Basic Mammography

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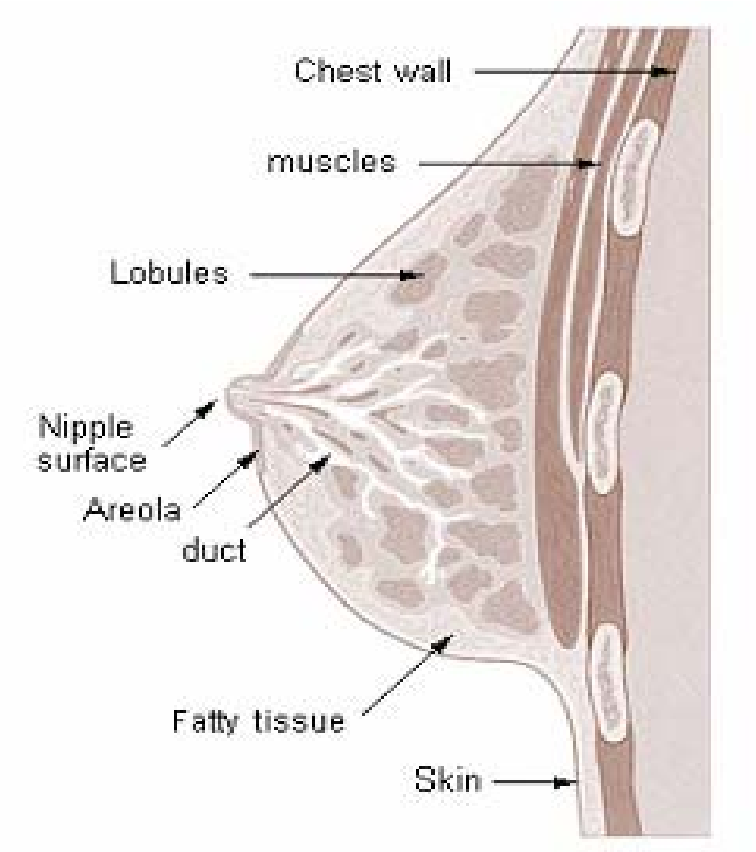
- Energy Requirements
- Types of X-Rays
- Added Tube Filtration
- Components
- Images

Breast Anatomy

It is difficult to obtain good subject contrast between normal and diseased tissues in because of subtle attenuation difference. The breast is composed of glandular and fibrous tissue.



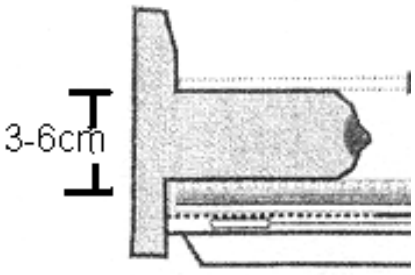
Energy Requirements

Appling High Energies- Diminishes subject contrast

Appling Low Energies- Results in contribution to tissue dose without significantly to image formation.

Optimization of Energy

For breast of tissue thickness 3-6 cm the optimal energies fall between 17-25keV



The quasi-monoenergitic source can be obtained by using anode targets composed of:

Molybdenum
Ruthenium
Rhodium
Silver
Cadmium

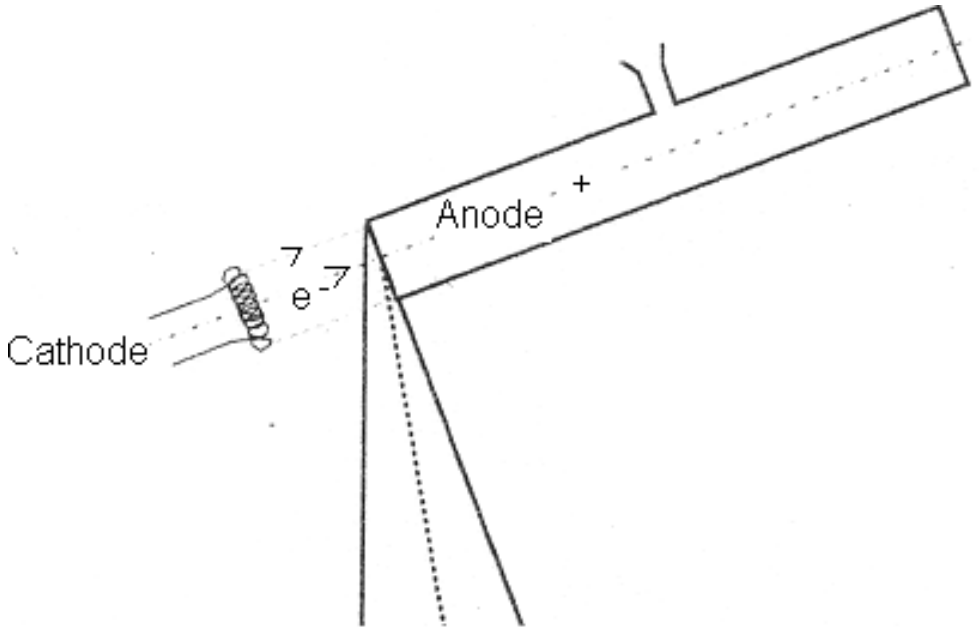
} Characteristic x-rays occur between 17-25keV

