



Subject Name: Biomedical Instrumentation Design II 2

5th Class, Second Semester

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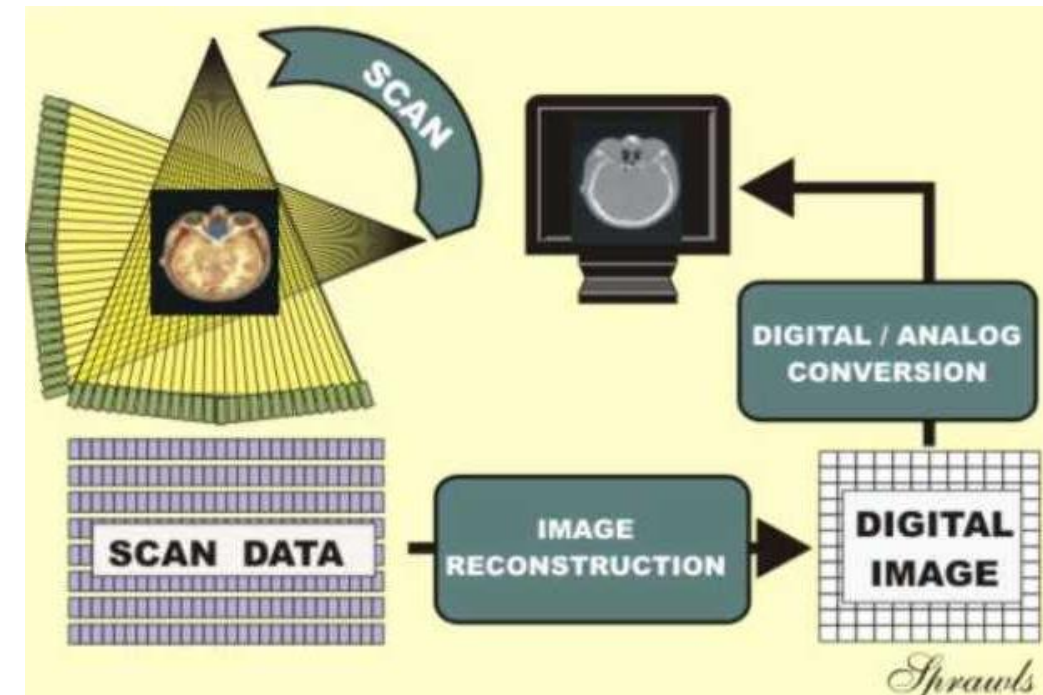
Lecture No.: 5

Lecture Title: Image reconstruction.



Image Reconstruction

- Each time the x-ray tube is activated, information is gathered and fed into the system computer.
- The computer processes thousands of bits of data from each scan acquired to create the CT image.
- These data must be saved to a computer file so that the information will be available for use in forming an image.
- These stored data can later be retrieved and manipulated.





- Raw data (scan data) are the thousands of bits of data acquired by the system with each scan and waiting to be made into an image. Raw data requires a vast amount of hard disk space.
- Image reconstruction: the process of using raw data to create an image.
- Prospective reconstruction: the reconstruction that is automatically produced during scanning.
- Retrospective reconstruction: the same raw data may be used later to generate a new image.
- Because raw data include all measurements obtained from the detector array, various images can be created from the same data.



