

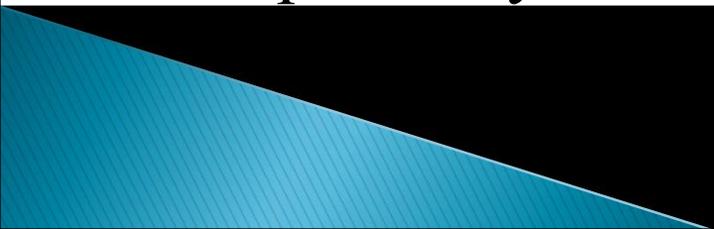


Centurion
UNIVERSITY

X-RAY CASSETTE

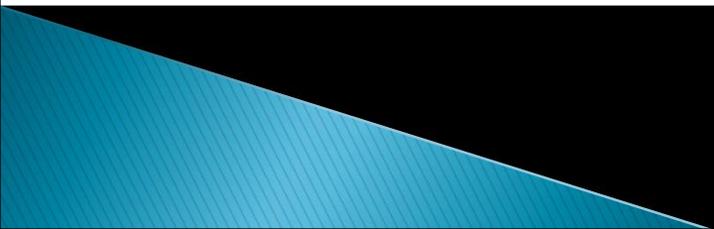
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X-RAY CASSETTES

- ▶ CASSETTE
 - ▶ A flat, light-tight container in which x-ray films are placed for exposure to ionizing radiation and usually backed by lead to eliminate the effects of back scatter radiation.
 - ▶ A light –tight metal container which is designed to hold the X-ray film and intensifying screens in close contact.
 - ▶ Used in conventional and Computed radiography (CR) for the screen film system and imaging plate respectively.
- 



Parts Of Cassette

- ▶ FRONT PART : faces the x-ray tube and consists of a sturdy metal frame into which is fixed a sheet of either light metal such as aluminum, or plastic material; the critical point being that it must be transparent to x-rays.
 - ▶ The frame constitutes a shallow container into which can be placed thin intensifying screens and a film.
 - ▶ Front is made of low atomic number material (e.g. plastic or carbon)
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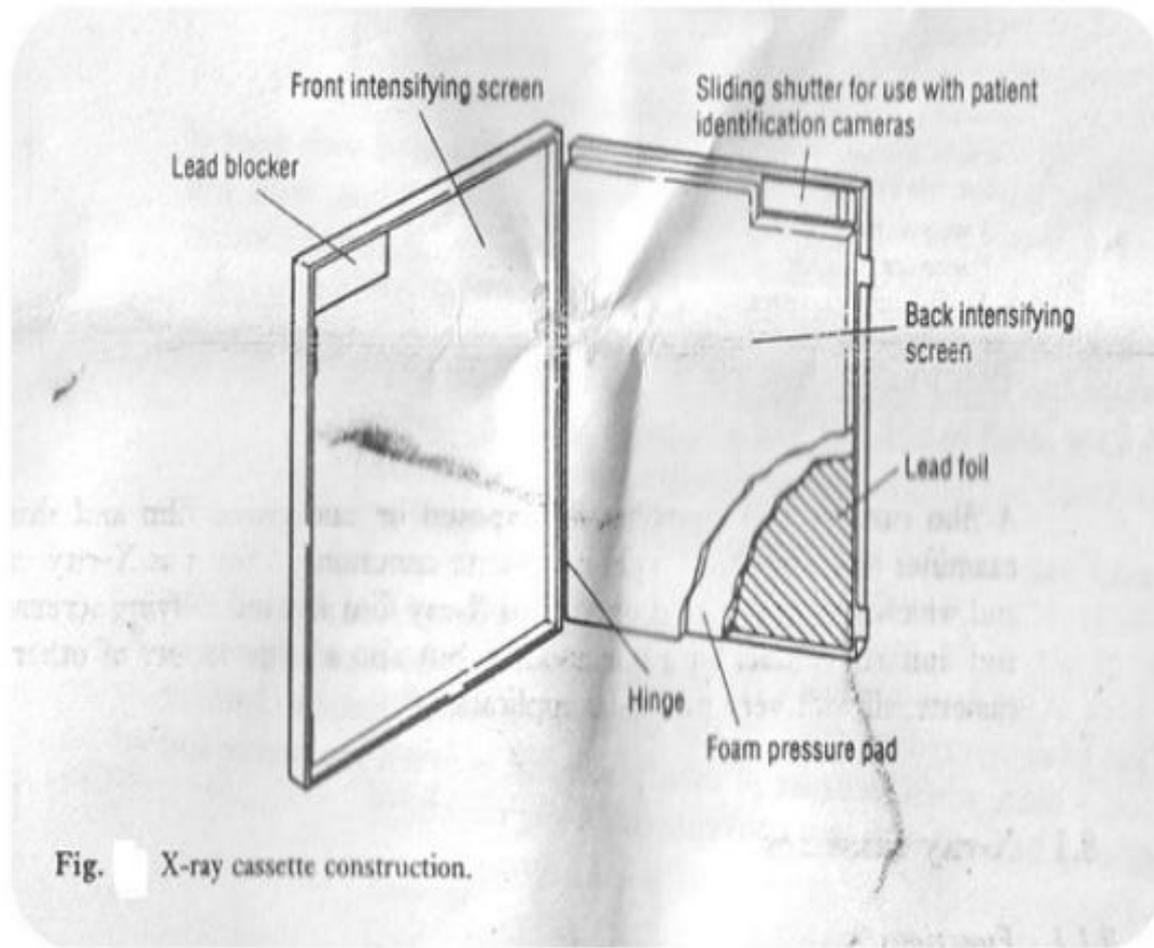
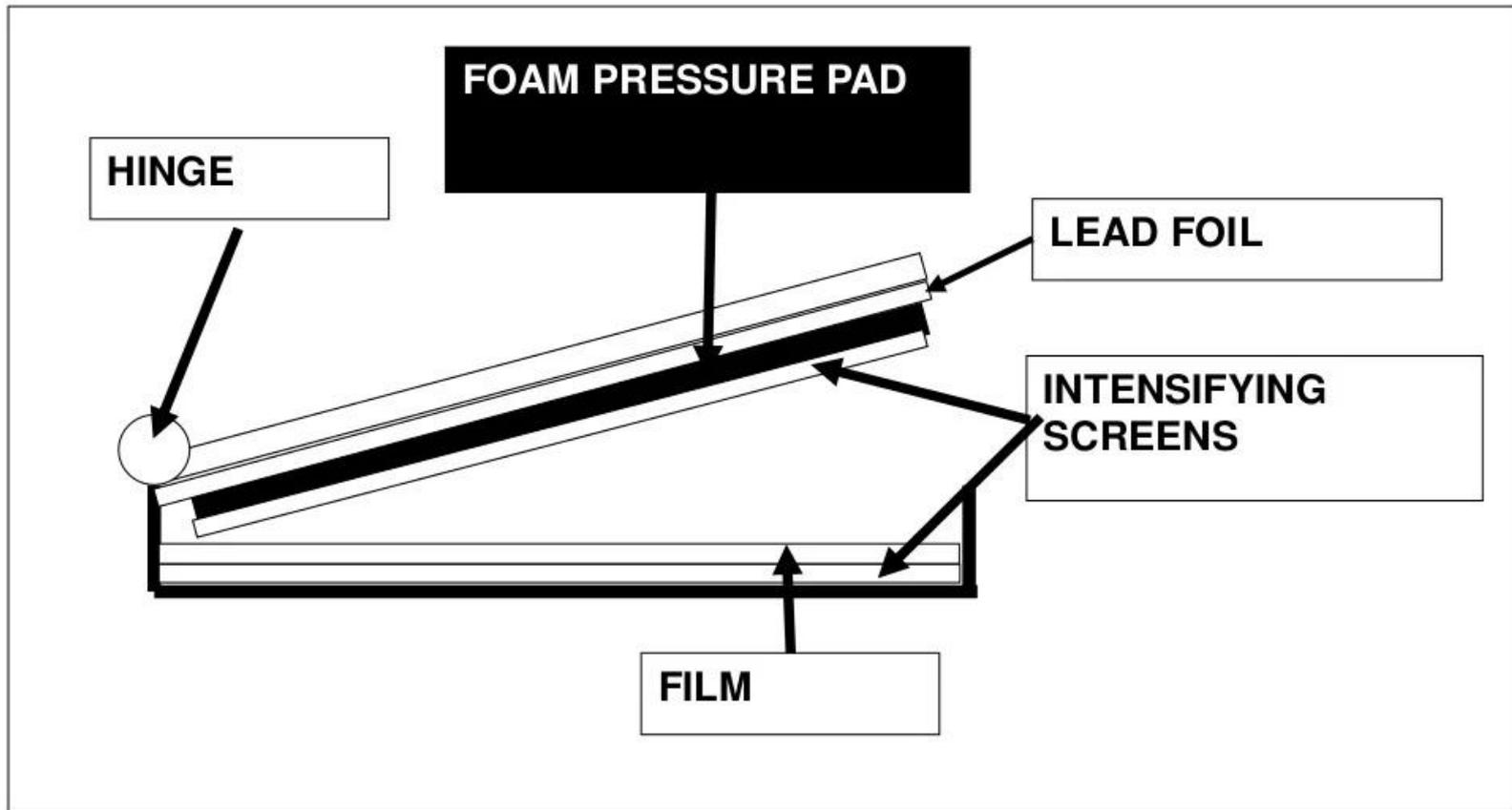


