Radiation physics –practical filtration

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1.1 introduction

Diagnostic x-ray beams produce with spectrum of many different energies.

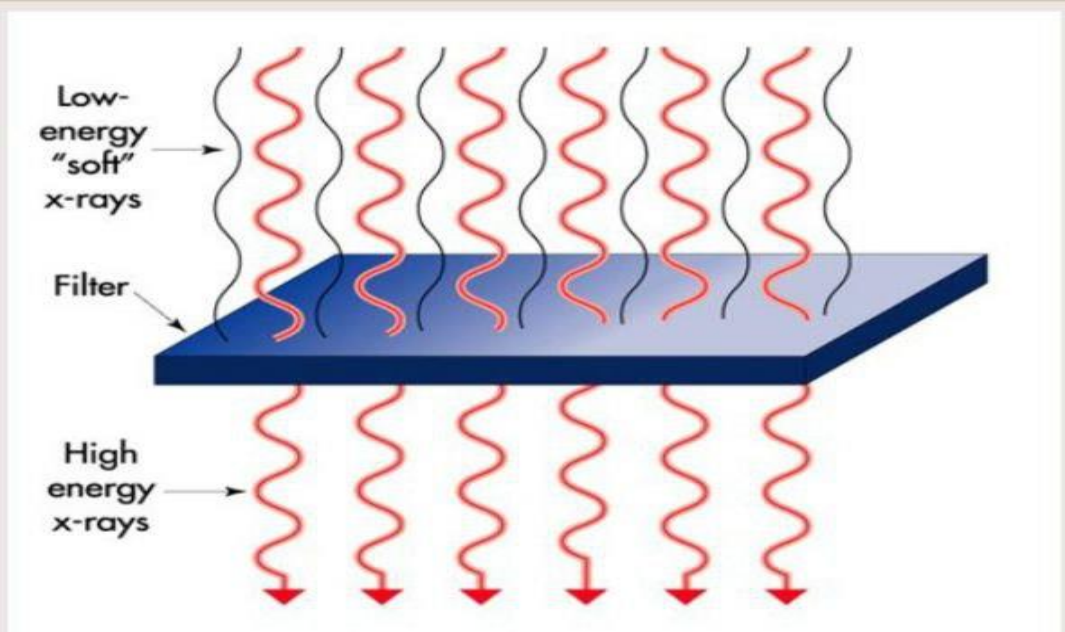
- **High energy photons transmitted to form the radiographic image.**
- **Low energy photons get absorbed/ scattered;**

✓ **Contributes to the increase in patient radiation dose.**

✓ **If scattered then effect the image quality. So we**

1.2 Filtration

- **Filtration X-ray imaging** **is systems have metal filters, usually 1 to 5 mm of aluminum (Al). The purpose of these filters is to reduce the number of low-energy x-rays. Low-energy x-rays contribute nothing useful to the image. They only increase the patient dose unnecessarily because they are absorbed in superficial tissues and do not penetrate to reach the image coming out.**



1.3 Effect of Filtration on the Absorbed Dose to the Patient.

1. **Reduces doses , If adequate filtration were not present, very low energy photons (20 keV or lower) would enter the patient and be almost totally absorbed in the body, thus increasing patient's dose, especially near or at the surface, but contributing nothing to the image process.**
2. **Effect on the image quality, Filtration remove low-energy X-ray photons that contribute to image noise and reduce image contrast. These low-energy photons are more likely to be absorbed by the patient's body tissues, resulting in less penetration and reduced image quality.**