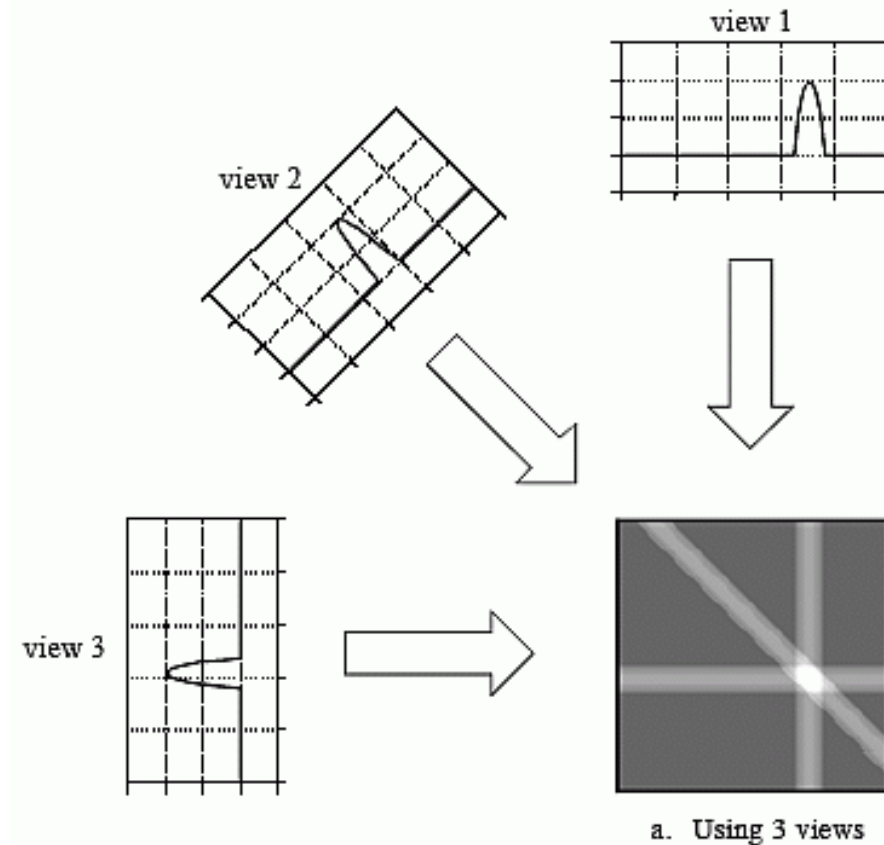
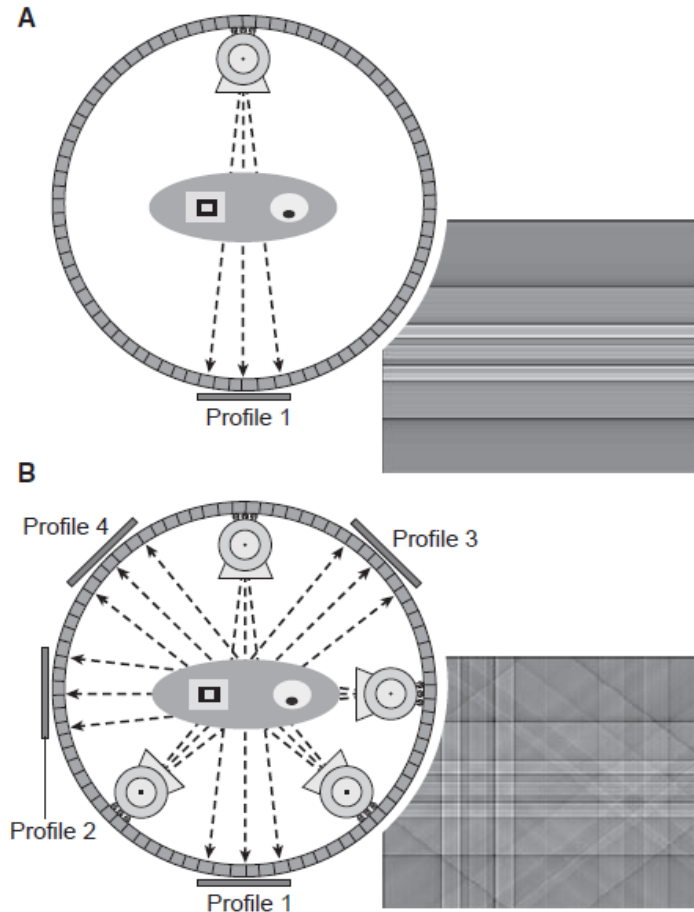
- The computer assigns one value (Hounsfield unit) to each pixel in order to form an image.
- The density number is the average of all attenuation measurements for that pixel and represents the proportional amount of x-ray energy that passes through anatomy and strikes the detector.
- Once the data are averaged so that each pixel has one associated number, an image can be formed.
- The data included in this image are appropriately called image data that require approximately one-fifth of the computer space needed for raw data.

Discuss the following:

“If only image data are available, data manipulation is limited.”



- As the x-ray tube travels along its circular path, continuous x-ray energy is generated and passes from the x-ray tube to the detector in a path called ray.
- The DAS reads ray sum (each arriving ray and measures how much of the beam is attenuated), which is known as a **view**.





- The DAS reads ray sum (each arriving ray and measures how much of the beam is attenuated), which is known as a **view**.
- To form an image, The CT system accounts for the attenuation properties of each ray sum and correlates them with the position of the ray.
- The result of this type of correlation is called an ***attenuation profile*** for each **view** in the scan.
- The information from all of the profiles is projected onto a matrix.
- This process of converting the data from the attenuation profile to a matrix is called **back projection**.