Fig. X-ray cassette construction.

THE BACK OF CASSETTE

- ▶ Constructed from a strong metal customary to spray the internal surface with lead paint, to absorb secondary radiation, preventing it from being scattered back onto the film.
- ▶ Contains a felt pad; function of the felt is to maintain the screen, the film and its fellow screen in uniform, firm contact.
- ▶ Front and back of the cassette are held tightly together, either by spring clips on the edge opposite to the hinge or by means of pivoted resilient metal bars on the back of the cassette

CASSETTE - CROSS SECTION



Functions of cassettes

- ▶ 1. To contain a film
- ▶ 2. To exclude light
- ▶ 3. To maintain the film in close, uniform contact with both screens during the exposure
- ▶ 4. To protect the intensifying screens from physical damage.
- Cassettes are used in association with intensifying screens and screen films

Properties of cassettes

- ▶ Should be light
- ▶ Ease of operation
- ▶ Size: Slightly larger than x-ray beam and area to radiographed.
- ▶ Robust structure
- ▶ Flexibility:
 - ❖ i. Non flexible - so as not to allow the film to bend.
 - ❖ ii. Flexible - for panoramic machines.

Types of cassettes

- ❑ Single Screen Cassettes:
 - ▶ Have a single intensifying screen
 - ▶ Designed to be used with single sided emulsion film.
 - ▶ Principal application in mammography

- ❑ Double screen cassettes:
 - ▶ Have screen on both sides
 - ▶ Used with double sided emulsion film
 - ▶ Principal application in general radiography

❑ **Curved cassettes:**

- ▶ Internally constructed as conventional cassette with double sided intensifying screen
- ▶ Only shape is curved to provide good contact between object and cassette.

❑ **Gridded cassette:**

- ▶ Have a secondary radiation grid between the front intensifying screen and the front of cassette.
- ▶ Used for radiography where conventional Bucky system is unavailable e.g. in ward radiography.

❑ **Multi section cassettes:** Designed to hold 3-7 films, with their respective intensifying screens and spacers of about 5 or 10 mm in thickness.