What are Characteristic X-Rays?

Two types of x-ray

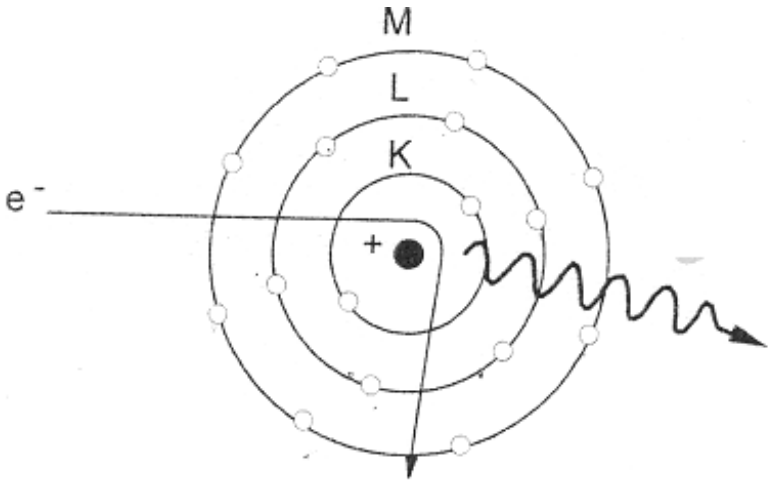
1) Bremsstrahlung
2) Characteristic

These x-rays are produced by electrons that are accelerated towards a target.



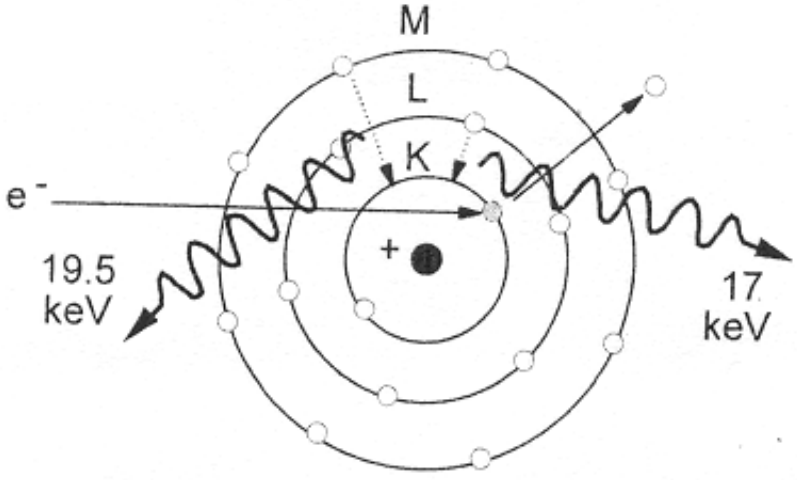
Current is driven through the filament producing thermionic emission of electrons.

