Mammography:

Mammography Equipment

MRT Program

Mammography Considerations

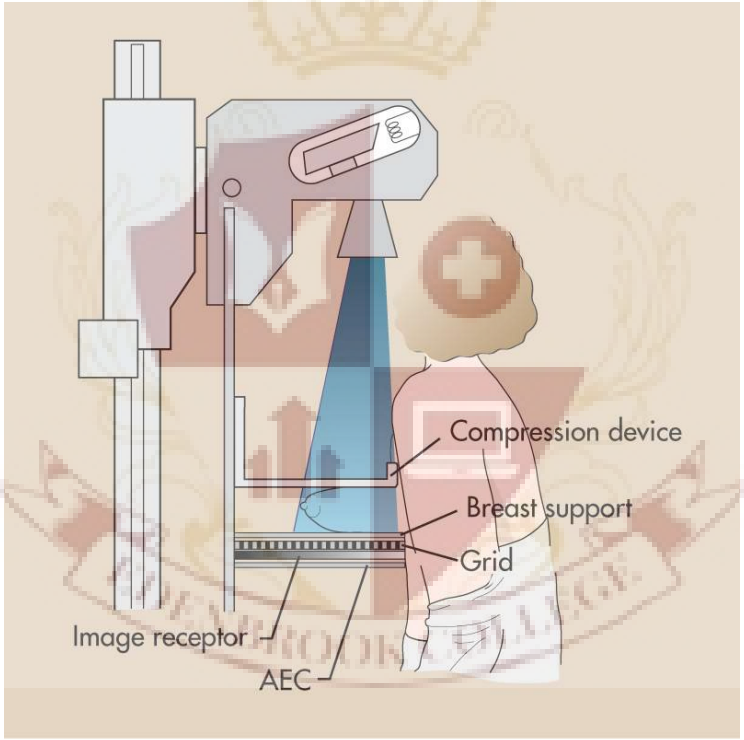
- Conventional radiography, the subject contrast is greater
- Imaging soft tissue- very similar densities and effective atomic numbers
- Soft tissue radiography, there is less subject contrast

Mammography Units

- Conventional units are **unacceptable** for mammography.

- Mammography requires specially designed, dedicated machines.
  - Target/Filter Material
  - Focal-Spot Size
  - Compression device
  - Low ratio grid
  - AEC
  - Collimation

Mammography Tube and Receptor



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High Frequency Generator

- High Frequency
- Precise control of kVp, mA and time
- Linearity and reproducibility are excellent
  - Single-phase input unit
  - DC voltage waveform
  - DC power to a high frequency
- Results in voltage ripple at ~ 1%, essentially constant potential
  - Reduced space requirement, cost and equipment bulk
  - Housed inside of mammography unit

Target Composition

- Mammographic x-ray tubes are manufactured Molybdenum (Mo), or Rhodium (Rh)
- Mo/Rh and Rh/Rh combinations are used for better penetration of denser breasts with thick tissues
- X-rays most useful for enhancing differential absorption in breast tissue and for maximizing contrast are those in the 17-24 keV range.
- Mo has an atomic number of 42 compared and produces most prominently characteristic x-rays

Target Composition (cont.)

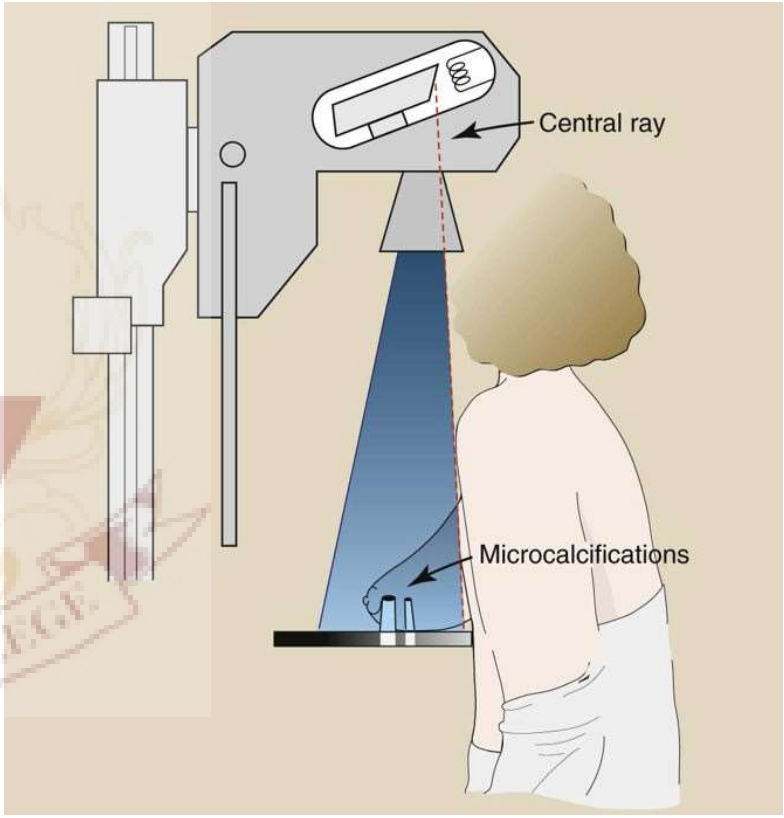
- Ro has a slightly higher atomic number (Z) of 45 and therefore a slightly higher K-edge and more intense bremsstrahlung x-rays
- Bremsstrahlung x-rays are produced easily in target atoms with Z number
- Mo and Rh K-characteristic x-rays have energy corresponding to their respective K-shell electron binding energy,
- Most effective for breast imaging
- Mo-Mo, Mo-Rh and Rh-Rh target filters common