❑ **Advantage of using spacers:** Films which are separated by 5mm spacers will produce images of body sections 5mm apart and like
spacers.

❑ **Vacuum cassettes**

- ▶ Made from flexible vinyl material
- ▶ Have a valve attached at one end
- ▶ Inside is removable plastic folder containing single intensifying screen
- ▶ For use , a single sided emulsion film is inserted inside the folder .
- ▶ The entire folder is placed inside the cassette and sealed.

❑ **Formatter cassettes**

- ▶ Consist of frame designed to hold two single sided emulsion films by their edges Do not contain intensifying screens
- ▶ USES: Used for imaging from CRT and TV monitors in ultrasound, nuclear medicine CT, DSA and MR

❑ **Angiography cassettes**

- ▶ Can hold up to 30 sheets of films, size 35*35 cm each positioned with metal spacers

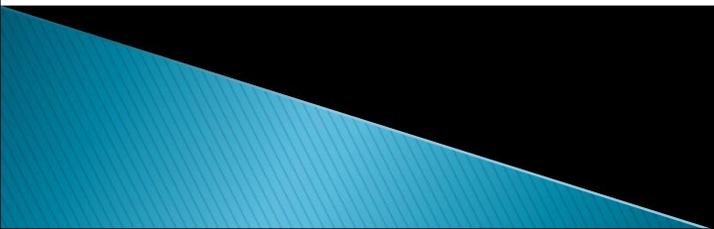
❑ **Photo fluorography cassette**

- ▶ Photo fluorography or the recording of images from output phosphor of an image intensifier tube is usually carried out on 70 mm or 105 mm roll film or on 100 mm sheet film

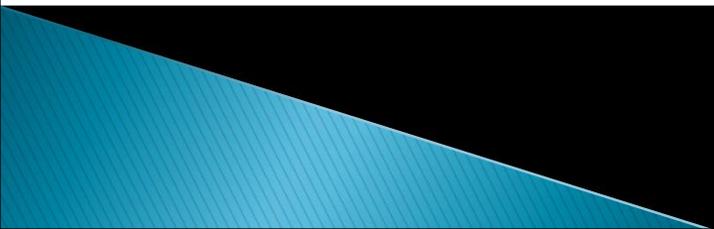
❑ **Computed radiography (CR) cassettes**

- ▶ Use PSP plates in place of film and screens
- ▶ The plates are coated with europium activated Barium Fluoro Halide
- ▶ Information is stored in PSP imaging plates as electrons, in semi stable higher energy states
- ▶ Image information is acquired by scanning the plate by a laser beam

Care of Cassette

- ▶ General care is aimed at the avoidance of rough handling by all who use them.
 - ▶ Helpful to mark each cassette, with identifying numerals which are inconspicuous; makes it easy to eliminate, if radiographic faults are observed.
 - ▶ Screens come with a sticker indicating the film speed and this sticker is placed on the outside of the cassette.
 - ▶ Flexible cassettes may tear at the edges allowing the entry of light, and this must be regularly checked.
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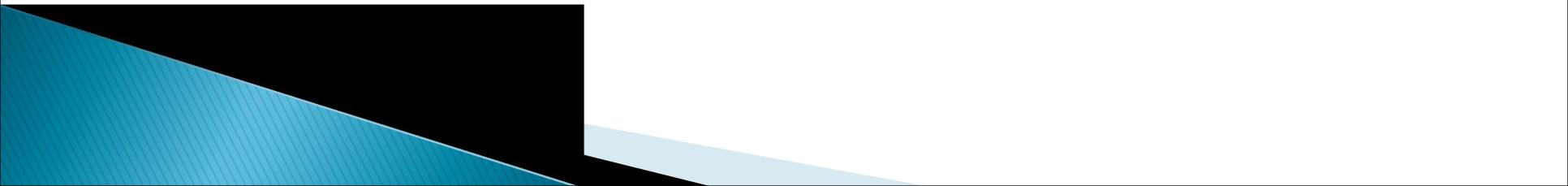
INTENSIFYING SCREENS

- ▶ This device is placed to convert the x-ray beam into visible light
 - ▶ This visible light interacts with the radiographic film , forming the latent image .
 - ▶ 30% of the x-rays incident on an intensifying screen will interact with the screen
 - ▶ Only 3.6% of x-ray radiation coming out of the patient's body contributes to the latent image formation .
 - ▶ A large number of visible light photons are emitted .
 - ▶ IS acts as an amplifier for the remanant radiation reaching the screen film cassette .
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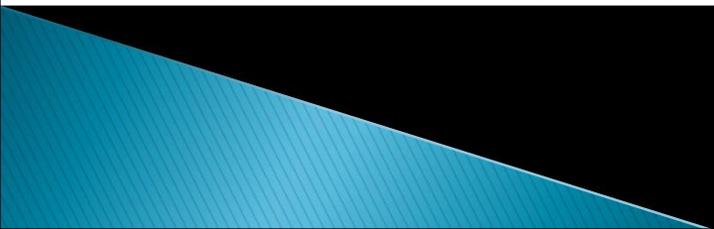
USE OF INTENSIFYING SCREEN

- ▶ The use of intensifying screen results in lowering the patient dose and also increases the radiographic contrast
- ▶ The size of the screen comes in sizes corresponding to film sizes .