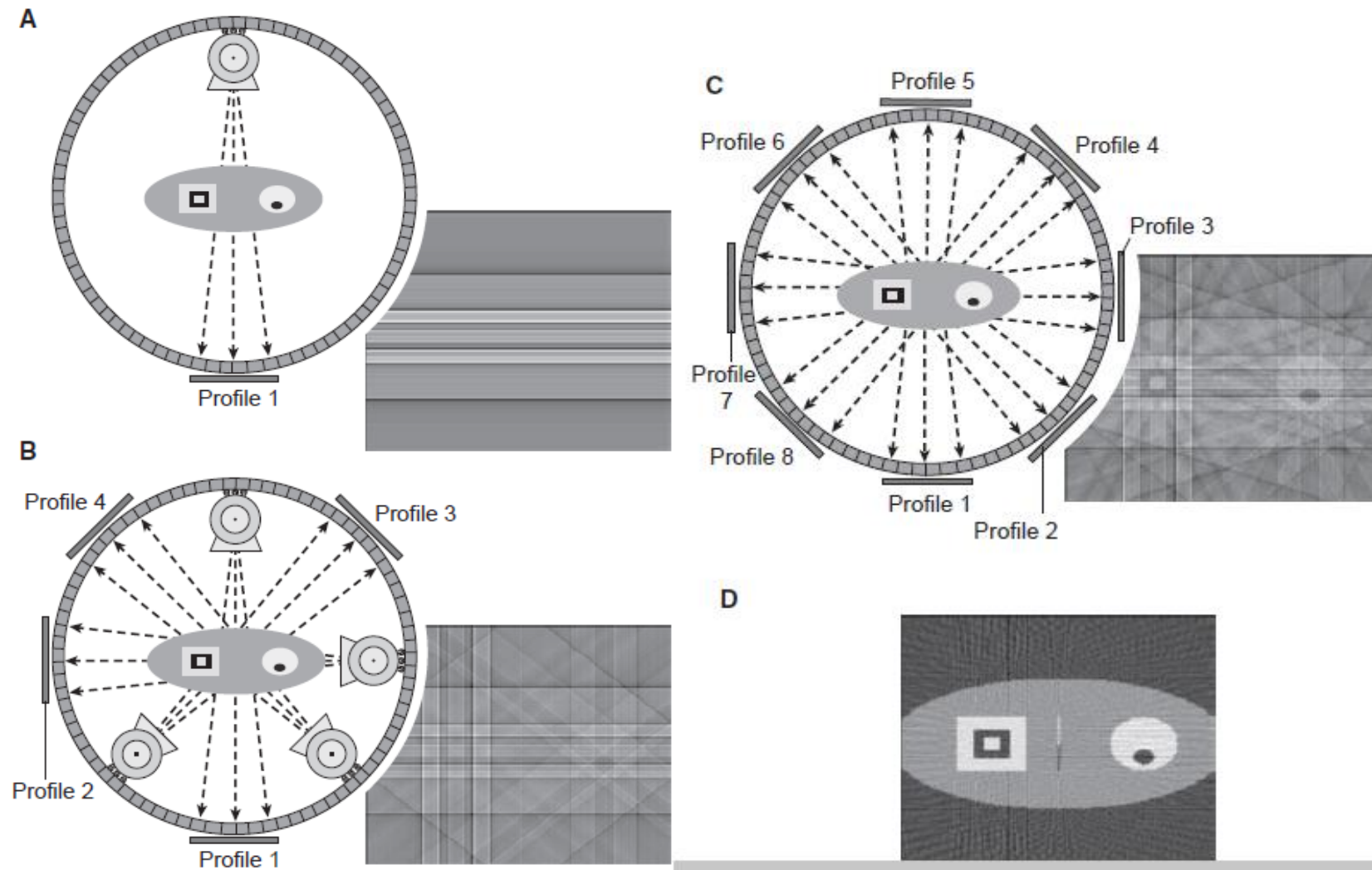
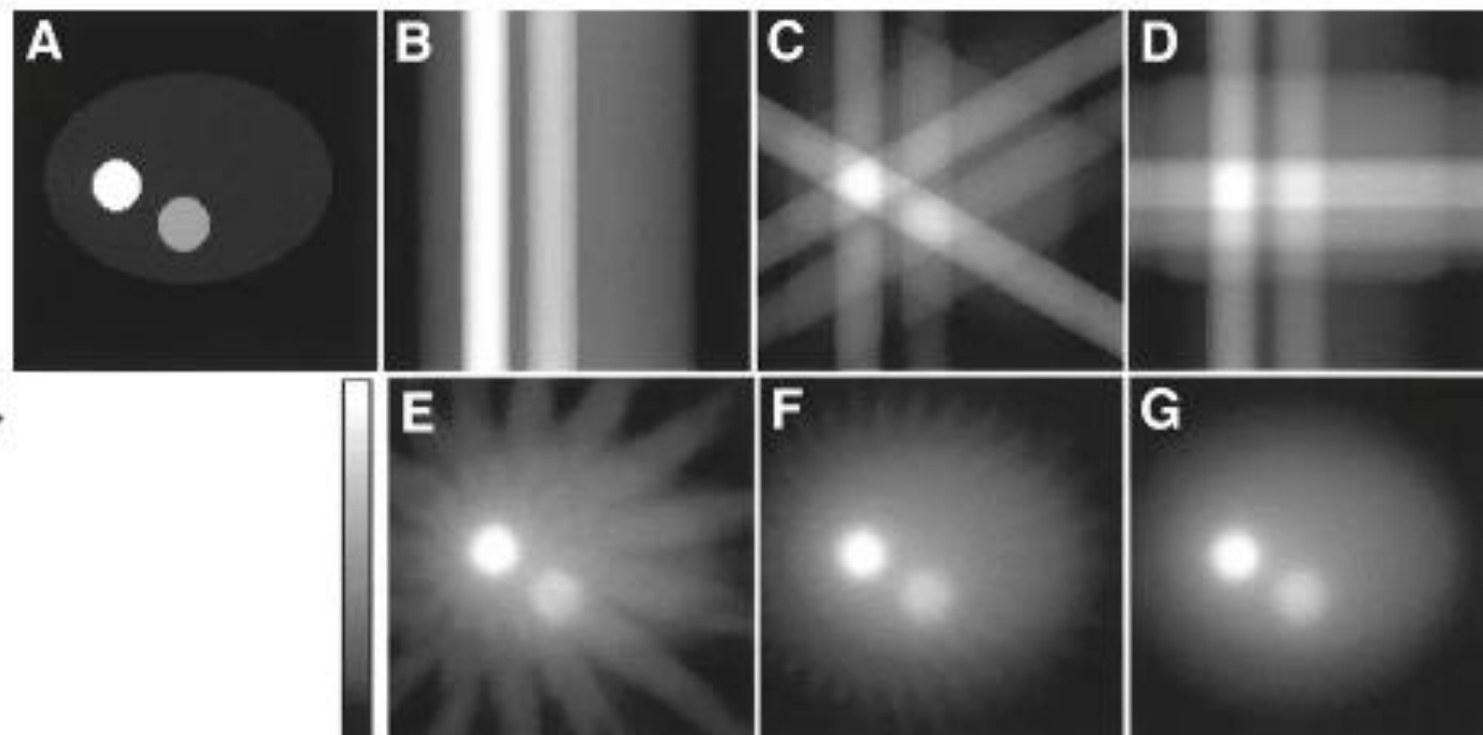