Focal Spot

- Usually have stated focal spot sizes
  - E.g. - Large 0.3 mm, Small 0.1mm
- Shape
  - Circular
  - Rectangular
- Tilting the x-ray tube is very important
  - Line-focus principle
  - X-ray intensity

Focal Spot Size

- When the x-ray tube is tilted in its housing, the effective focal spot is small, the x-ray intensity is more uniform and tissue against the wall is imaged



Filtration

- Low kVp is used in mammography important that the x-ray tube window not attenuate the x-ray beam significantly
- Dedicated mammography x-ray tubes have either a beryllium (Z=4) window or a very thin borosilicate glass window
- Most have inherent filtration in the window of approx. 0.1 mm Al equivalent
- Under no circumstances is total beam filtration less than 0.5mm Al equivalent
- Filters purpose to reduce higher energy bremsstrahlung x-rays

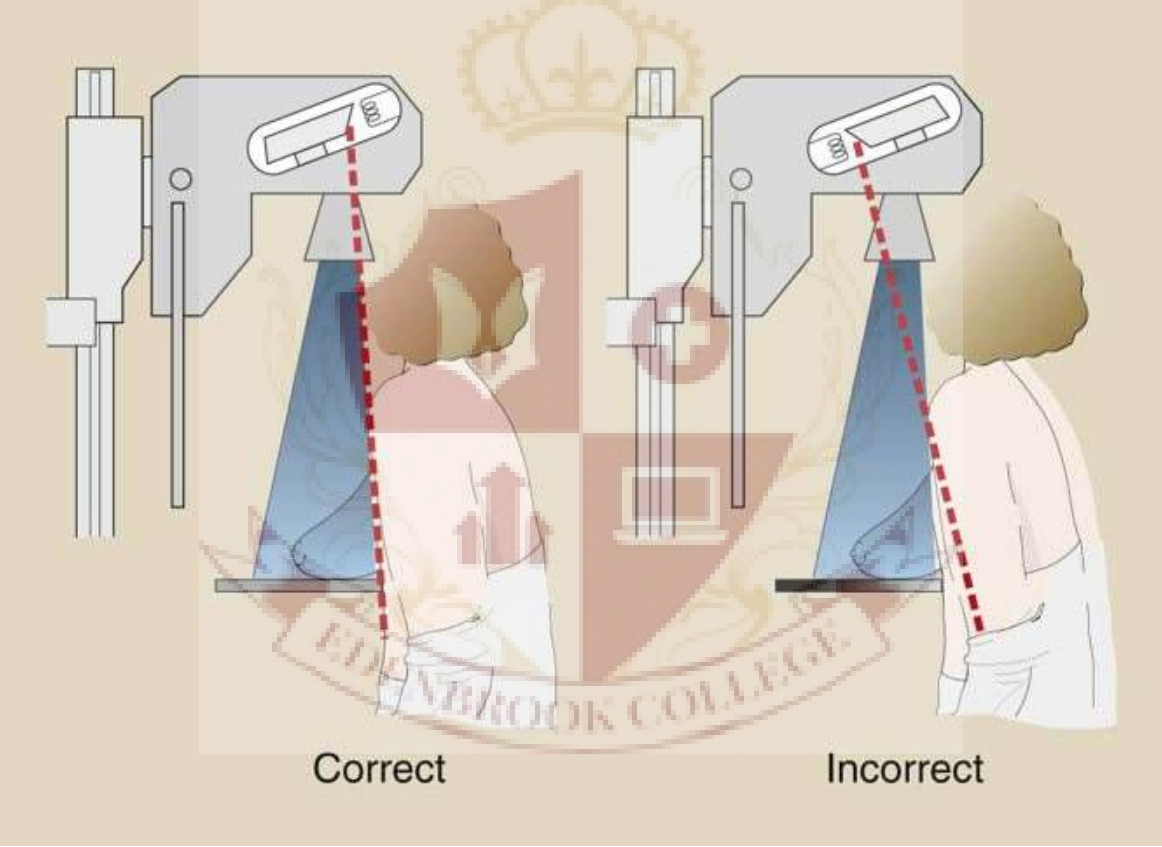
Filtration

- Technologist selects the proper filter after determining patients breast characteristics
- Use of filter with same element as the target allows the K-characteristic x-rays to expose the breast while suppressing higher and lower bremsstrahlung x-rays
- If Mo target is used then Mo filtration of 30 micrometers or Rh filtration of 50 micrometers is recommended
- If Rh target used then filtered with 25 micrometers (thicker more dense breast tissue)
- Regardless half value layer is low

Anode Heel Effect

- Anode heel effect is important to mammography
- The conic shape of the breast requires higher intensity near the chest wall than at the nipple to ensure near-uniform exposure of the IR
- Done by positioning the cathode to the chest wall
- A shorter SID of 60-80 cms with the x-ray tube tilted =smaller focal spot size
- More comfortable for patients as head is close to x-ray tube housing during exam
- Most mammo units use grids, AEC and compression device