PARTS OF THE INTENSIFYING SCREEN

- ▶ **Basically the intensifying screen has 4 layers**
 - ▶ PROTECTIVE COATING
 - ▶ PHOSPHOR
 - ▶ REFLECTIVE LAYER
 - ▶ BASE
- 

PROTECTIVE COATING

- ▶ This is the closest layer of intensifying screen to the film
 - ▶ Considered to be the transparent layer
 - ▶ The thickness of this layer is about 15–25 μm
 - ▶ It also protects the film from the damage caused due to mishandling and also helps in making the screen resistant to abrasion .
 - ▶ Build up of static electricity is eliminated and also provides a surface for routine cleaning without disturbing the active phosphor .
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PHOSPHOR

- ▶ Is the active layer of the intensifying screen
- ▶ The phosphor emits light during stimulation by x-rays
- ▶ The thickness varies from 150-300 μm
- ▶ Which depends on the type of the screen
- ▶ The active material of a conventional phosphor is crystalline calcium tungstate embedded in a polymer in a polymer matrix

FOUR MUST PROPERTIES PHOSPHOR SHOULD HAVE

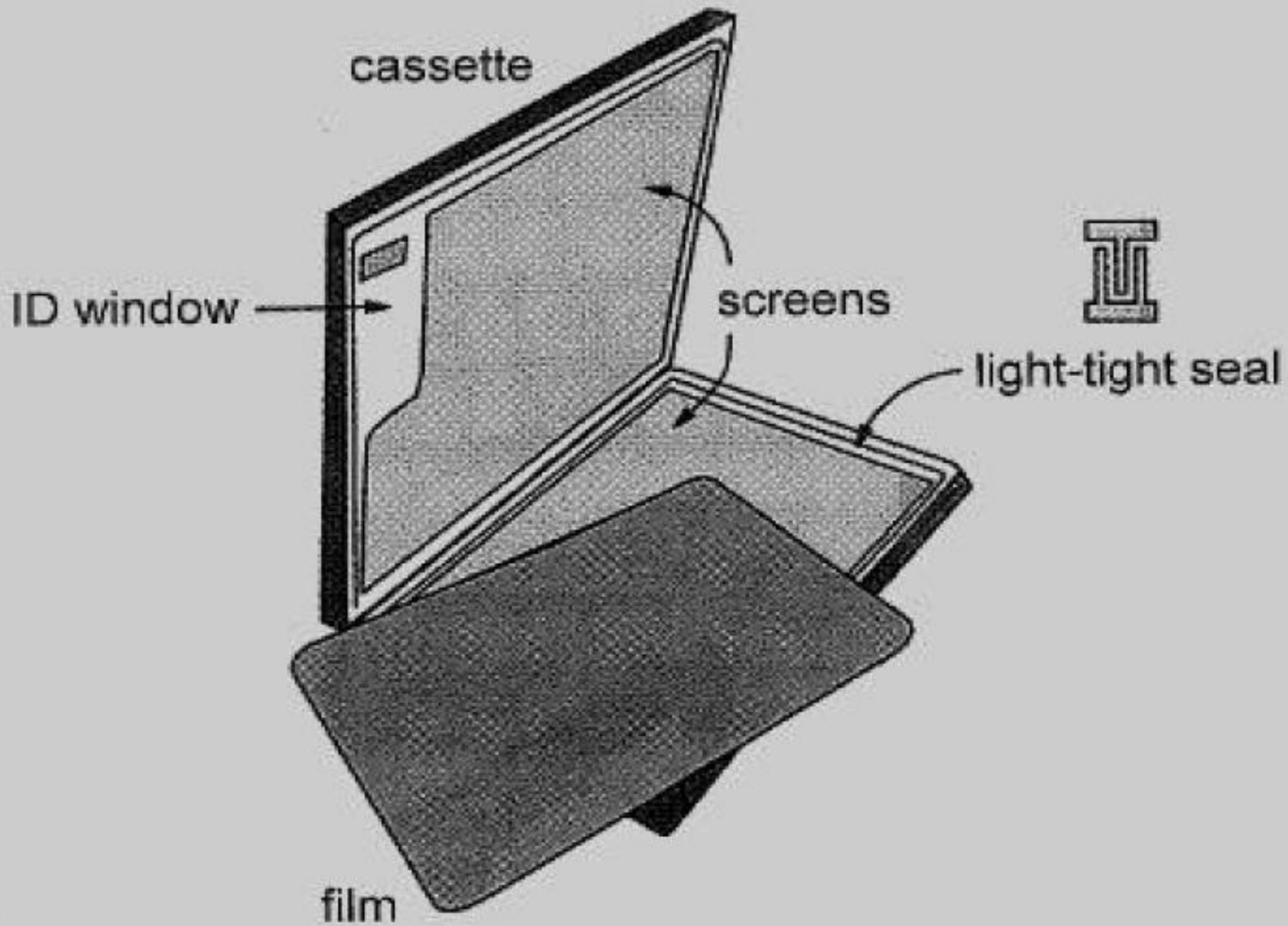
- ▶ Should have the high atomic number so the probability of the x-ray interaction is high
- ▶ It should emit a large amount of light per x-ray interaction
- ▶ The light emitted must be proper wavelength (colour) to match the sensitivity of the x-ray film
- ▶ Phosphor after glow , the continuing emission of light after stimulation of the phosphor by x-ray , should be minimum

REFLECTIVE LAYER

- ▶ The reflective layer is in between the phosphor and the base
- ▶ Having thickness of about 25 μm
- ▶ Made of a shiny substance such as magnesium oxide or titanium dioxide
- ▶ Light emit in all the directions after x-rays interact with the active phosphor , about half of the light is emitted in the direction of the film
- ▶ Reflective Layer intercepts light headed in other directions and redirects it to the film
- ▶ This way the reflective layer increases the efficiency of the intensifying screen

