College of Health and Medical Technologies
Department of Radiology Technologies

Radiographic Technique
- Milliamperage, Kilovoltage, Helical Pitch
- Rotation Time - Slice Thickness - Matrix Size and Reconstruction Algorithms
Window setting:
- Different levels - Different organs and exams

4 th stage

LECTUER 2

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Tube Current [mAs]

The mAs selected for scanning directly influences the number of x-ray photons used to produce the CT image, thereby affecting the SNR and the contrast resolution.

Doubling the mAs of the study increases the SNR by 40%. Therefore, if the initial image was degraded by quantum noise then doubling the mAs will improve the contrast resolution of repeat scans.

The tube current, stated in milliampere-seconds [mAs], also has a significant effect on the radiation dose delivered to the patient. A patient with more body Width requires an increase in the tube current to achieve an adequate image quality. Thus, more corpulent patients receive a larger radiation dose than, for instance, children with a markedly smaller body width. Body regions with skeletal structures that absorb or scatter radiation , such as shoulder and pelvis, require a higher tube current than, for instance, the neck, a slender abdominal torso or the legs. This relationship has been actively applied to radiation protection for some time now

The Influence of kV

When examining anatomic regions with higher absorption (e.g. ,CT of the head,shoulders, thoracic or lumbar spine, pelvis , and larger patients), it is often advisable to use higher kV levels in addition to , or instead of, higher mA values: when you *choose* higher kV, you are hardening the x-ray beam .Thus x-rays can penetrate anatomic regions with higher absorption more easily. As a positive side effect, the lower energy components of the radiation are reduced, which is desirable since low energy x-rays are absorbed by the patient and do not contribute to the image. For imaging of infants or bolus tracking, it may be advisable to utilize kV lower than the standard setting.