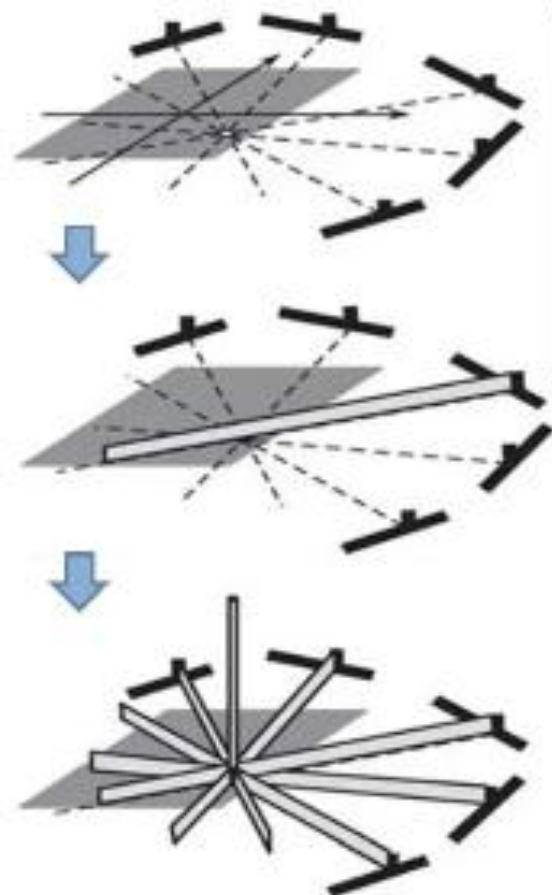
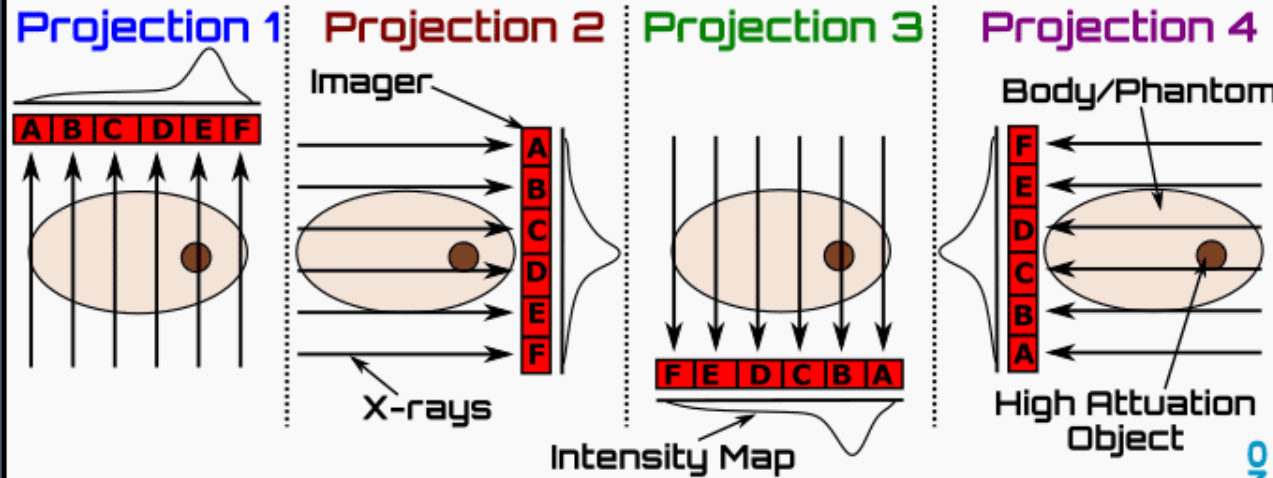