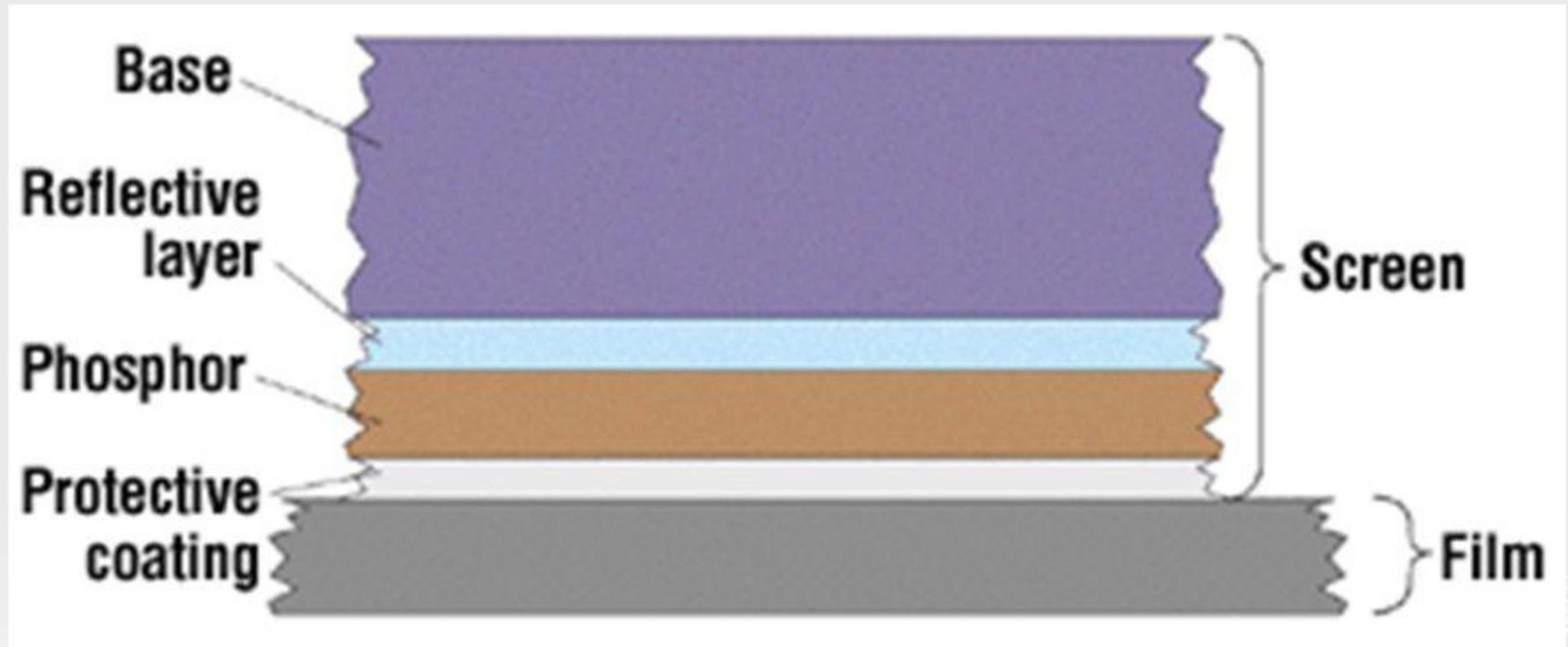
BASE

- ▶ The farthest layer of the film is base
- ▶ The thickness of base is 1mm
- ▶ This serves as a mechanical support for the phosphor layer
- ▶ cellulose nitrate was used as base after 1914
- ▶ Cellulose nitrate is quite flammable , so due to this property several fires were caused due to improper handling and storage of the film
- ▶ A new safety base was urgently sought and in 1924 a safety film with a cellulose triacetate base was developed
- ▶ Later in 1960 a polyester base was introduced
- ▶ Polyester as base offers the advantage of improved dimensional stability even in different humidity

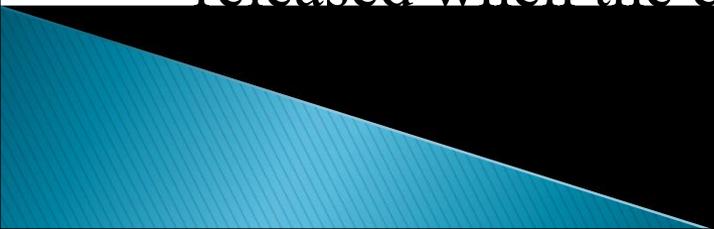


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Intensifying screens



LUMINESCENCE

- ▶ Material is said to be luminescent when it emits light in response to some outside stimulation , like the phosphor and the visible light so emitted is called the luminescence
 - ▶ Outer shell electrons of the luminescent material are raised to excited levels when stimulated
 - ▶ Creating a hole in the outer shell electron which makes the atom unstable
 - ▶ The hole is filled when the excited electron returns to its normal state and this transition is accompanied by the emission of electron to an excited state , and thus energy is released when the electron returns to its normal state
- 

- ▶ The wavelength of the light emitted is determined by the level of excitation to which the electron was raised
- ▶ Two types of luminescence are identified
 1. FLUORESCENCE : light emitted within 10^{-8} sec after absorption of x-ray photon is called fluorescence
 2. PHOSPHORESECENCE :the light emitted after 10^{-8} sec is called phosphorescence
 - Phosphorescence is virtually nil in IS
 - Phosphorescence in an intensifying screen is called phosphor glow.

INTENSIFYING SCREEN SPEED

- ▶ It refers to the amount of light emitted by the screen for a given amount of x-ray exposure.
- ▶ A Screen that is designated as fast, creates an increased amount of light compared with a screen designated as slow when both are exposed to identical kVp, and mAs.

INTENSIFYING FACTOR

- ▶ Screen speed can be measured by intensification factor, relative name or speed value.
- ▶ Intensification factor
- ▶ The exposure required to create a certain optical density without a screen is divided by the exposure required with a screen to create the same optical density, w/c determines the intensification factor

INTENSIFICATION FACTOR

- ▶ Intensification factor = $\frac{\text{exposure w/o screens}}{\text{exposure w/ screens}}$

Example:

- If a 100mAs creates an optical density of 1.0 on a direct exposure film and a 5mAs creates the same optical density value with a film/screen combination.
- Then that screen has an intensification factor of 20. The larger this value, the faster the speed of the screen

SENSITOMETRY

- ▶ In 1876 Ferdinand Hurter and Vero Charles Driffield, proposed a form of evaluation of the performance of photographic material.
- ▶ The main interest in radiography is how the film will react to (apparently) x-radiation, although usually the real interest is how the film will react to the light produced by the IS.

