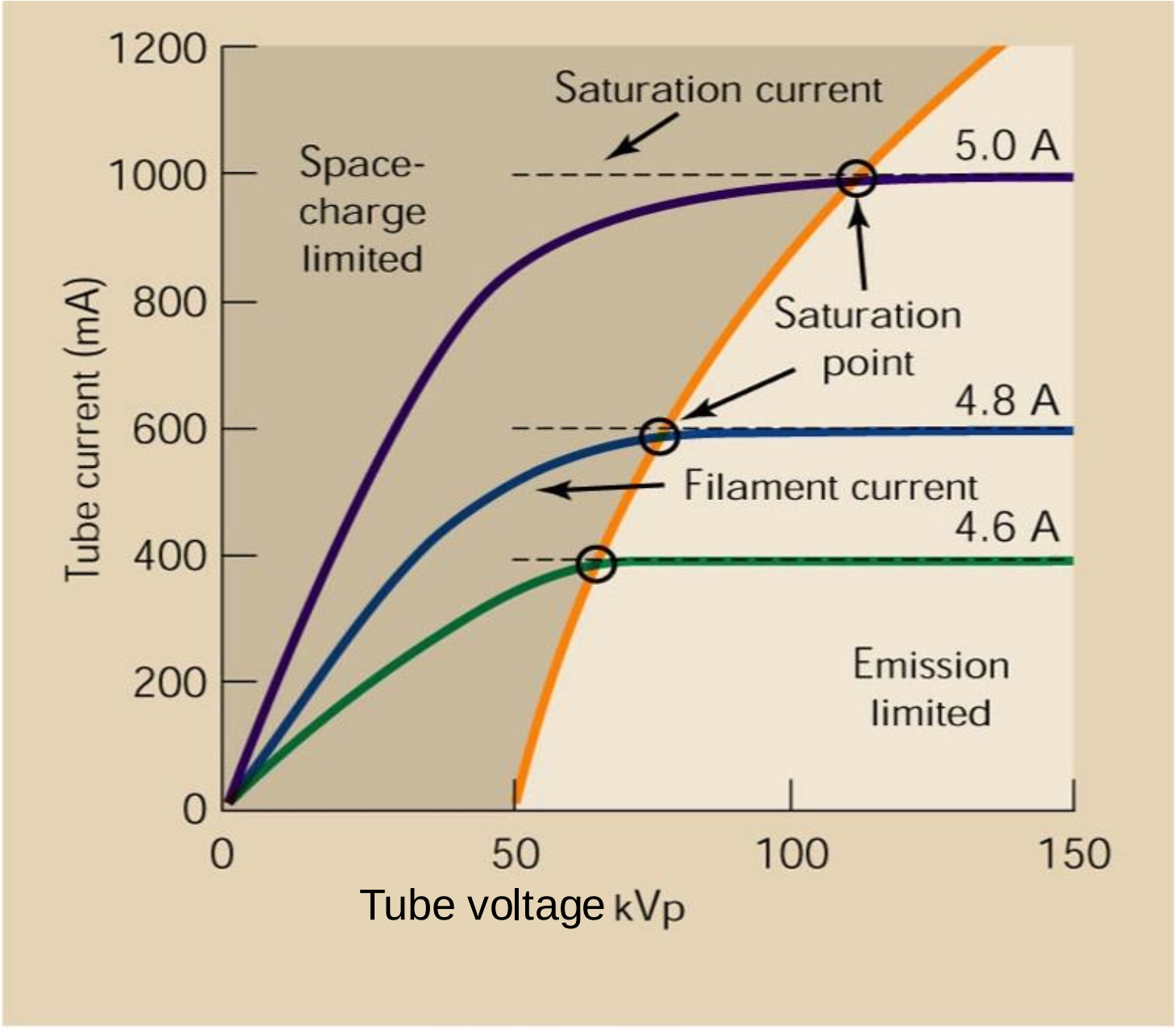
Lec 5: X-ray tube

Operating the tube



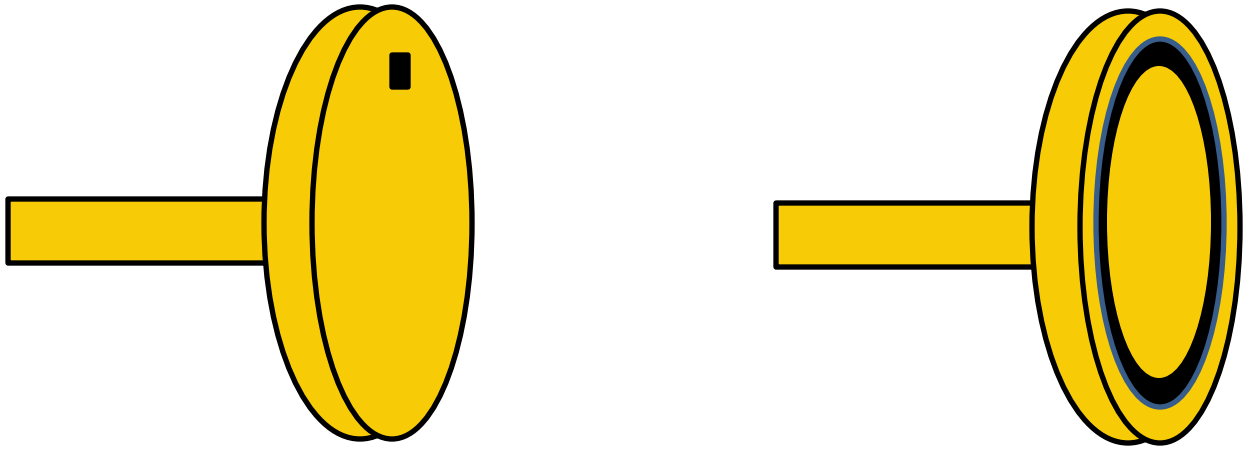
Heat dissipation in the anode

~ 99% of energy is dissipated as heat in the anode. Can reduce its lifetime. What can we do to improve the situation?