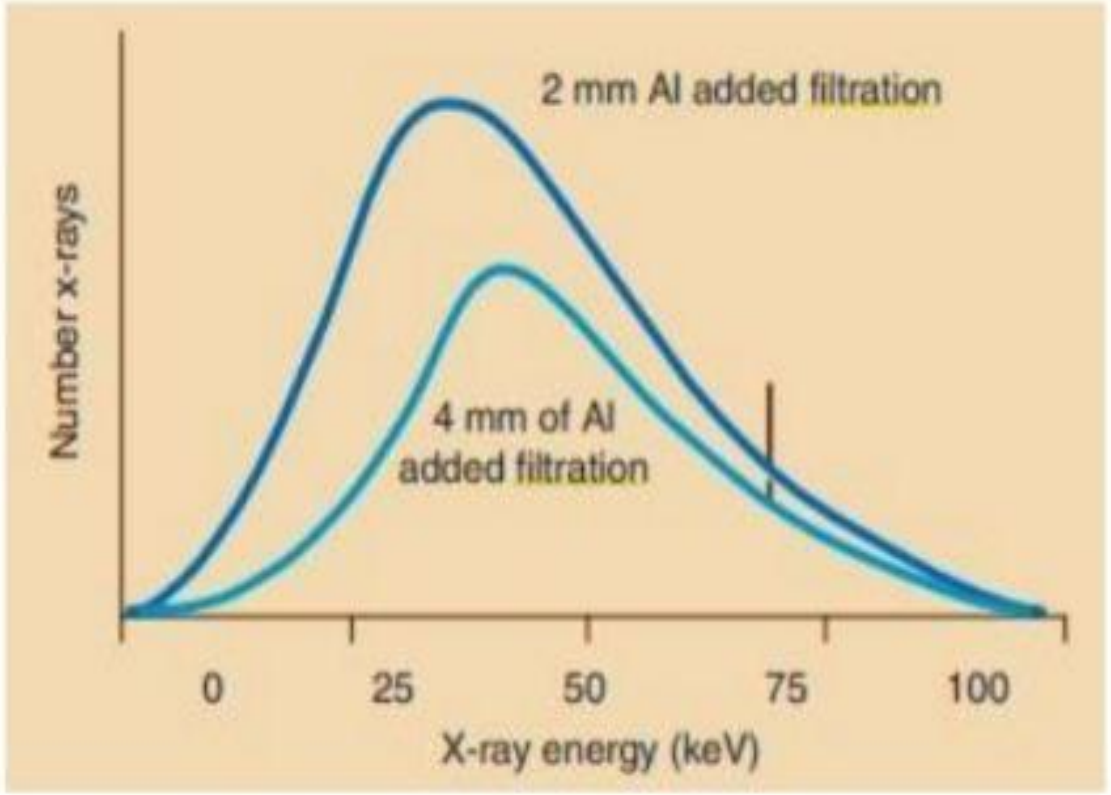


Figure 1:Adding filtration to an x-ray tube results in reduced x-ray intensity but increased effective energy.