SENSITOMETRY

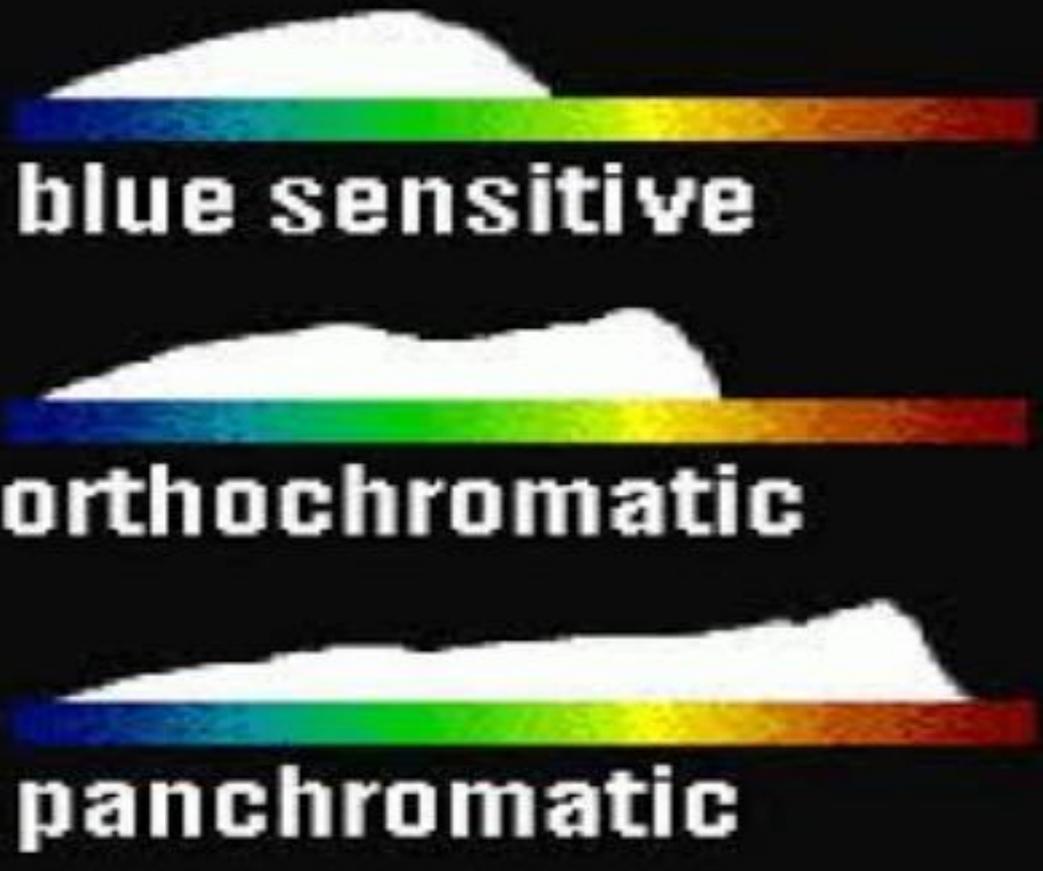
- ▶ The study of the relationship between intensity of exposure of the film and the blackness after processing .
- ▶ or is the measurement of the sensitivity of the film towards radiation.

SPECTRAL RESPONSE

- ▶ The ability or behavior of film emulsion to absorb different wave lengths differently is known as spectral response.
- ▶ Basic silver bromide is only sensitive for blue, violet and UV range of spectrum but Color sensitizers are added in film emulsion to control spectral response.

SPECTRAL RESPONSE

- ❑ Photographic emulsion can be classified as:
 - ▶ Monochromatic(sensitive up to blue color)
 - ▶ Orthochromatic(sensitive up to green color)
 - ▶ Panchromatic(sensitive up to red color)

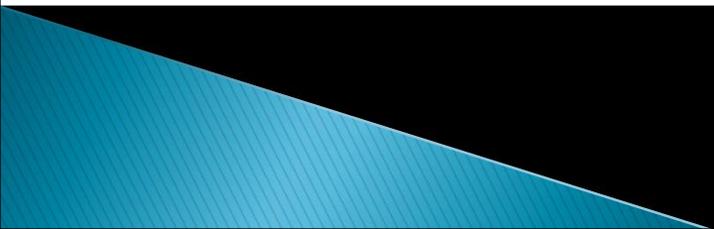


blue sensitive

orthochromatic

panchromatic

SENSITOMETRY

- ▶ **Photographic density** is normally the blackness of the film.
 - ▶ **Characteristic curve** is the graph which shows the relationship between the log of exposure and the density produced in the film.
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PHOTOGRAPHIC DENSITY

- ▶ On the developed film, the deposit of Ag may be said to have a light-stopping effect or a degree of blackness; this varies with amount of Ag present, which in turn increases with increase in exposure.
- ▶ The greater blackening of the film allows less light to be transmitted.

EQUIPMENTS USED FOR SENSITOMETRY

- ▶ Sensitometer (Penetrameter):– measures film sensitivity to light,
and
- ▶ shows the range of densities on an image.

PENETRAMETER

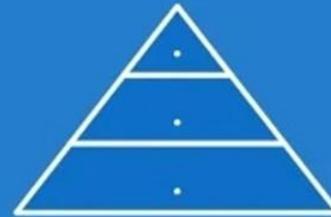


Step-wedge cause the differential attenuation that creates different range of intensities.