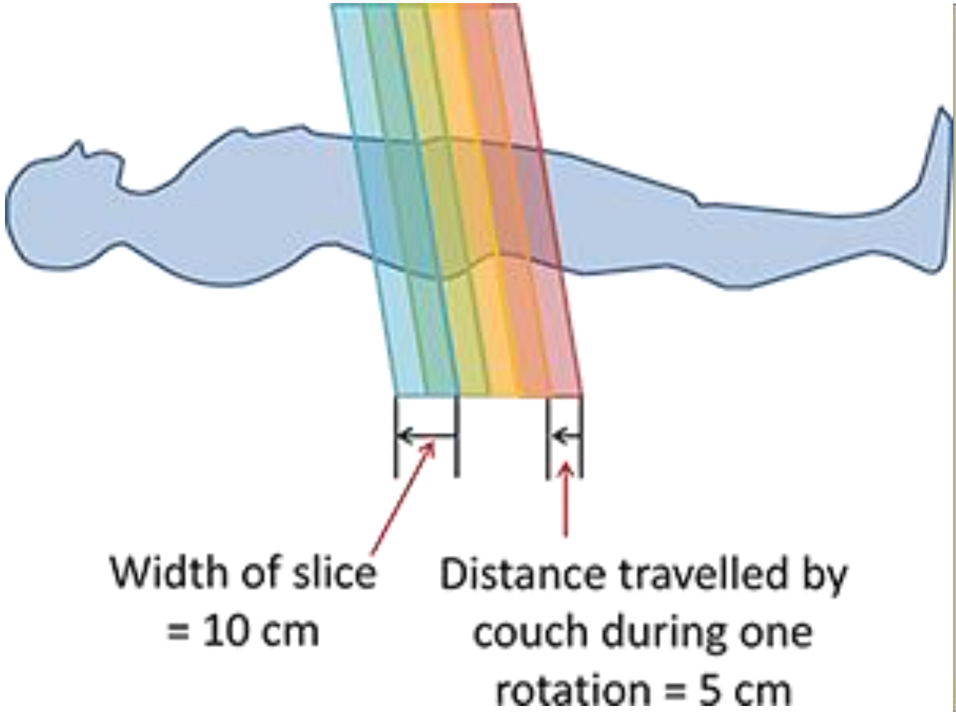
Scan Time

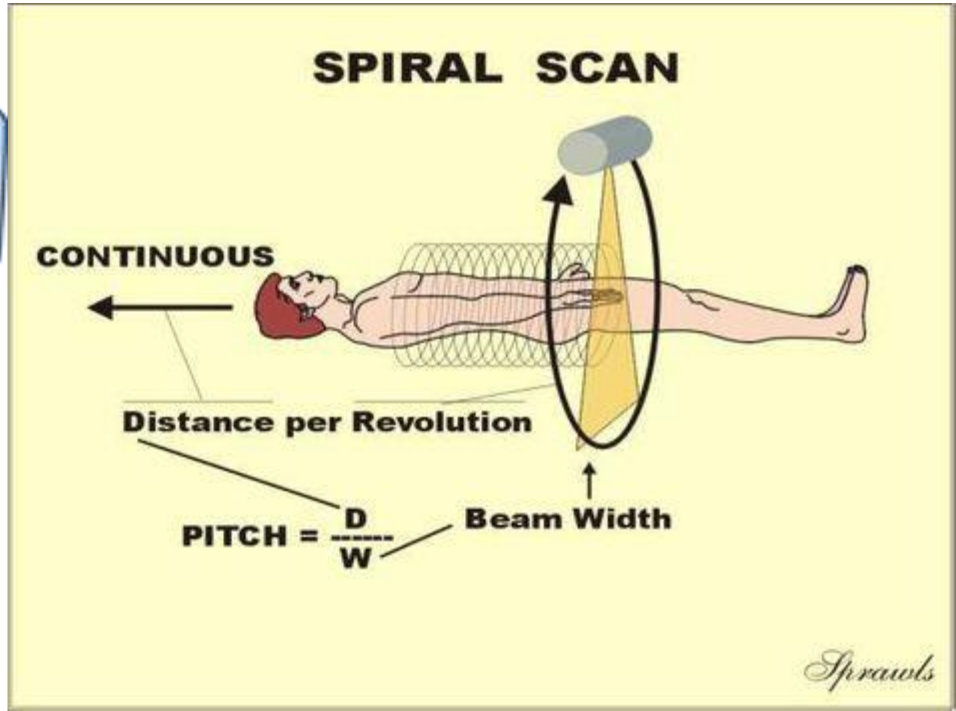
It is advantageous to select a scan time as short as possible, particularly in abdominal or chest studies where heart movement and peristalsis may degrade image quality.

Other CT investigations can also benefit from last scan times due to decreased probability of involuntary patient motion. On the other hand, it may be necessary to selecta longer scan time to provide sufficient dose or to enable more samples for maximal spatial resolution. Some users may also consciously choose longer scan times to lower the mA setting and thus increase the likelihood of longer x-ray tube life.

Pitch

During a helical scan acquisition, the x-ray tube is continually on while the table moves through the gantry. Pitch is a parameter that is commonly used to describe the CT table movement. It is most commonly defined as the travel distance of the CT scan table per 360° rotation of the x-ray tube, divided by the x-ray beam collimation width. When the table feed and beam collimations are identical, pitch is 1. When the table feed is less than the beam collimation, pitch is less than 1 and scan overlap occurs.