FIGURE 3-3 Data are converted from the attenuation profiles to a matrix with a process known as back projection. **A.** With only one back projection, not much information about the object scanned is revealed. **B.** With four back projections, some details start to emerge. **C.** With eight back projections, more details are visible. **D.** With 60 back projections, the image finally resembles the objects scanned.



Computed Tomography

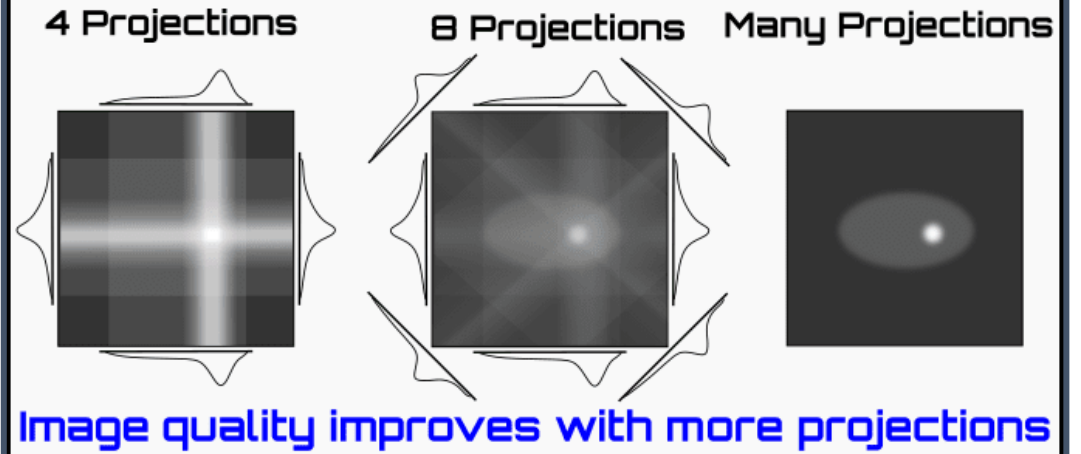
Step 1. Gather Projection Data

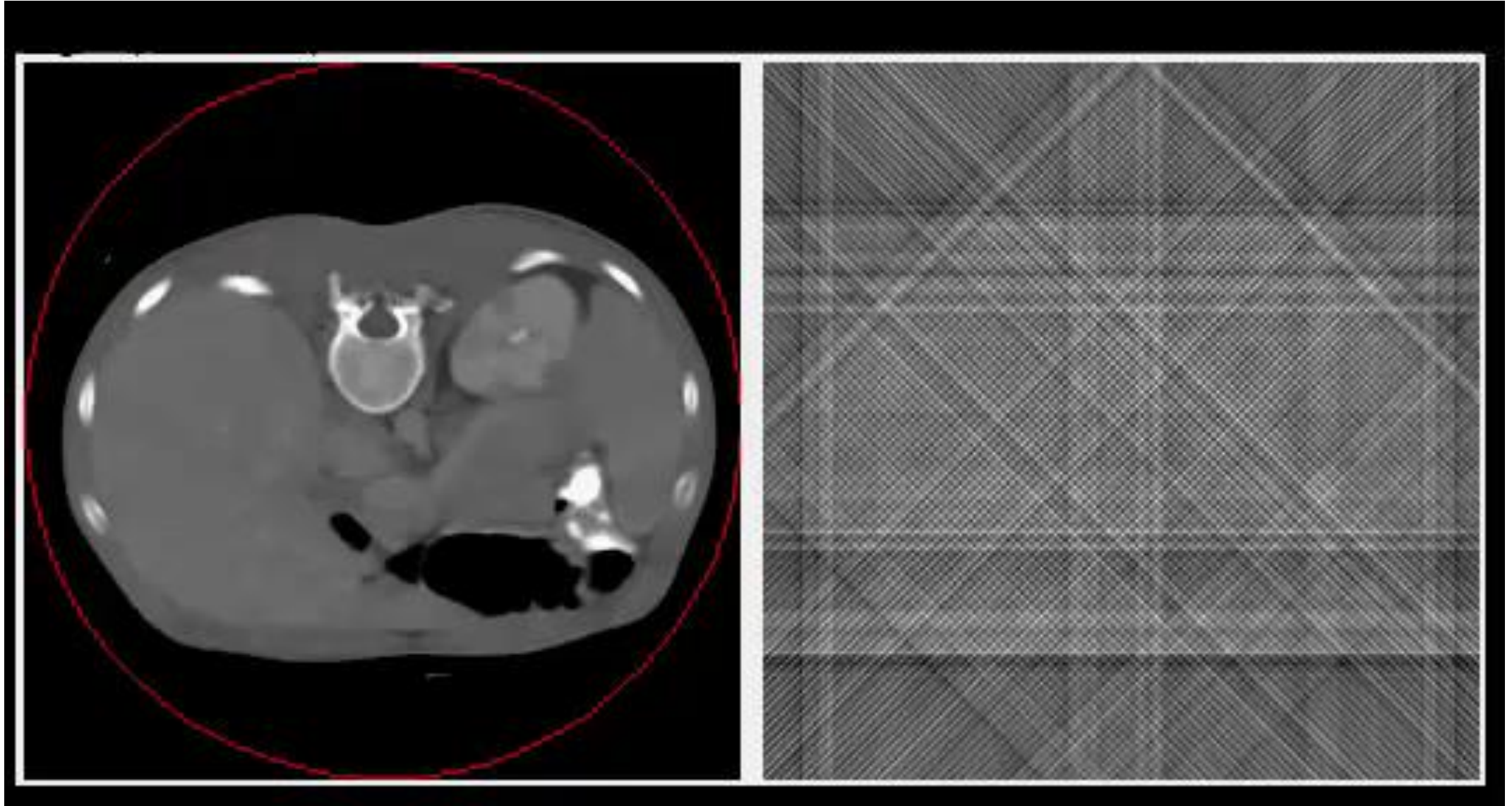


Step 2. Store Data in Sinogram



Step 3. Back Projection







- During back projecting data onto a matrix, streak artifacts are produced in a star pattern on the image.
- Convolution process is a complicated mathematical steps that filters the scan data before back projection and is used to reduce streak artifacts.
- Filtered back-projection algorithms use Fourier theory to reduce statistical noise and create an image that is pleasing to the eye.
- The filter selection depends on which parts of the data must be enhanced or suppressed.
