



2025

KARNATAKA RADIOLOGY EDUCATION PROGRAM

FILTERS & COLLIMATOR

Filtration is the process of shaping the X-ray beam to increase the ratio of photons useful for imaging to those photons that increase patient dose or decrease image contrast.

Diagnostic X-ray beam is polychromatic, comprising of whole spectrum of energies. The mean energy will vary from 1/3rd to one half of the their peak energy. The first few centimeters of the tissues receive much more radiation than the rest of the body tissues of the patient.

Filters are sheets of metal, attached at the opening of tube housing, which will absorb the low energy photons from the X-ray beam before it reaches the patient.

Types of filtration

The X-ray beam is filtered by absorbers at three different levels

1. Inherent Filtration [X Ray tube and housing]
2. Added filtration [sheets of metal placed in the path of beam]
3. The Patient

1. Inherent Filtration [X Ray tube and housing]

The insulating oil surrounding the tube

Window in the tube housing

Inherent filtration at the tube housing is 0.5 to 1.0 Al.Eq.

Below 50 kVp 0.5 mm Aluminum

50-70 kVp mm Aluminum

Above 70 kVp 2.5 mm Aluminum

2. Added filtration Aluminum At.No. 13 Copper At. No. 29

Compound Filter copper + Aluminum, Copper is used to cut down the thickness of filter
Copper will absorb high energy photons and Aluminum will absorb the characteristic radiation from copper (8 keV)

X-ray Filtration

- The leaded glass window of the tube acts as **Inherent Filtration**.
- Aluminum is attached to the mirror in the collimator. This is called **Added Filtration**.



Measurement of filtration

Filtration is measured in Aluminum equivalents which is defined as the thickness of the Aluminum that would produce the same degree of attenuation as the thickness of material in question.

Effects of filtration : Patient exposure and Exposure factors

Effect on exposure factors : There will be reduction in the intensity of X-ray beam as the filters absorb some photons at all energy levels. To Compensate the loss of high energy photons, increase in the exposure factors (mAs) is required.

Types of filters

Single Filter Aluminum

Compound Filter Aluminum +Copper

Wedge Filter Used in the angiography

Molybdenum Filters used in Mammography.

K. Edge filter

Molybdenum filters

Used in molybdenum target X-ray tubes used for mammography

17.5 kev K alpha and 19.6 kev K beta characteristic radiation of Mo

When operated at kVp, Mo will produce bremsstrahlung with energies higher than 20 kev

Mo filter attenuates these high energy rays

K- Edge filters

These filters make use of K absorption edge of elements with atomic No. greater than 60.

The purpose of heavy metal filters or K edge filters is to produce an X-ray beam that has a high number of photons in the specific energy range

Enhance contrast for Iodine and barium, reduce patient dose, and increase tube loading

RESTRICTORS

X-ray beam restrictors

An X-ray beam restrictor is a device that is attached to the opening in the X-ray tube housing to regulate the size and shape of the X-ray beam.



Types of restrictors

Aperture diaphragms

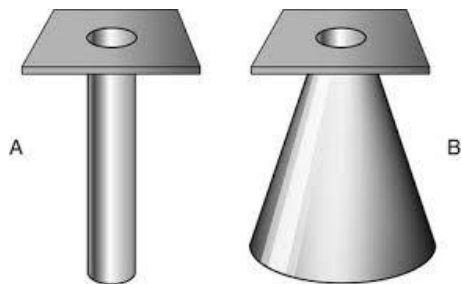
Cones & cylinders

Collimators

Aperture diaphragm

It consists of a sheet of lead with a hole in the center. The size and shape of the hole determine the size and shape of the X-ray beam.

Cones



Cones are usually flare shaped , Ideal geometric configuration for an X-ray beam restrictor.

The flare of the cone is greater than the flare of the x ray beam.

Cylinders

Beam restriction with cylinder takes place at the far end of the barrel, so there is less penumbra.

Disadvantages

Penumbra: Partially exposed periphery of the X-ray field is called penumbra

Another major disadvantage with cones and cylinders is severe limitations they place on the number of available field sizes.

Collimators

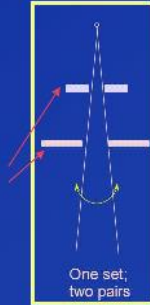
Collimators

• Advantages

- Provides adjustable rectangular field
 - » fluoro may also have circular field
- light beam indicates x-ray field

• Configuration

- two sets of shutters
 - » longitudinal
 - » transverse
- sets may actually have two pairs of shutters operating together



Collimator is the best all round X-ray beam restrictor ,These are two types:

Manual collimator

Automatic collimator or PBL (Positive beam limitation device or automatic light localised variable aperture collimator)

Advantages

It provides infinite variety of rectangular or square X-ray fields.

The light beam shows the exact center and configuration of X-ray field.

Automatic collimators

When the cassette is loaded in the Buckey tray the sensors in the tray identify the size and alignment of the cassette and relay the information to collimator motors, which positions shutters to the exact size of the film used.

Functions of X ray beam restrictors : Protects the patient from unnecessary radiation

It decreases the scatter radiation. The number of scattered radiation depends upon field size, Small fields generate little scatter, as the field increases scatter increases.

Collimators are only successful in decreasing the scatter radiation with small fields, so we should reduce the size of X-ray beams as much as possible.

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REF : Christensen's Physics of Diagnostic Radiology, Radiopedia.

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