What can we do?

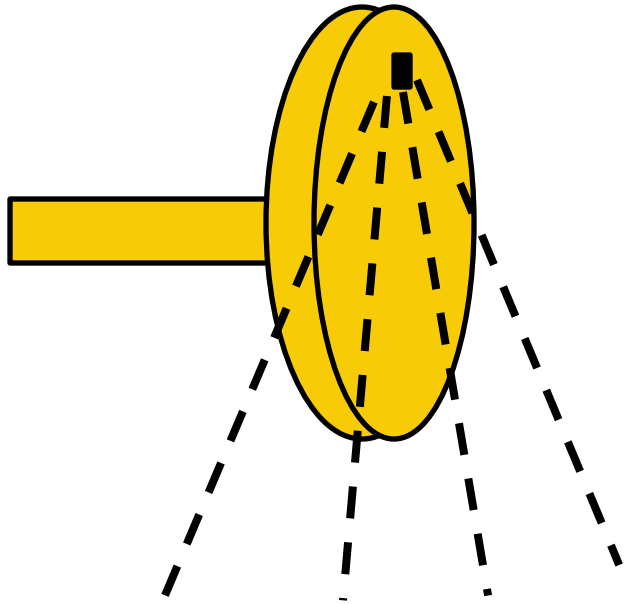
1. Anode material (adding rhenium to tungsten improves strength)
2. Thin layer of anode material (e.g. tungsten) embedded in a thick copper block