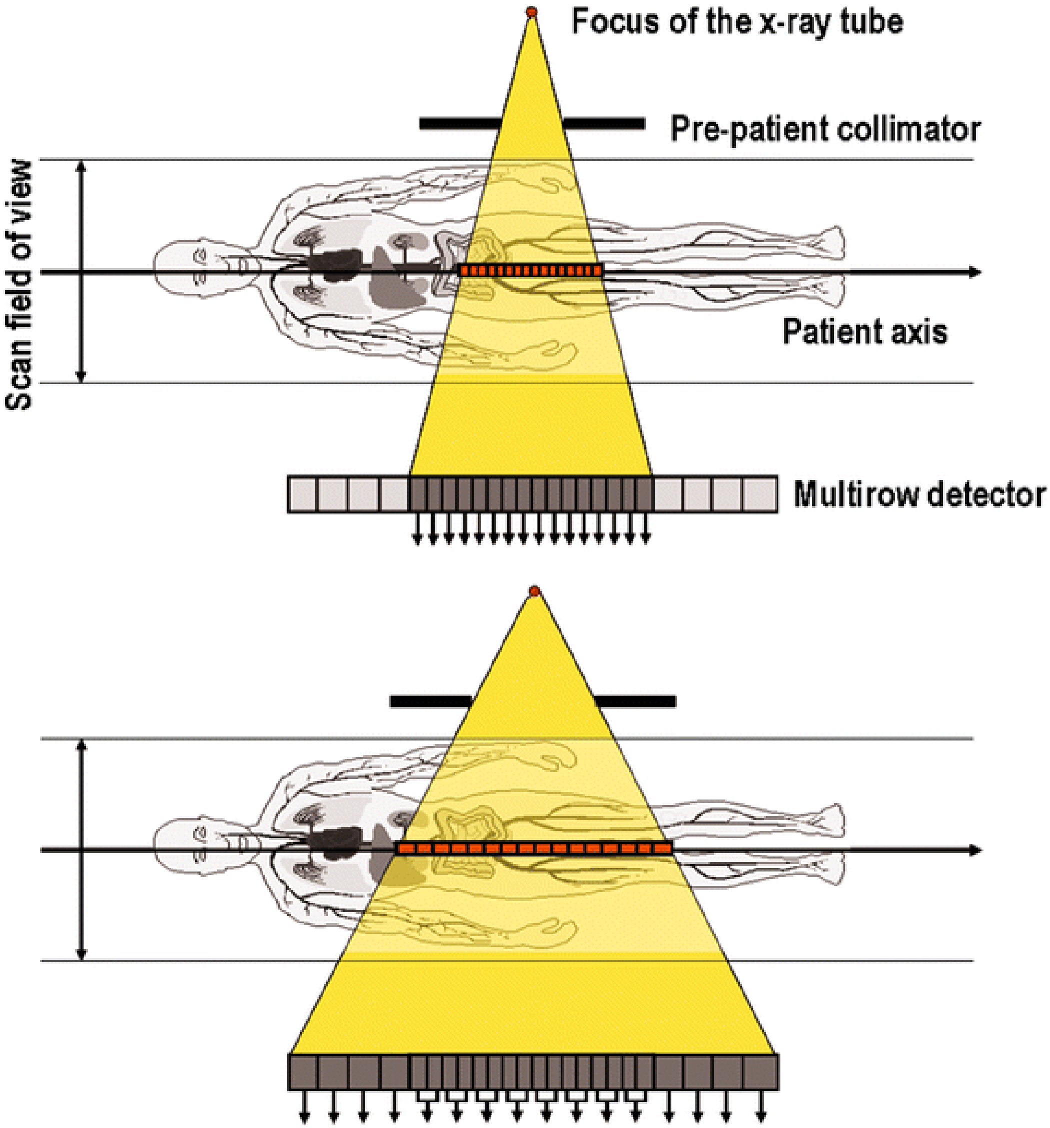




Slice Thickness

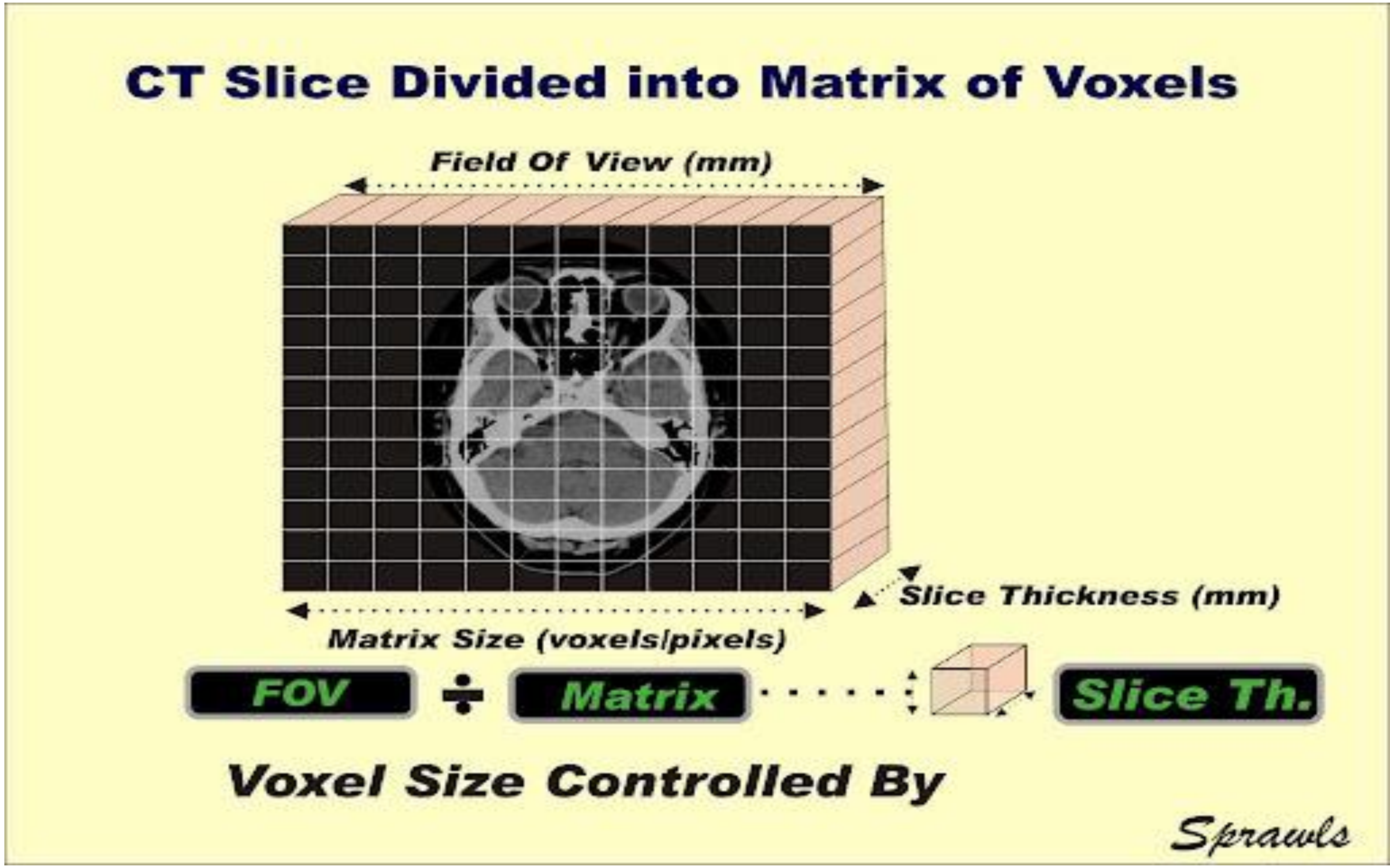
Slice thickness is important in CT and has a significant impact on image quality. In discussions of image quality we are primarily interested in the slice thickness (how the data were acquired) rather than image thickness (how the data are reconstructed).

The slice thickness has a linear effect on the number of x-ray photons available to produce the image—a 5-mmslice will have twice the number of photons as a 2.5-mm slice. Because thicker slices allow more photons to reach the detectors they have a better SNR and appear less noisy. However, this improvement comes at the cost of spatial resolution in the *z* axis.