Bremsstrahlung



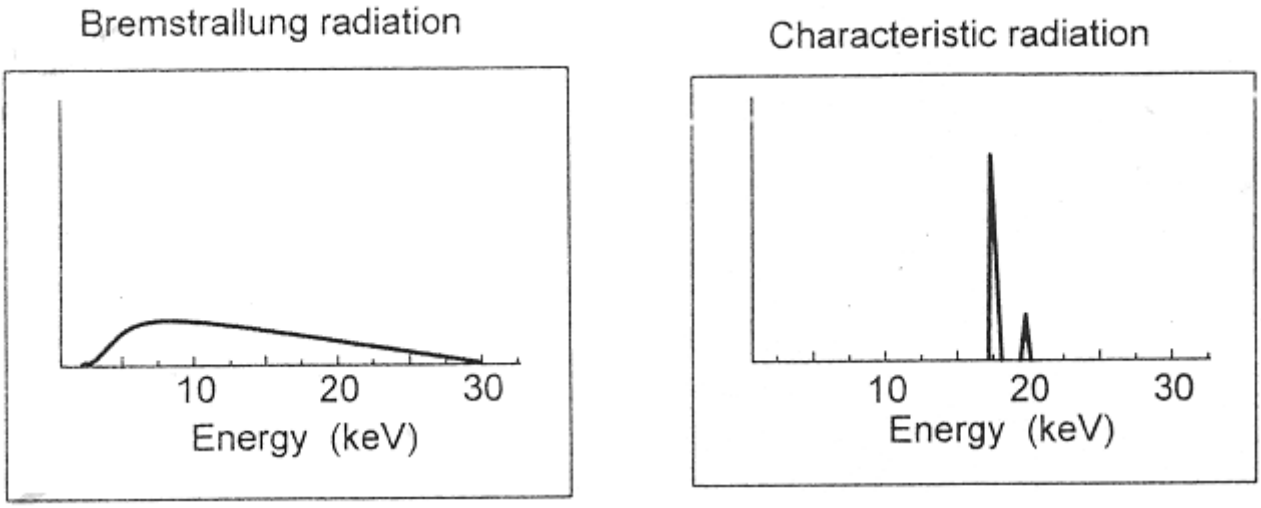
Molybdenum (Moly) Target
Electron Energy 30keV

Characteristic



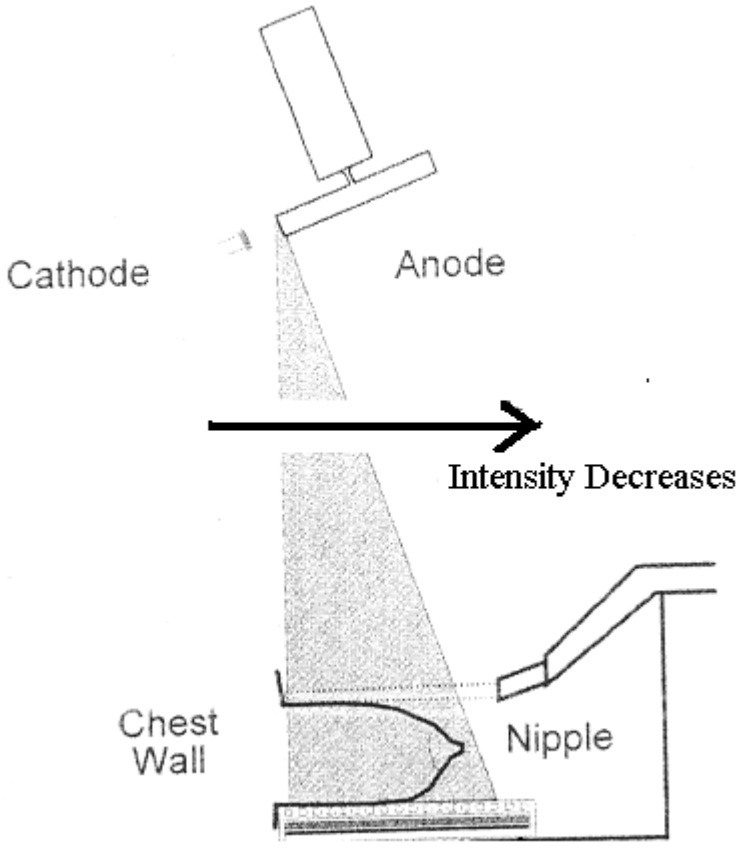
Edges
K = 20 keV
L = 3 keV
M = 0.5 keV

Energy Spectrum



Heel Effect

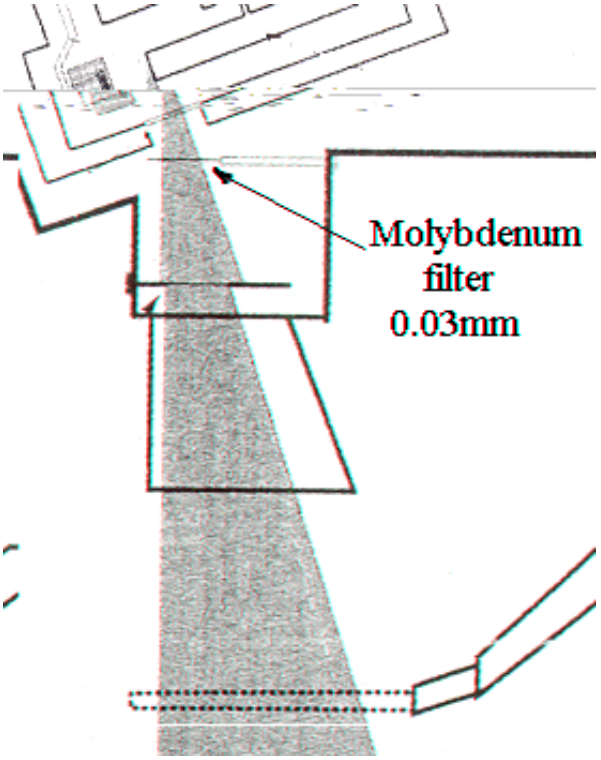
The energy of the beam is non-uniform. The intensity of the beam decreases as it moves further from the source.