- Smoothing filters reduce the difference between adjacent pixels. This can help to reduce the appearance of artifacts but reduce spatial resolution.
- Conversely, some filters accentuate the difference between neighbouring pixels to optimize spatial resolution, but must make sacrifices in low contrast resolution.



Discuss:

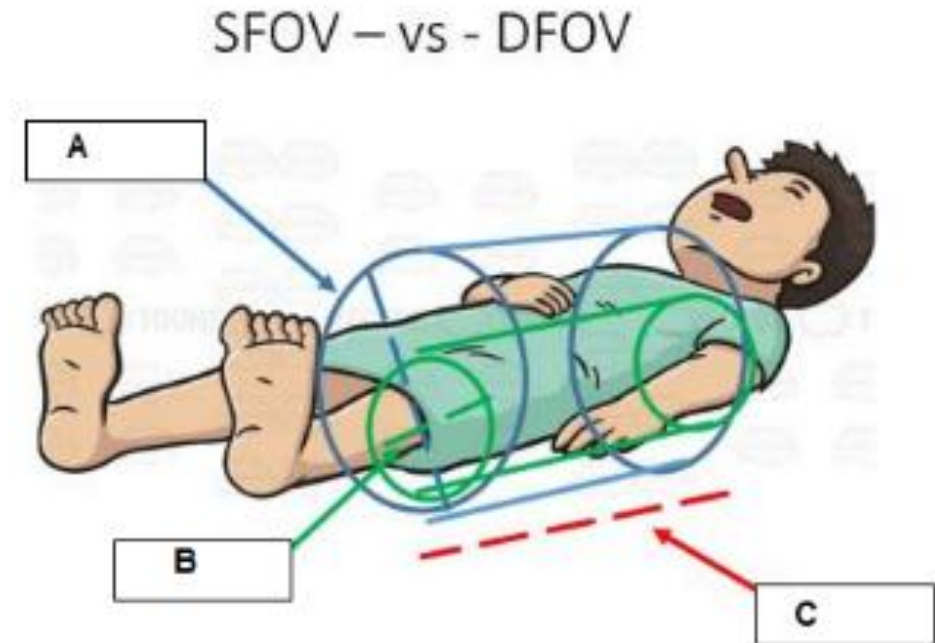
- Changing the window setting merely changes the way the image is viewed. Changing the algorithm will change the way the raw data are manipulated to reconstruct the image



- Scan field of view (SFOV), also called calibration field of view, determines the area within the gantry from which the raw data are acquired.
- By selecting a 25 cm SFOV, a technologist acquires data in a circular shape, with a diameter of 25 cm, lying in the absolute center, or isocenter, of the gantry where the patient is positioned.
- SFOV selection determines the number of detector cells collecting data.
- Data are not acquired on everything within the gantry!
- If the gantry opening is 70 cm but the largest SFOV available is 48 cm, there will be a ring in which data cannot be collected.