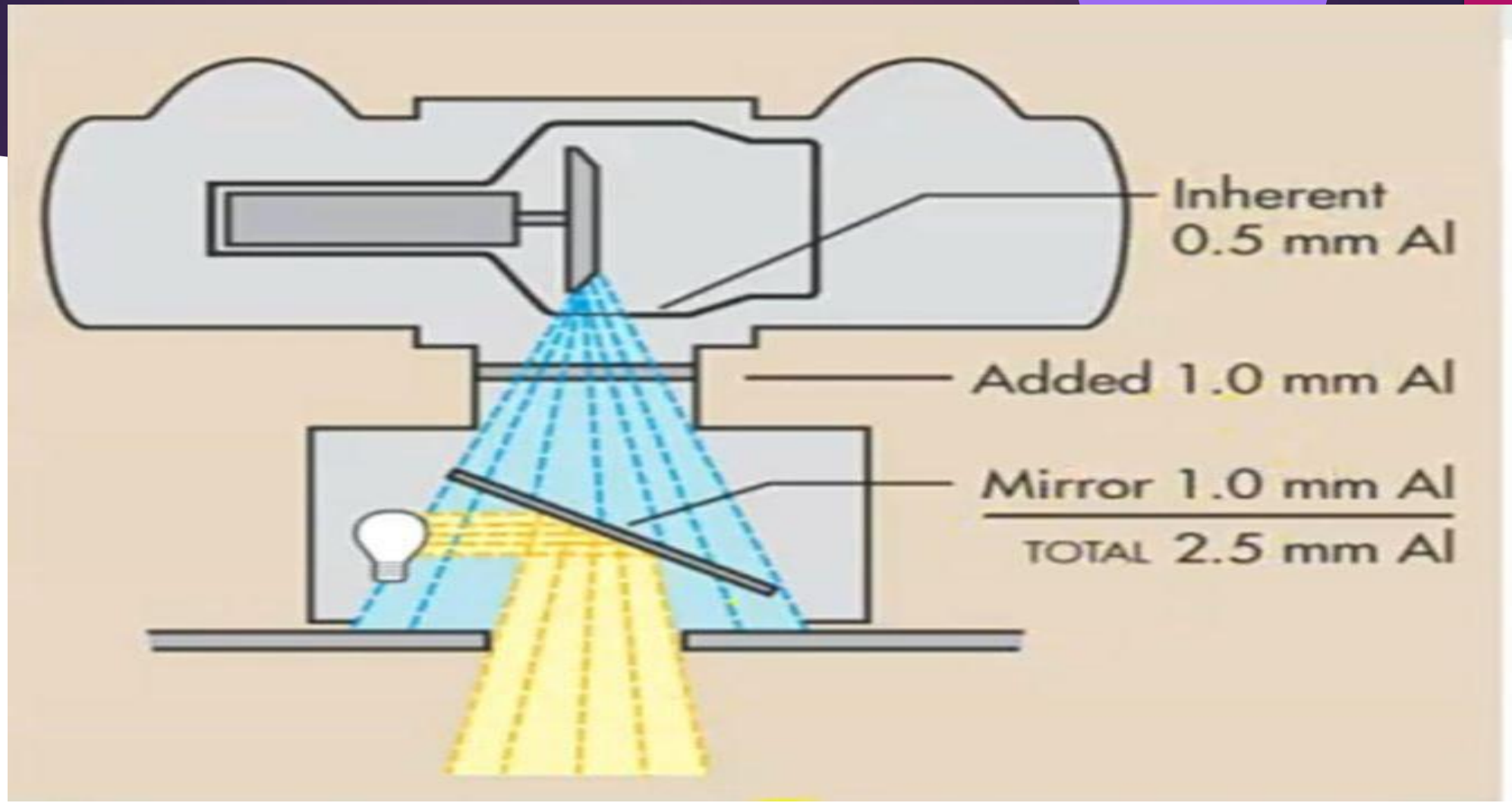
1.4 Material used in filtration

Almost any material could serve as an x-ray filter.

- **Al (Z = 13) is chosen because (commonly used)**
  - ✓ **It is efficient in removing low-energy x-rays through the photoelectric effect**
  - ✓ **It is readily available,**
  - ✓ **Lightweight, inexpensive,**
  - ✓ **Easily shaped.**
- **Copper (Z = 29), Tin (Z = 50), gadolinium (Z = 64), and holmium (Z = 67) have been used sparingly in special situations.**

1.5 Two Types of Filtration

- **Inherent Filtration - "In the tube"**
  - Glass envelope of the x-ray tube
  - Insulating oil around the tube
  - Diagonal mirror used for positioning
  - Thickness 0.5-1 mm Al equivalent
- **Added Filtration - added to**
  - Aluminum (Al) sheets placed in the path of the beam.
  - Work as filters to attenuate low energy photons
  - Thickness of added filtration usually has two sources**. First, 1-1.5 mm** or more sheets of Al are permanently installed in the port of the x-ray tube housing **between the housing and the collimator. The second from the collimator contributes an additional 1 mm Al** equivalent added filtration **from the silver surface of the mirror in the collimator**


Inherent
0.5 mm Al
Added 1.0 mm Al
Mirror 1.0 mm Al
TOTAL 2.5 mm Al

Total filtration

- **Total filtration** = inherent filtration +added filtration
- Recommended by NCRP

Operating kVp	Total filtration
Below 50kvp	0.5 mm aluminum
50-70 kVp	1.5 mm aluminum
Above 70kVp	2.5 mm aluminum