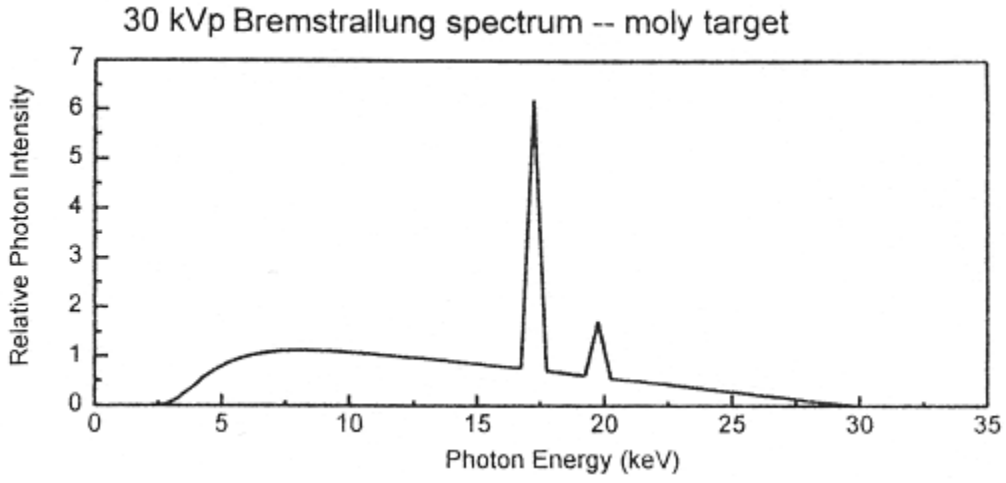


Compensating the Effect

The chest wall is positioned along the most intense area of x-ray beam leaving the less dense area of the breast under the less intense beam. This creates a more uniform exposure of the breast.

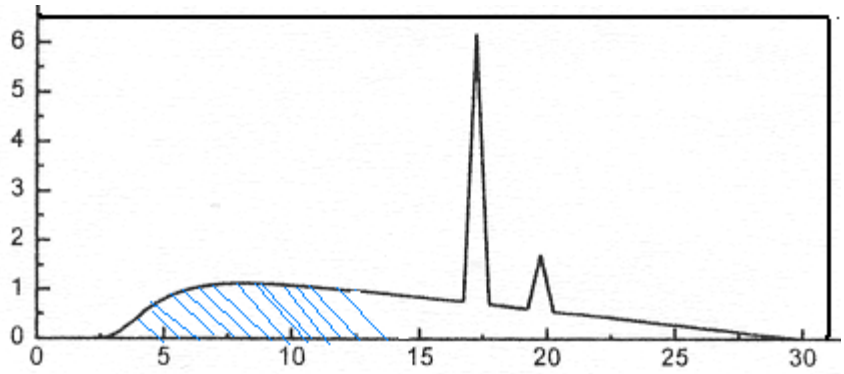
Energy Range Minimization by added Tube Filtration



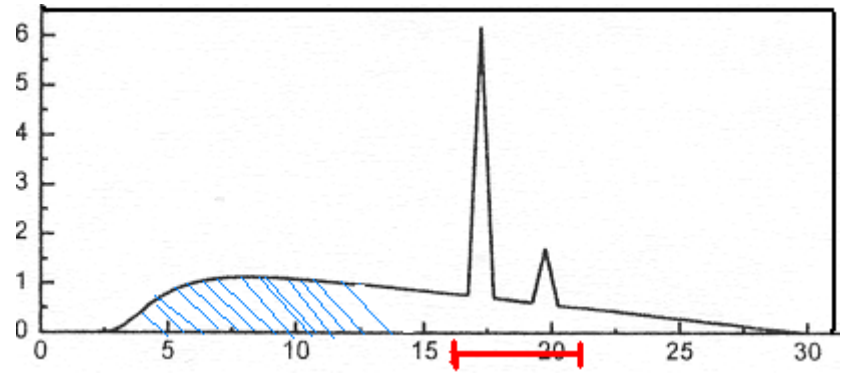


The tube selectively attenuates and optimizes the beam spectrum for three reasons.