➤ *SENSITOMETRY*

It provides measurement of light transmitted through film or measures optical density

RADIATION



STEP WEDGE

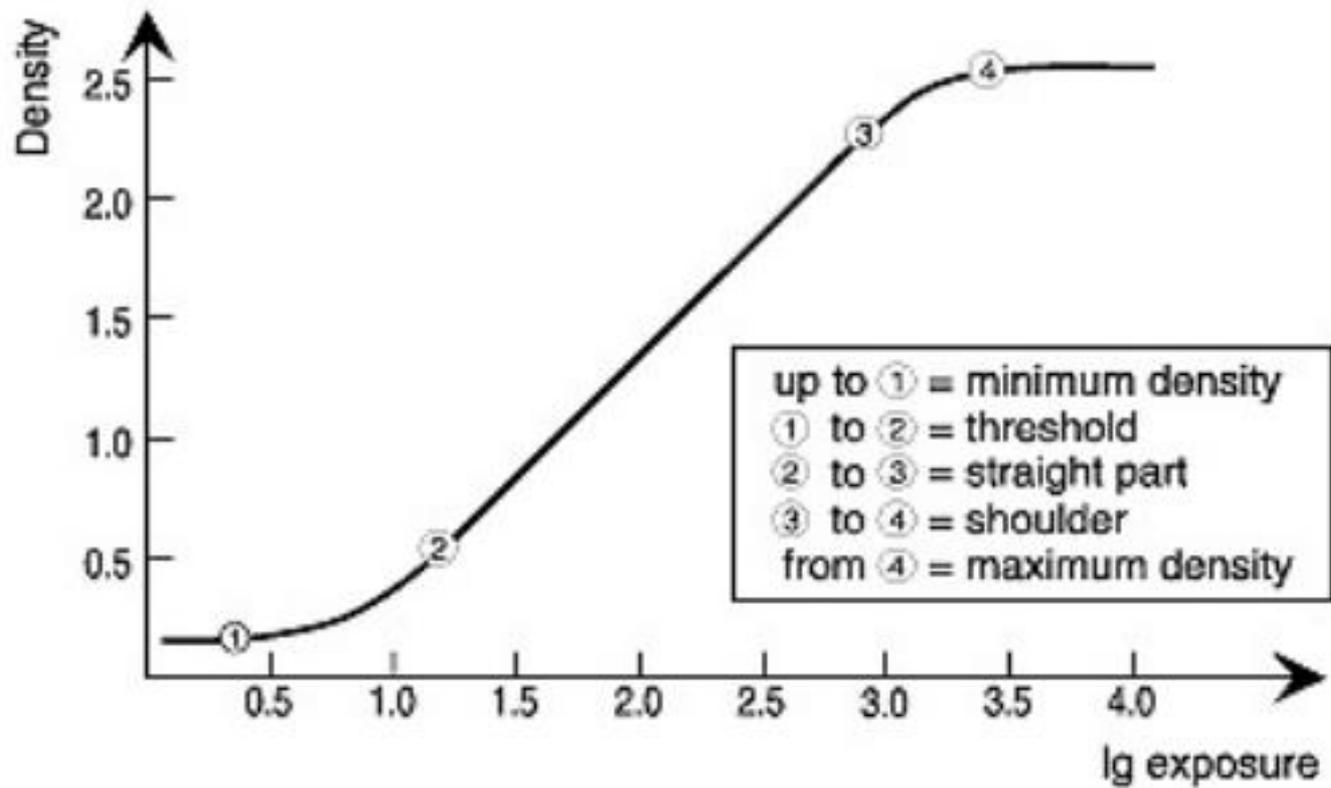


DENSITY OBTAINED IN THE IMAGE



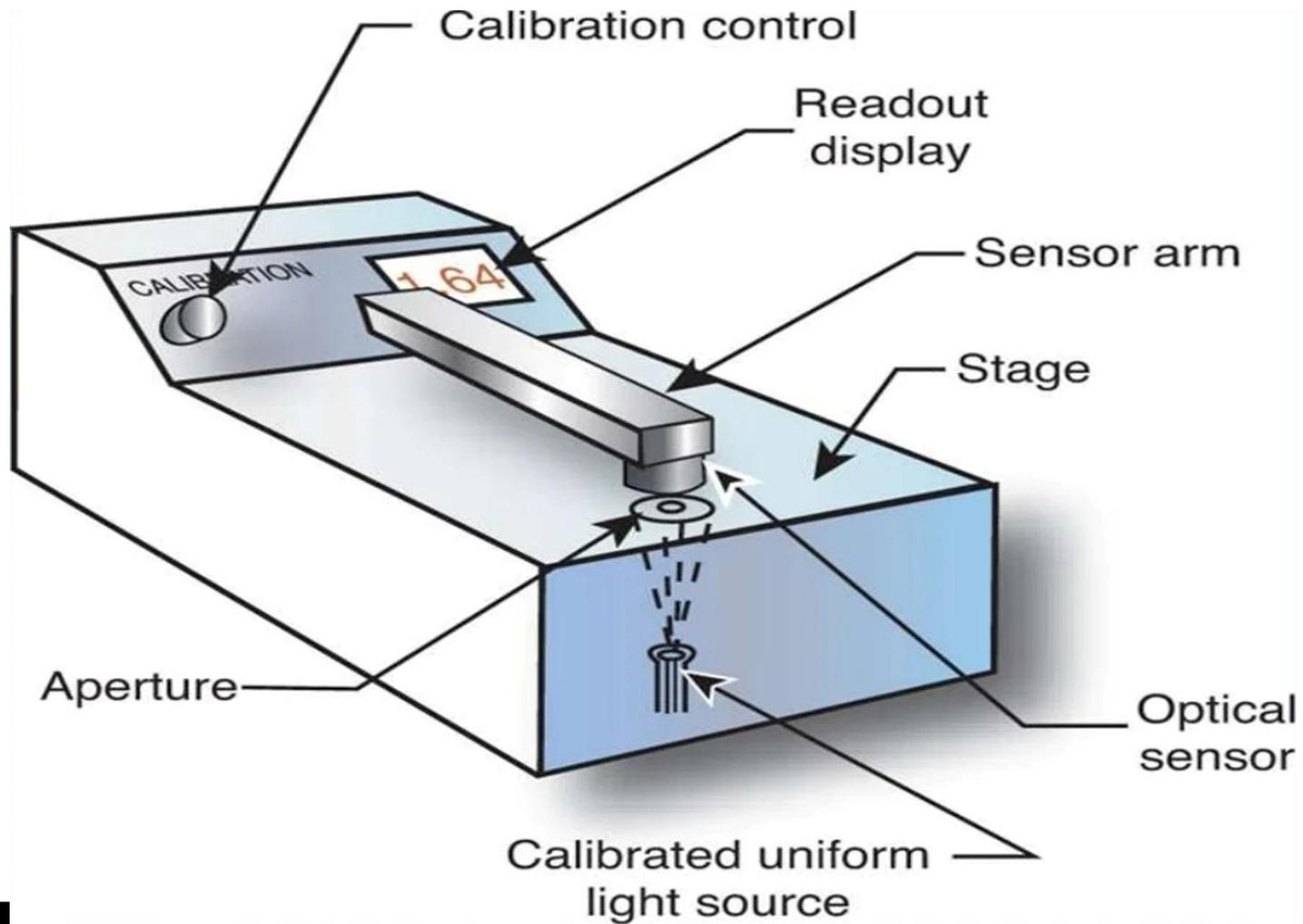
CHARACTERISTIC CURVE

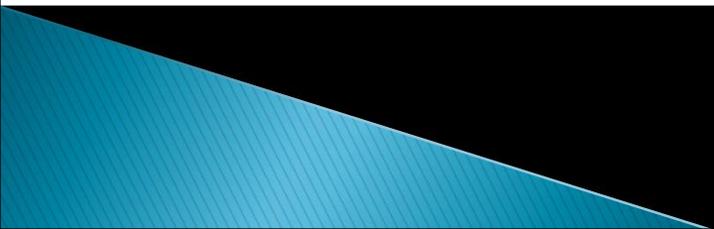
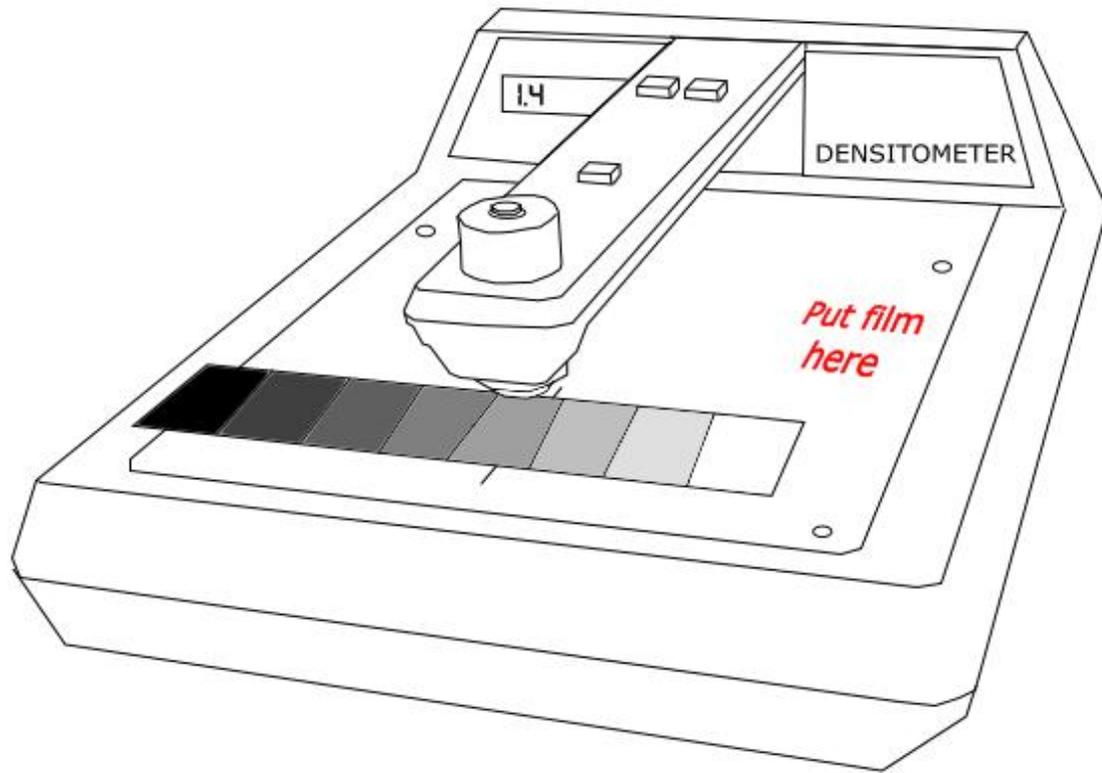
- ▶ The relationship between log of the exposure of a film received and the density produced by the exposure is the curve known as characteristic curve.
- ▶ It is found that the most useful graph is obtained by plotting
- ▶ Density (a logarithmic value) in Y-axis and the log of exposure in X-axis.



- ▶ This can be made for any photographic material and is characteristic of the material under certain conditions of exposure and processing.
- ▶ A series of exposures is done which progress in steps by a factor on the radiographic material and then the series of densities can then be measured by densitometer.

Densitometer





HOW TO MAKE CHARACTERISTIC CURVE?

- There are three basic stages involved
 - ▶ Exposing and processing film
 - ▶ Measuring the densities produced
 - ▶ Plotting the graph

Thank you