- A.** SFOV: Scan Field of View, the area within the gantry from which the raw data are acquired
- B.** DFOV: Display Field of View, the section of data selected for image display on a monitor
- C.** Scan Length: set by the rad during planning and determines the start and end of the length of data along the z-axis



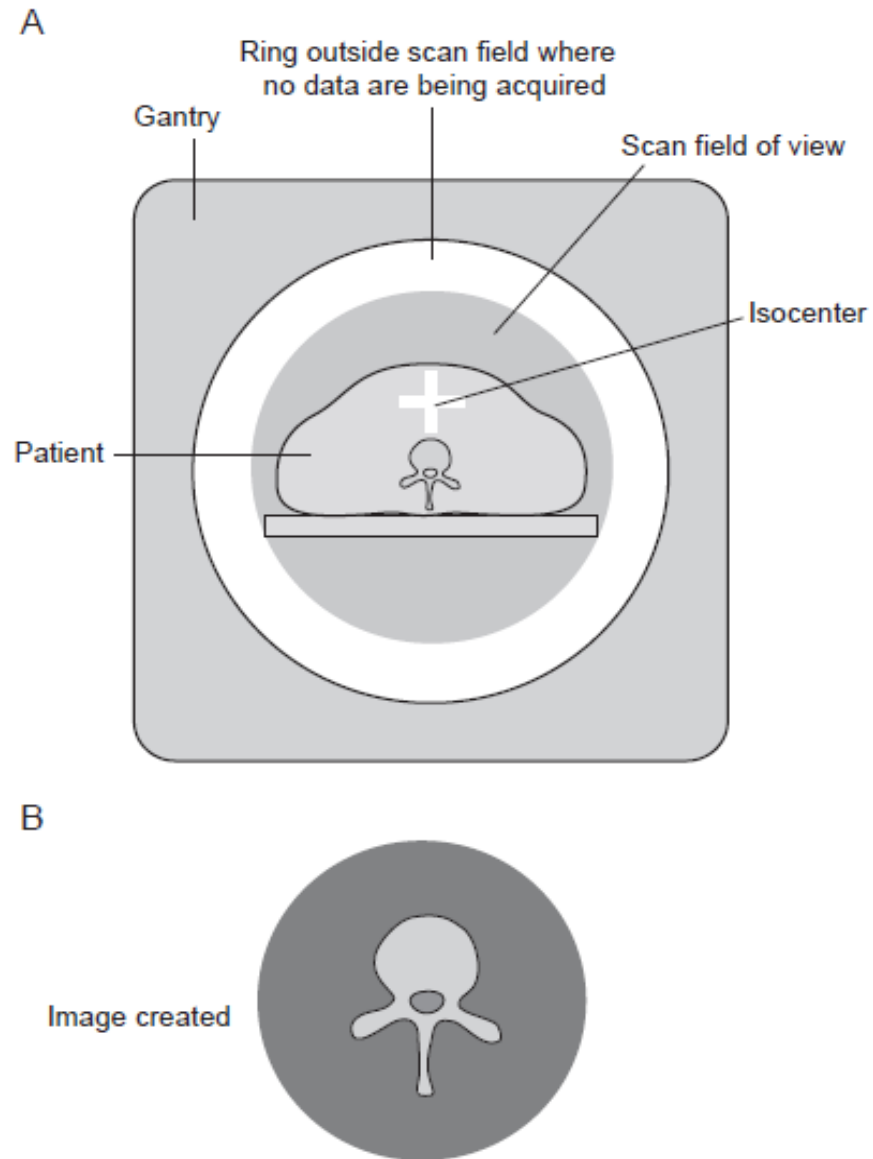


FIGURE 3-4 **A.** Raw data are collected within the scan field of view. **B.** Image data are confined to those displayed on the monitor.