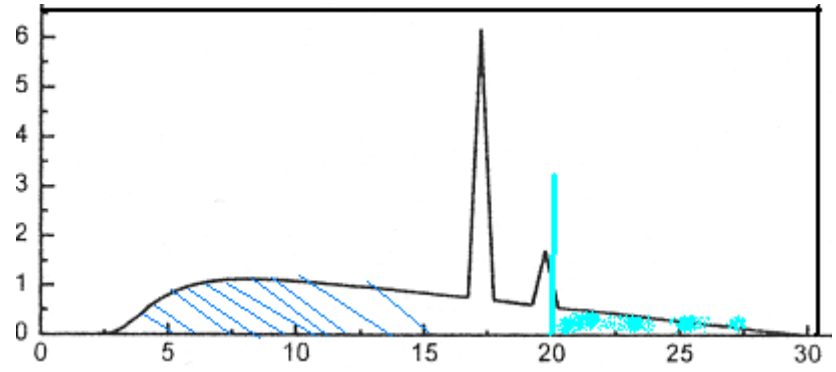
1. The filter absorbs the very low energies.

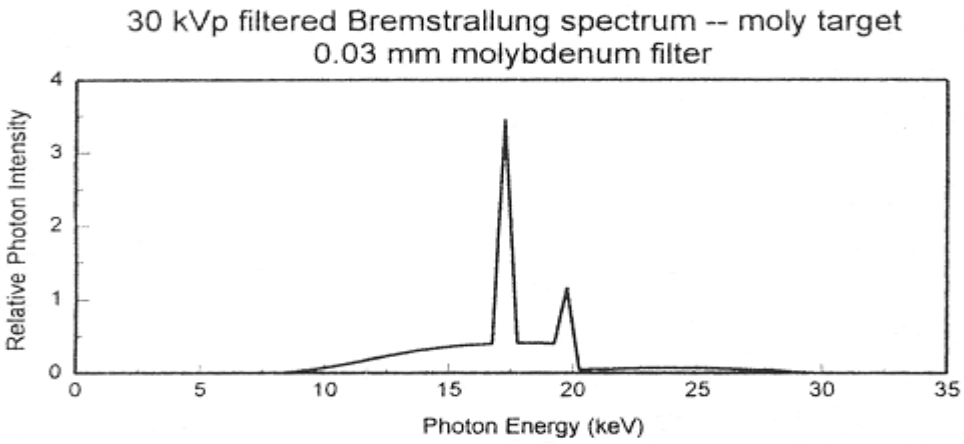


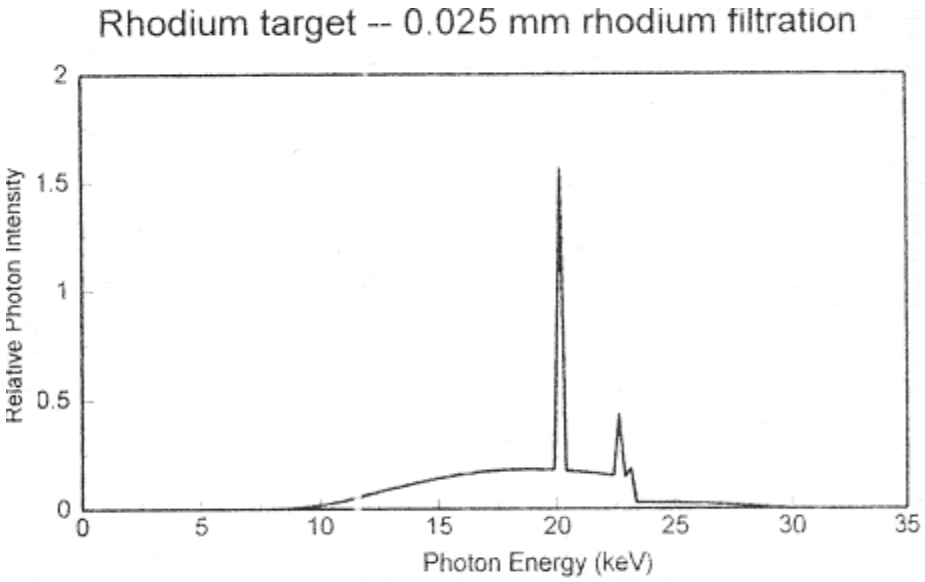
2. Minimal filter attenuation occurs in the same energy range as characteristic x-rays.