3. Rotation of anode (~3000 rpm)



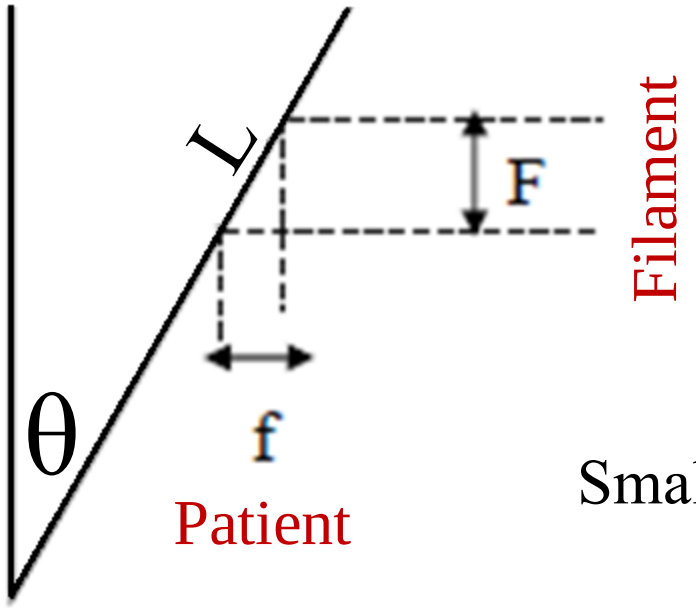
Focal spot in anode

Volume of the anode within which electrons are absorbed and x-rays are emitted



Anode bevel: line focus

Bevel angle (θ) = 12 - 15^{o}



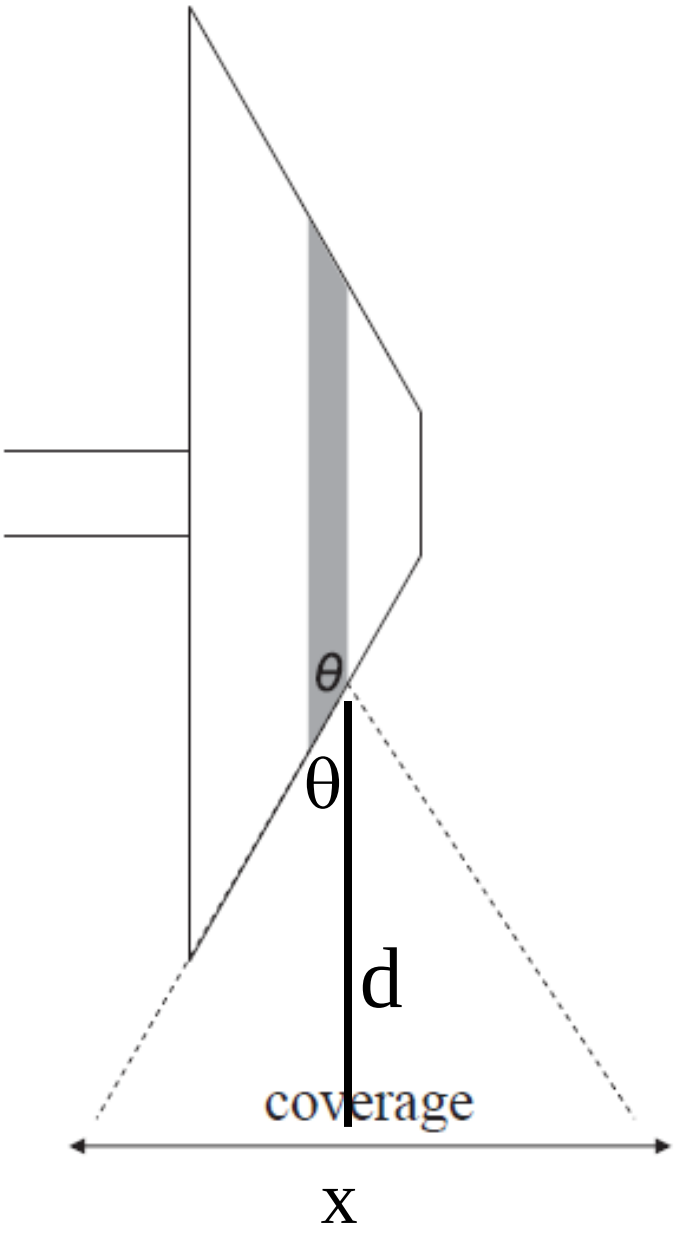
$f = L \sin \theta$

$F = L \cos \theta$

Small focal spot from patient's side

Effective focal spot size ranges between 0.6 and 1.2 mm

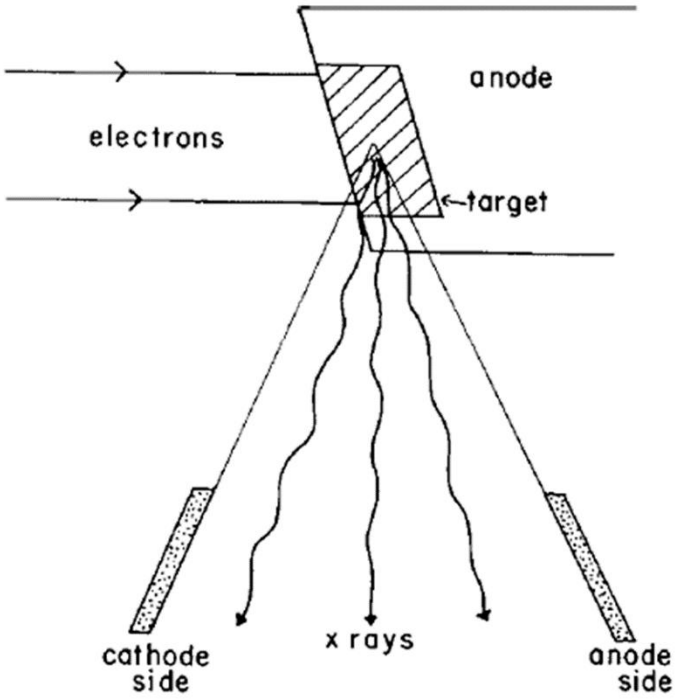
Coverage



Calculate the coverage (x) of the X-rays in terms of source-patient distance (d) and bevel angle (θ).

$$\frac{x}{2d} = \tan\theta$$

Anode heel effect



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- X-rays travel a longer distance to reach the anode side => more attenuation
- Signal intensity varies from one side to the other of an x-ray image.

Higher intensity x-rays on cathode side than anode side

Discussion point:

What kind of measures can we put in the x-ray tube to improve the image focus? (I am not talking about image processing here).

Filters

- Inherent filtration in tube (we have already seen in x-ray spectrum). Inherent filtration is equivalent to 1 mm Al filter.

- Additional filters (e.g. aluminium metal sheets) are added in the beam path to remove low energy x-rays.

- Why do we need filters?

X-ray output

Proportional to the product of

tube current (mA) and exposure time (sec)