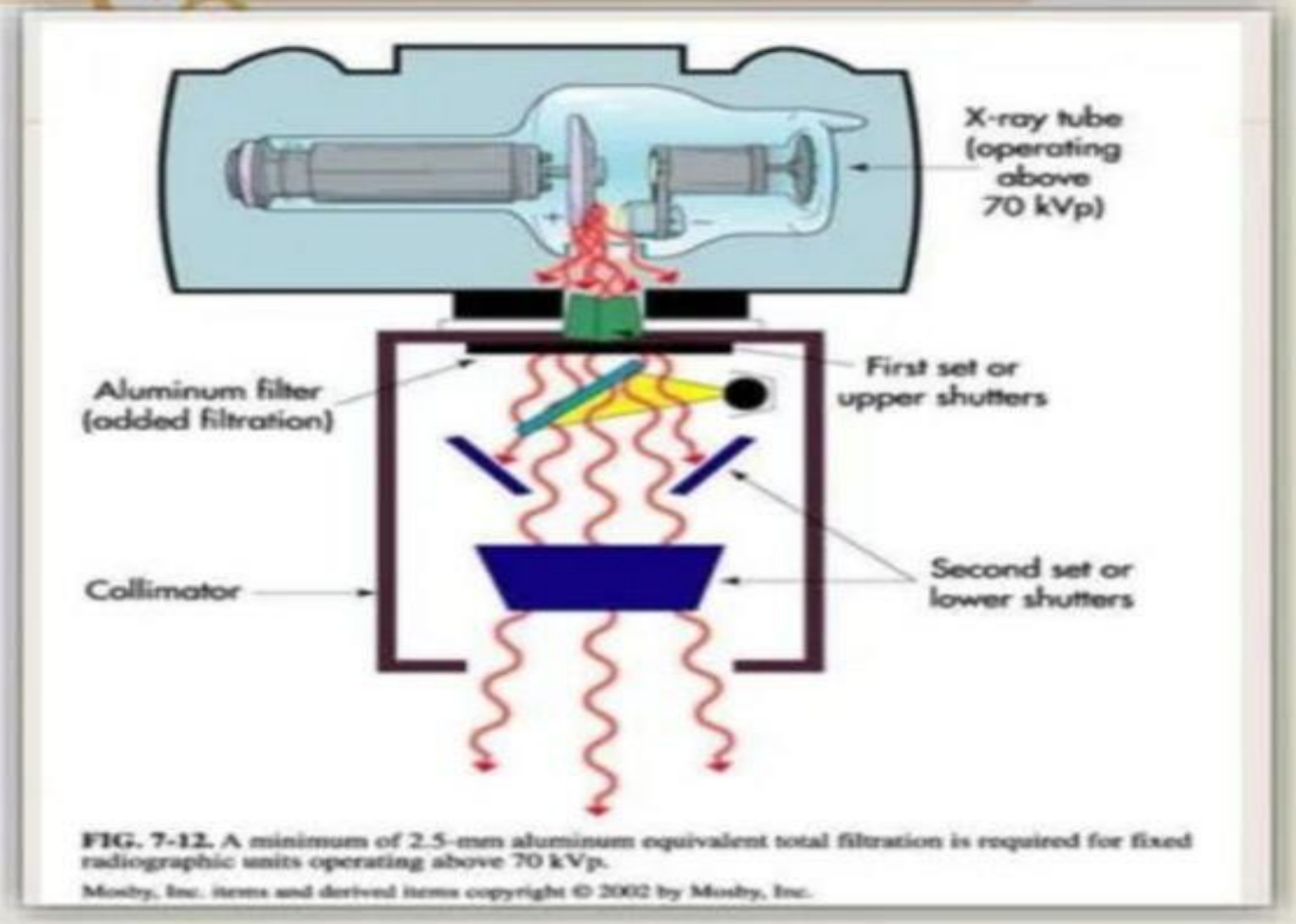


FIG. 7-12. A minimum of 2.5-mm aluminum equivalent total filtration is required for fixed radiographic units operating above 70 kVp.

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1.6 Ideal beam filtration

In diagnostic radiography, the ideal beam filtration typically ranges from 2.5 mm to 3.5 mm of aluminum equivalent . This level of filtration helps to remove low-energy X-ray photons that contribute to image noise and reduce image contrast. It also helps to reduce patient dose by selectively removing unnecessary low-energy radiation.

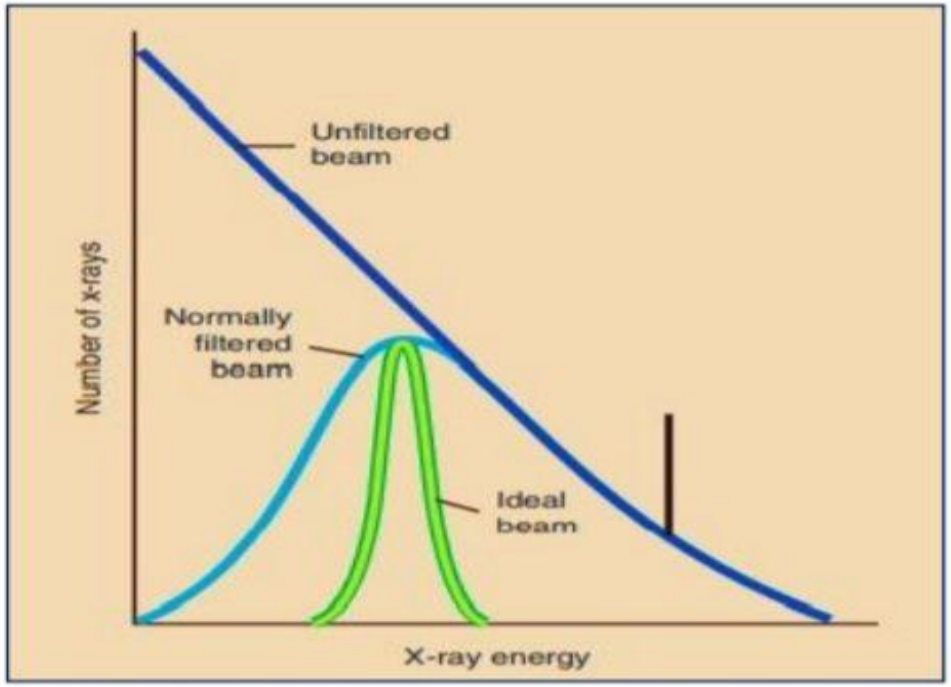

Figure 2: Filtration is used selectively to remove lowenergy x-rays from the useful beam. Ideal filtration would remove all low-energy x-rays.