3. Absorption edge increases abruptly at the k-shell binding energy.





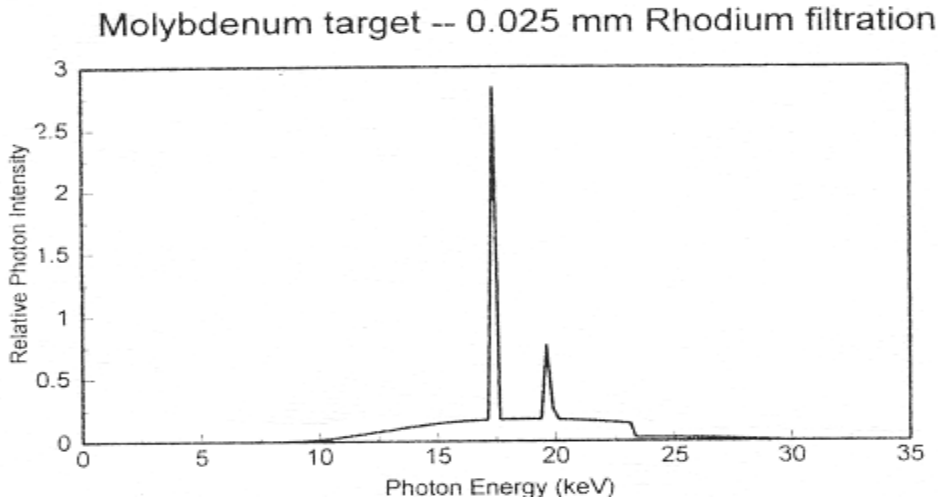


For thick, dense breast Rhodi-Rhodi is preferred.

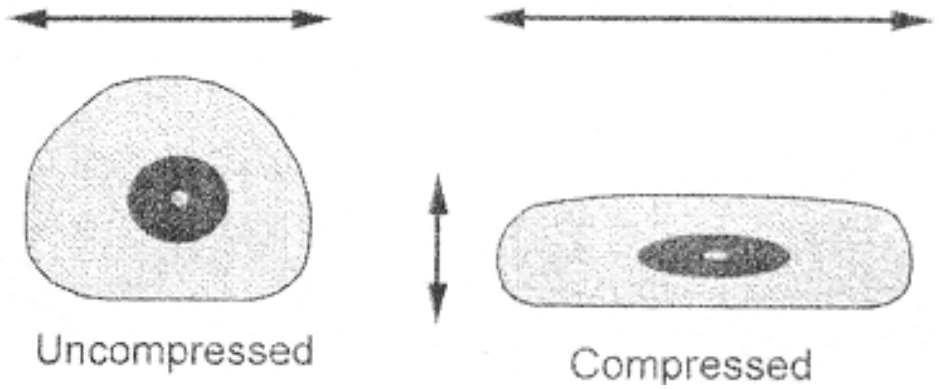
The high energies allow:

Reduction of exposure time, which lowers radiation dose by 40%

Moly-Rhodi Combination:



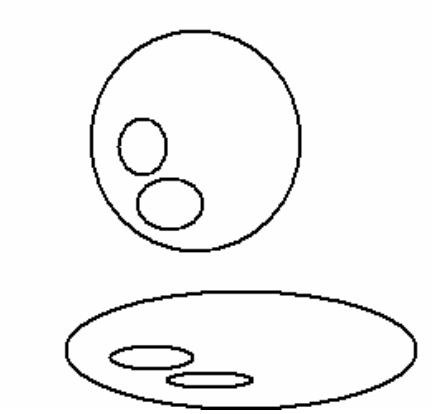
Compression



The compression paddle:

1. decreases x-ray scatter

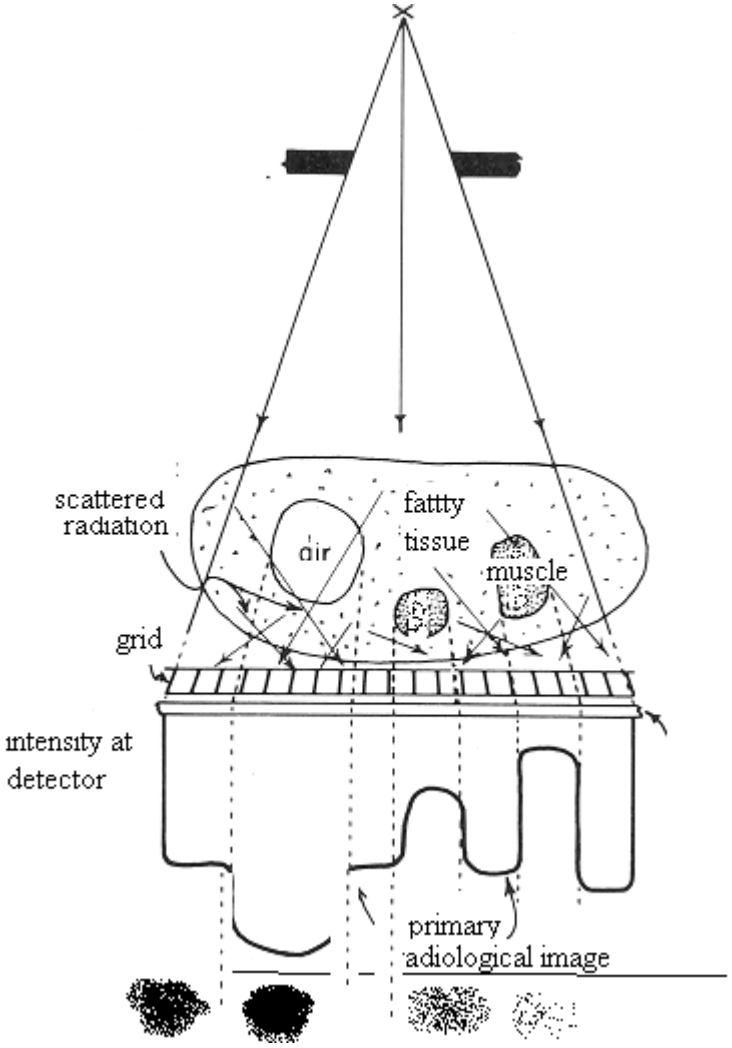
2. redistributes the anatomical details to reduce tissue overlap.



3. immobilizes the breast to eliminate image burring caused by motion.

Grid

The grid reduces the amount of scatted radiation, which produces a better image.



Film

Denser objects: have higher attenuation, which means they absorb more x-rays. There objects produce a lighter image on film.

Less dense objects: have lower attenuation and produce a dark image on the film

Phototimer

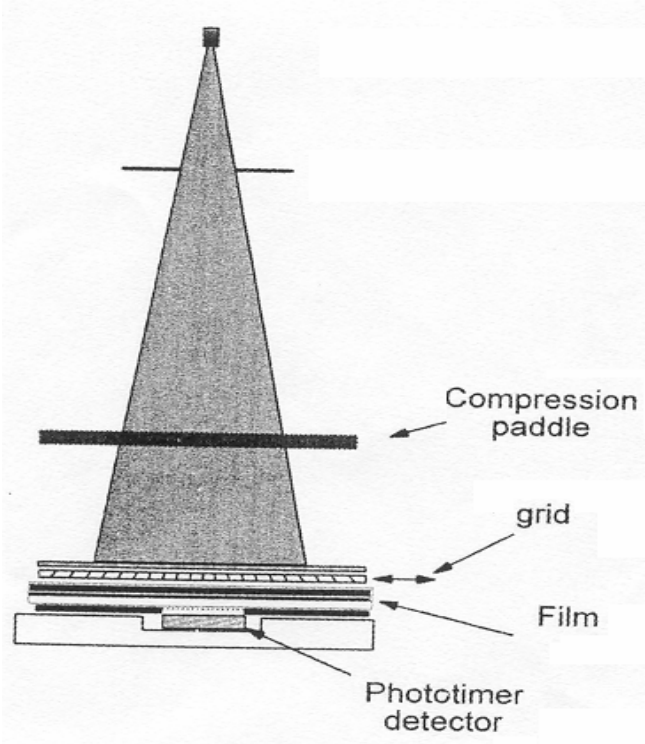
The phototimer ends the exposure.

Thin, lesser dense breast- require fast response from phototimer to end exposure

Thicker, more dense breast- require more exposure time

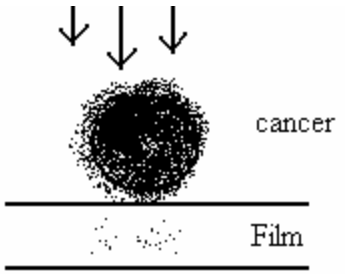
To estimate the time a pre-sampling is performed.

The pre-sampling estimates thickness and breast composition allowing for automatic adjustments to exposure times.



Images

Cancer shows high density because cancer is very firm and resists being compressed as thinly as normal tissue.



Density

High density: clearly higher than surrounding, suspicious.

Equal density: density not apparently different, neutral significance.

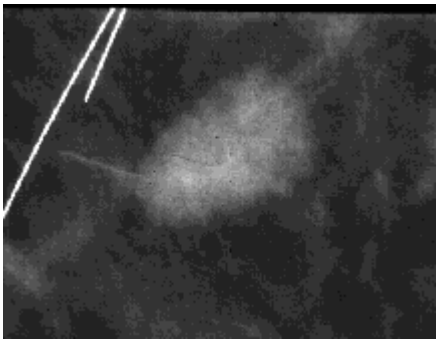
Low density: density lower, but not fat containing, neutral significance.