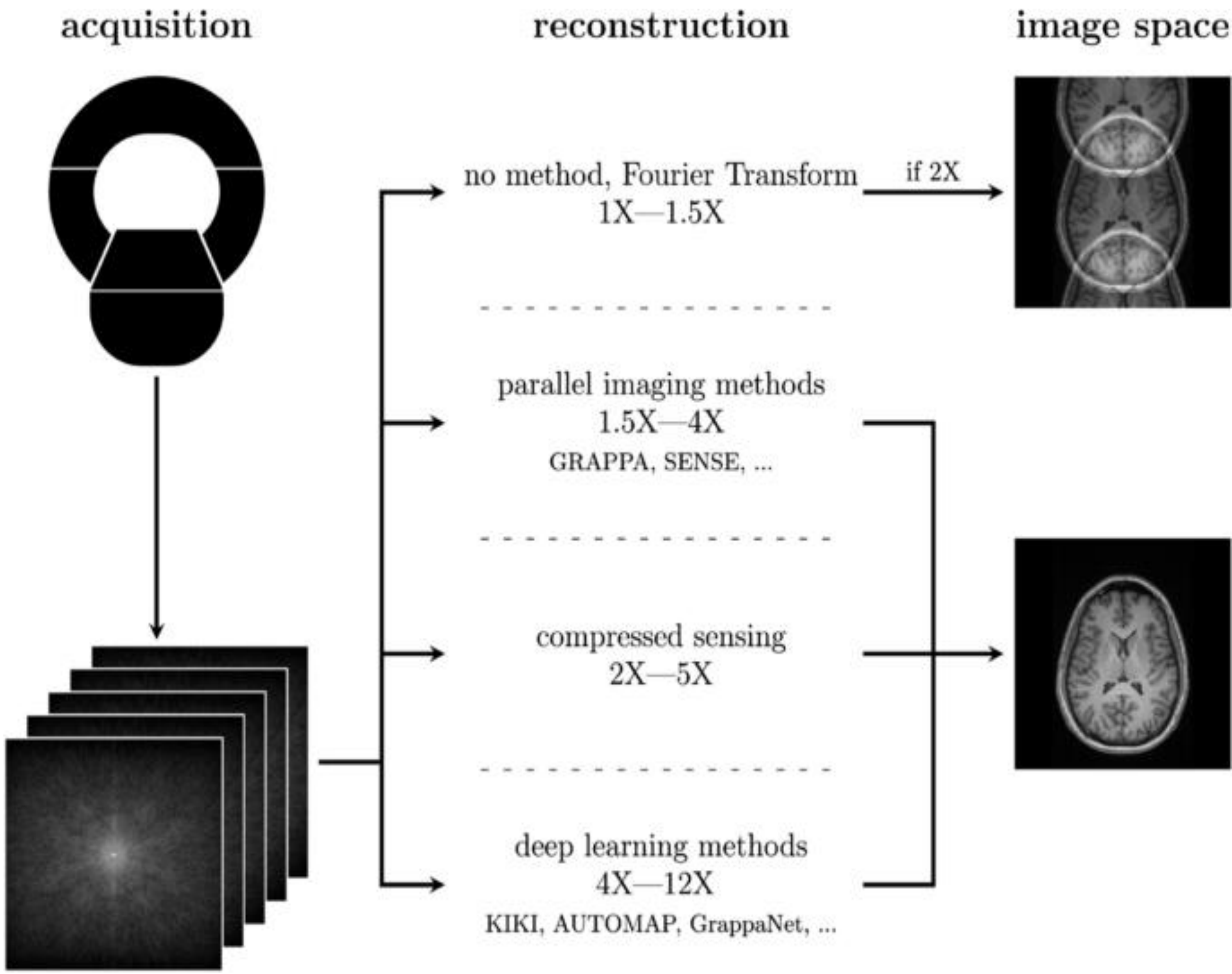
Field of View

Scan field of view (SFOV) determines the area, within the gantry, for which raw data are acquired. Scan data are always acquired around the gantry's isocenter. The display field of view (DFOV) determines how much, and what section, of the collected raw data are used to create an image .



Reconstruction Algorithms

Depending on the manufacturer, this feature may be called algorithm, convolution filter, FC filter, or simply filter. Current scanners offer several algorithm choices that are designed to reconstruct optimal images depending on tissue type. By choosing a specific algorithm, the operator selects how the data are filtered in the reconstruction process. Filter functions can only be applied to raw data (not image data). Therefore, to reconstruct an image using a different filter function, the raw data must be available for that image. It is important to differentiate reconstruction algorithms from merely setting a window width and level. Changing the window setting (see Chapter 4) merely changes the way the images viewed. Changing the reconstruction algorithm will change the way the raw data are manipulated to reconstruct the image.



Matrix Size, Display Field of View, Pixel Size

Matrix size and DFOV selection determine pixel size. Pixel size plays an important role in the in-plane spatial resolution of an image. a matrix is used to segment the raw data into distinct squares called pixels.

The pixels are arranged in a grid like arrangement of columns and rows. Each pixel has a width x, and a length y. In CT, pixels are always square,

so x = y.

Matrix size refers to how many pixels are present in the grid. Because the perimeter of the square matrix is held constant, the greater the total pixels present in the image, the smaller each individual pixel. Therefore, matrix size is one factor that controls pixel size. In practice, matrix size seldom varies in CT. DFOV determines how much raw data pixel size = DFOV/matrix size