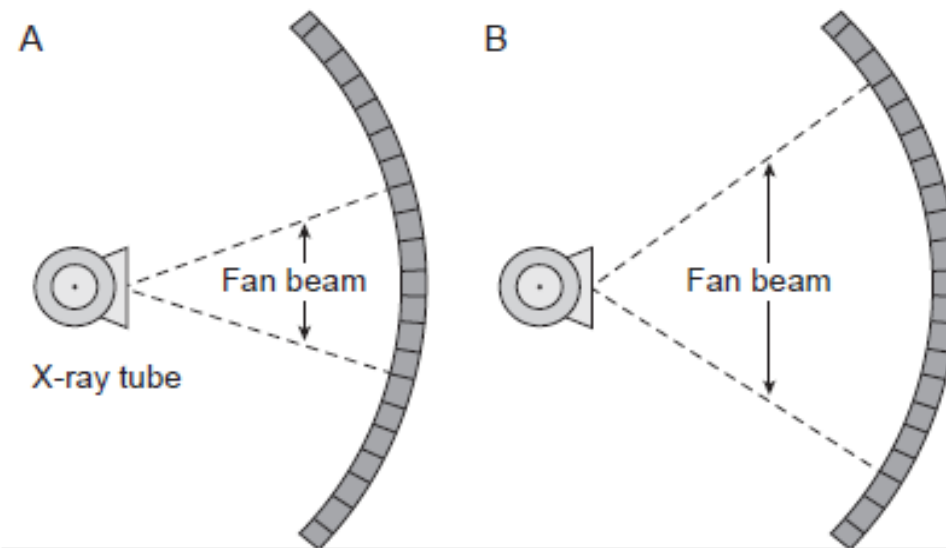


FIGURE 3-5 The selection of scan field of view determines the number of detector cells collecting data.



- Display field of view (DFOV; also called zoom or target) determines how much of the collected raw data is used to create an image.
- For example, if a lumbar spine is correctly scanned with a large SFOV to include the entire body, but the operator chooses to target the image so that the vertebrae occupy most of the screen, the rest of the patient's abdomen is not visualized on the image.
- Changing the DFOV will affect image quality by changing the pixel size.
- To select the amount of raw data to be displayed on the CT image, the operator selects some number (in either centimeters or millimeters depending on the scanner manufacturer) as the DFOV.
- Because the data selected for the DFOV are a subset of all the scan data available, the DFOV cannot be larger than the SFOV



- Choosing the optimal display field improves the detectability of abnormalities.
- Selecting too large a DFOV makes the image appear unnecessarily small, in addition to the inherent difficulty in viewing smaller images, more data are included in each pixel and spatial resolution decreases.
- On the other hand, too small a DFOV may exclude necessary patient anatomy.

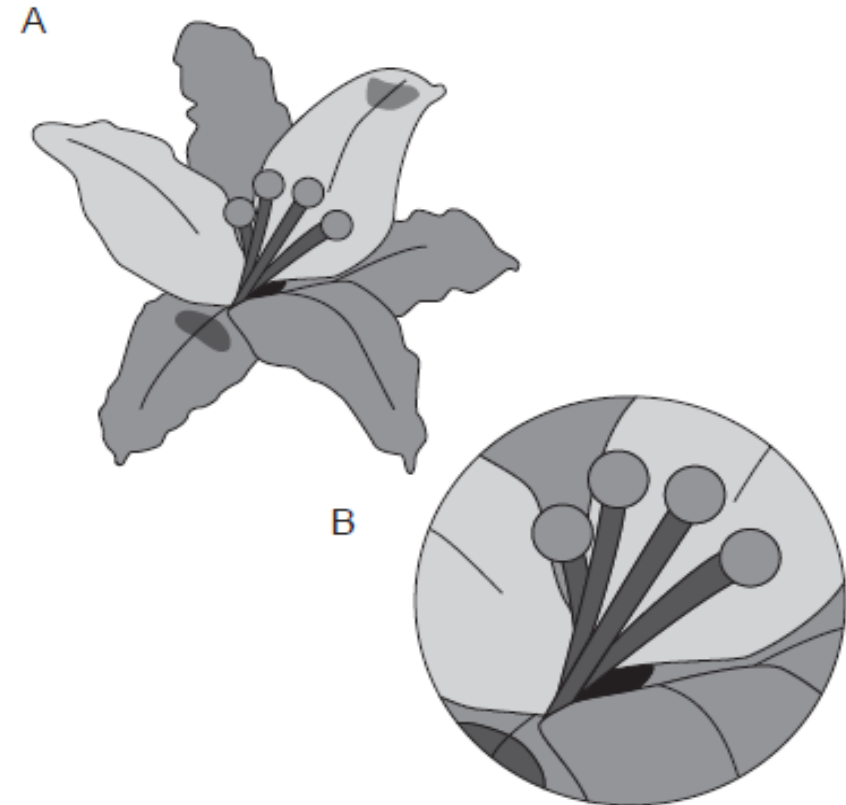


FIGURE 3-6 Selecting the display field of view determines how much of the raw data are used to create an image. Display field works like the zoom on a camera and can be used to show the entire area or to display a specific region of interest in greater detail.

A decorative geometric pattern consisting of several overlapping triangles in a golden-yellow color, located on the left side of the slide.

THANK YOU

A decorative geometric pattern consisting of several overlapping triangles in a golden-yellow color, located on the right side of the slide.