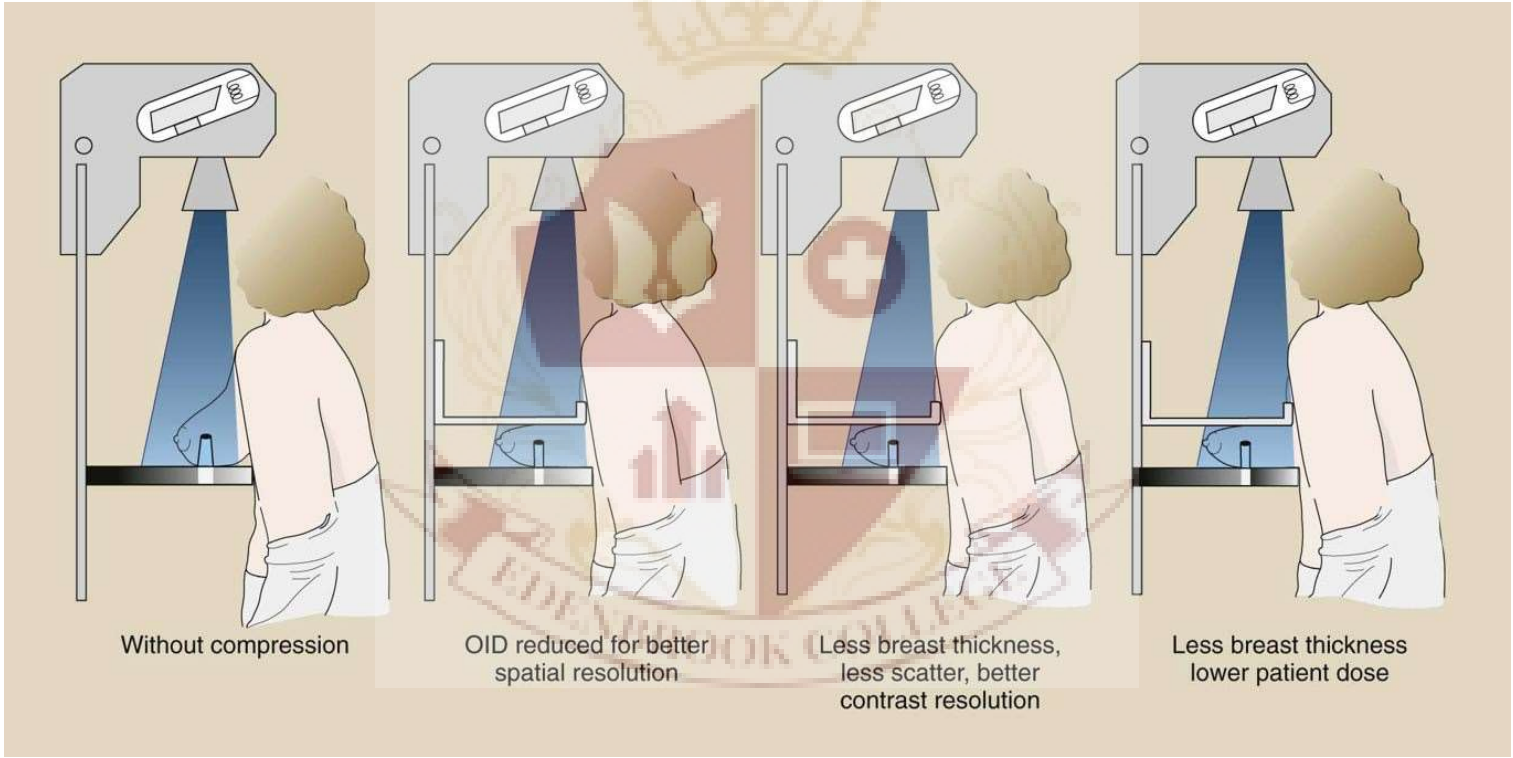
Anode Heel Effect



Compression

- Vigorous compression must be used
- All tissue is brought closer to the IR and focal spot blur is reduced
- Reduces absorption blur and scatter radiation
- All mammo units have built in compression device that's parallel to IR
- Necessary to get best image quality
- 15-30 pounds of pressure (up to 40 pounds) may be applied

Compression



Compression

- Compression spreads out breast tissue so easier to see small changes



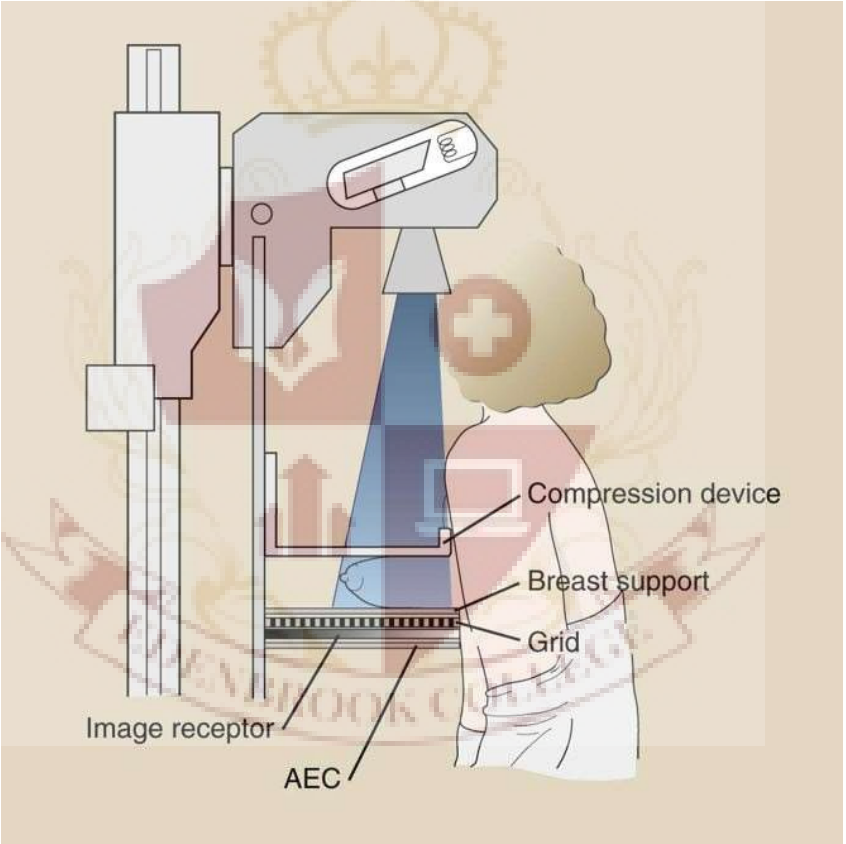
Grids

- Specialized grids developed in 1980's to reduce scatter and increase contrast
- Moving linear focused grids and other highly specialized
- Ratio of 4:1 or 5:1 focused to the SID to increase image contrast
- Grid frequencies of 40 lines/cm are typical
- Doubles dose to patient but is still considered low and contrast improved significantly

Automatic Exposure Control

- Measure x-ray intensity and also quality of the beam
- Positioned after the image receptor to minimize the OID and improve spatial resolution
- Can have single detector or multiple positioned along the chest wall to the nipple axis detectors are filtered differently so AEC can estimate the beam quality
- Allows assessment of breast composition
- And selection of proper target filter combination