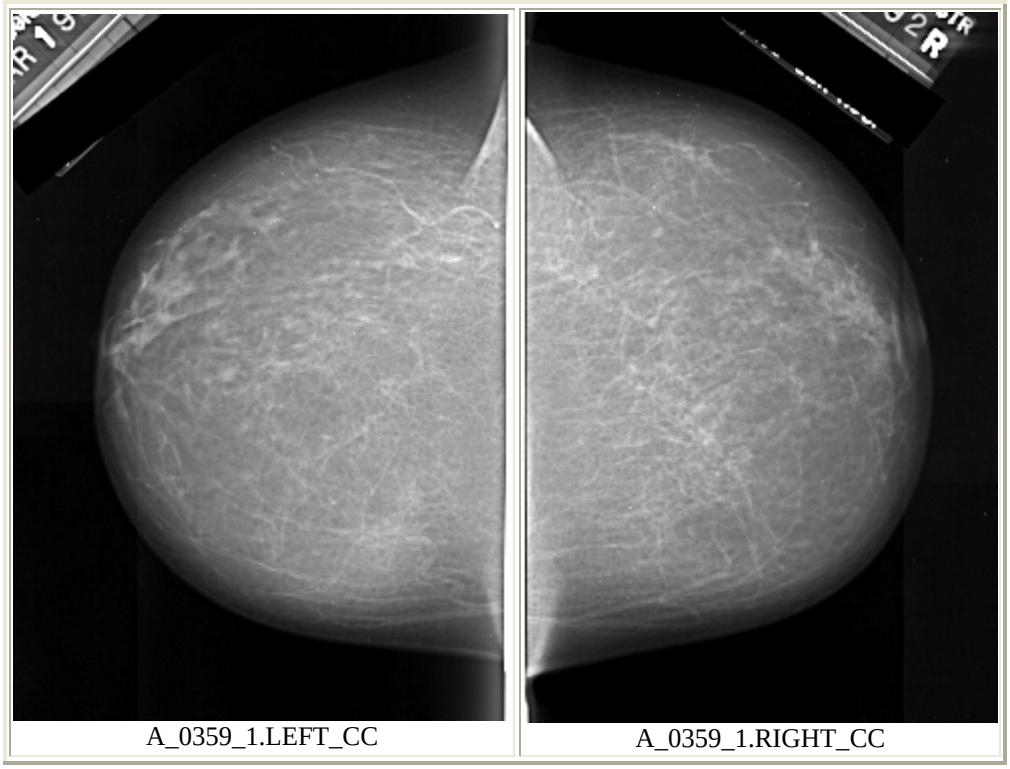
Shape

Well defined masses with smooth edges are often benign

Irregular shapes with non-smooth edges are often malignant.

Normal well defined mass:
Lymph node





A_0359_1.LEFT_CC

A_0359_1.RIGHT_CC

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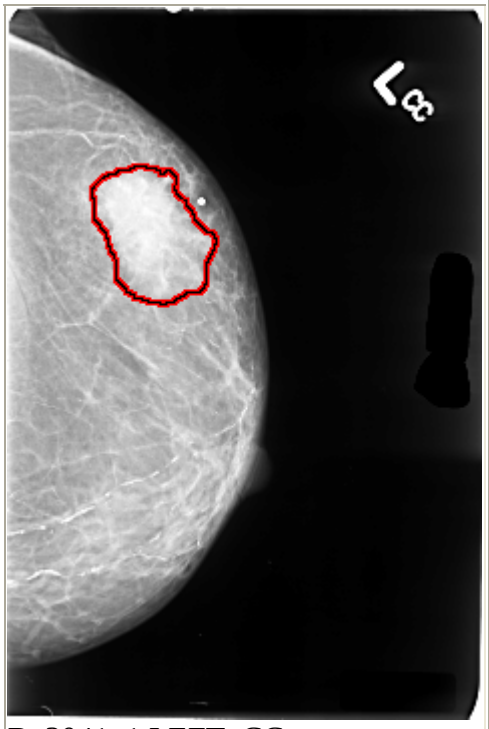

B_3041_1.LEFT_CC

References

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Thomas S. III Curry, James E. Dowdey, Robert C. Jr Murry: Christensen's Physics of Diagnostic Radiology. 4th ed. Philadelphia, Pa: Lea and Febiger; 1990