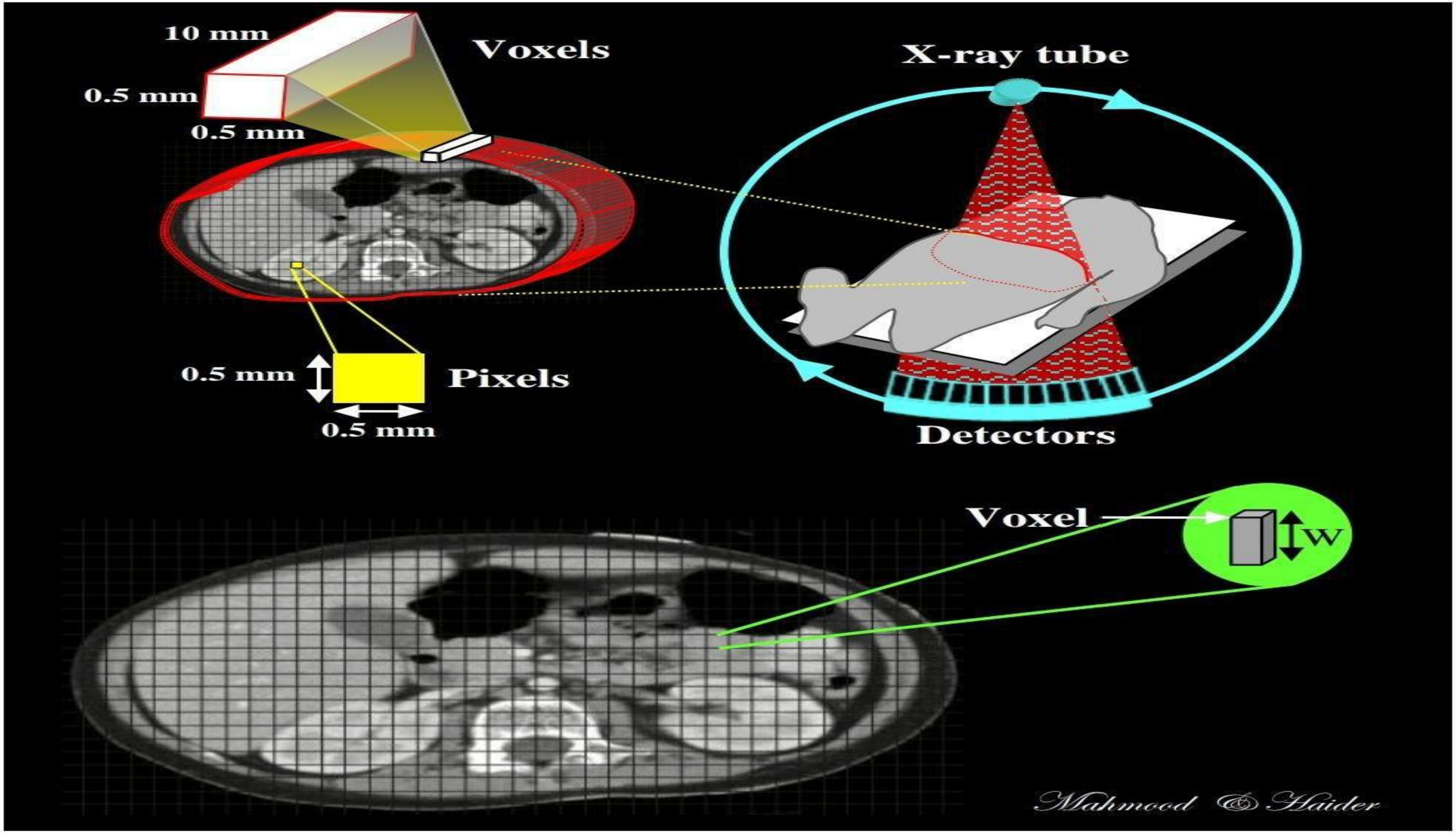
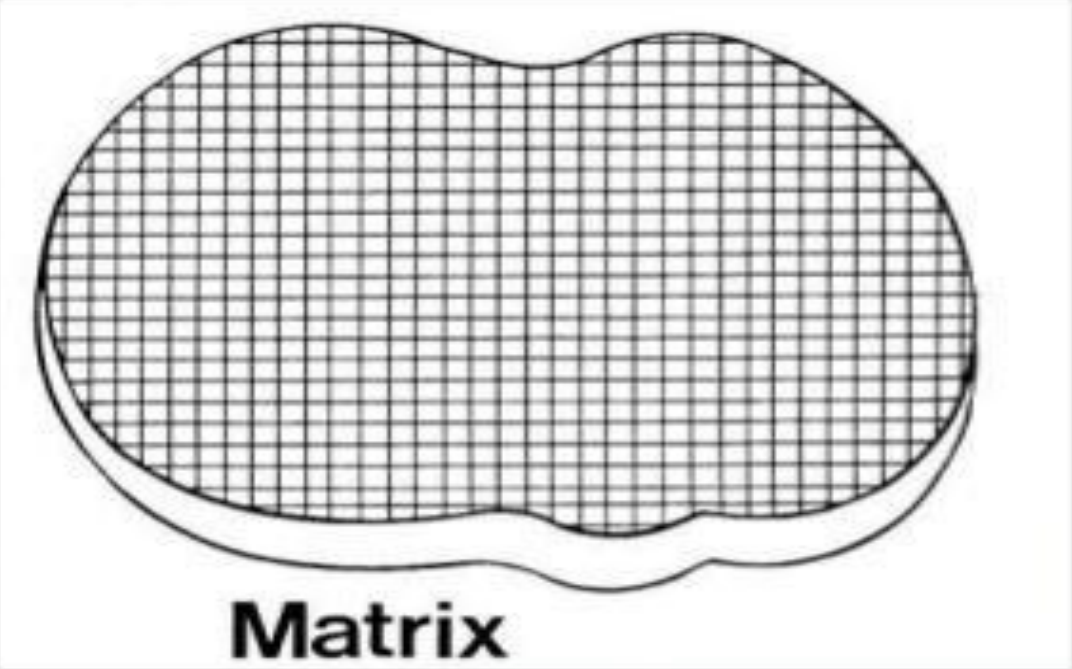