Automatic Exposure Control



Full Field Digital Mammography (FFDM)

- Allows radiologists to manipulate digital images electronically
- Improves the sensitivity of mammography especially with women with dense breast tissue
- Digital breast imaging requires much finer resolution than other body imaging
- FFDM files are extremely large require lots of archival pace in PACS and viewed on special monitors (5megapixels)

Digital Breast Tomosynthesis (DBT)

- Three dimensional imaging technology that acquires images of stationary, compressed breast at multiple angles during a short scan
- Reconstructed images into thin, high resolution slices that can be displayed individually or in a dynamic cine mode
- These units can simultaneously acquire the traditional two dimensional mammogram and the additional exposures necessary to reconstruct a 3-D image
- Reduce number of recalled patients for additional views, number of biopsies in benign lesions and result in fewer short interval follow up exams

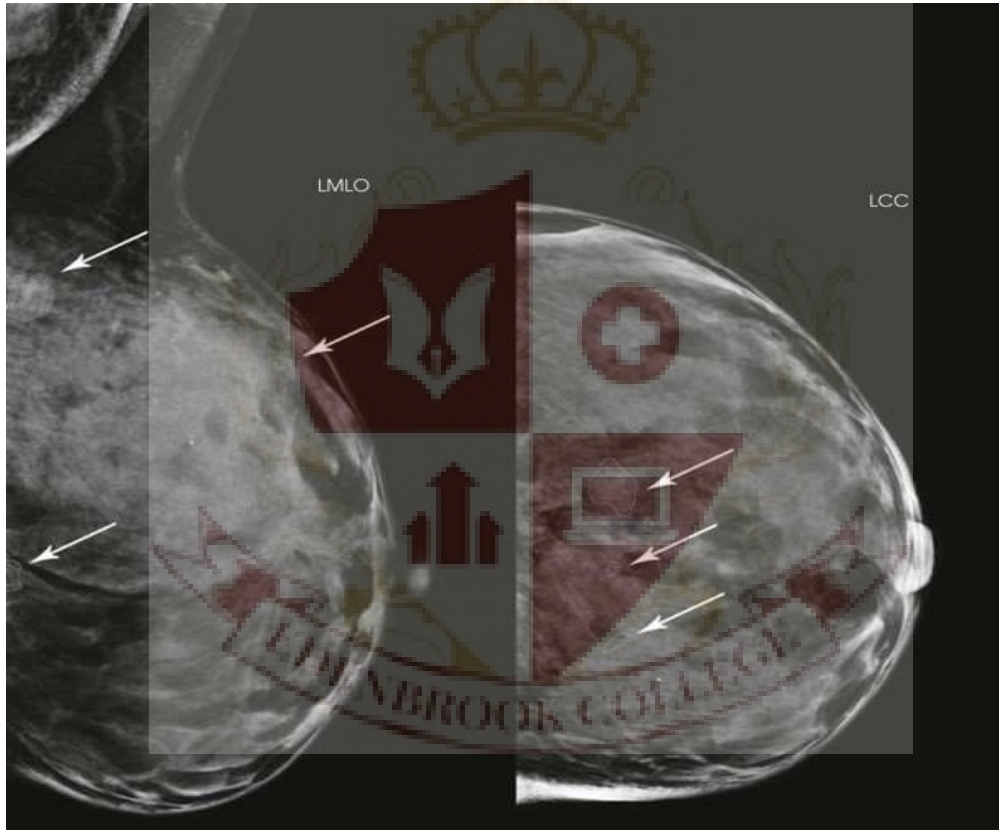
Computer Aided Detection

- Even with high-quality mammography some breast cancers get missed on initial interpretation
- Double reading of screening mammograms by a second radiologist can improve detection rates by approximately 10 %
- Efforts have been made to develop and apply CAD system to achieve the same result
- Add in a second reading and CAD can increase detection by another 8 %

Computer Aided Detection

- CAD is a computer analysis of digitally acquired images as a second opinion before making final interpretation
- An area is pointed out to the radiologist to check but up to the radiologist to order more views
- Objective is to improve early detection rates and minimize the number of unnecessary breast biopsies
- CAD is not subject to bias, fatigue or distractions
- Has become standard of care for many mammography practices

CAD At Work



Patient Comfort

- Patient comfort a priority for technologists and physicians
- Developed positioning aids to increase visualization of tissue
- Included rounded corners on Bucky devices and compression paddles, automatic release of compression post exposure and foot pedal controls