Figure 6.7: Sample CT image.

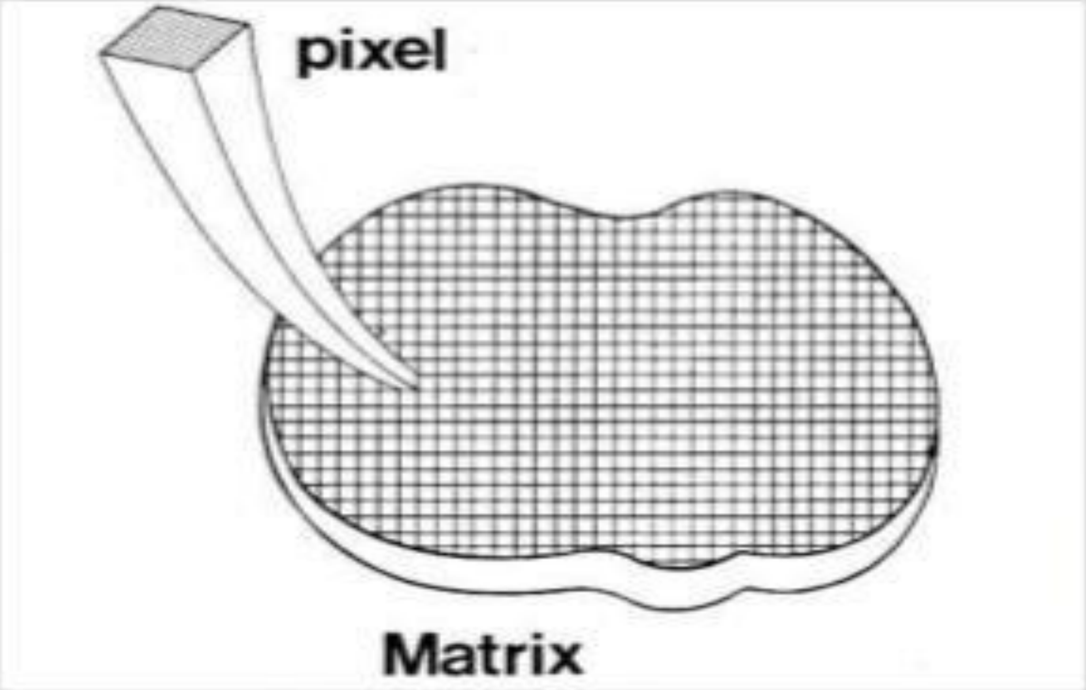
Matrix

- The image is represented as a MATRIX of numbers.
- **Matrix** :- A two dimensional array of numbers arranged in rows and columns.
- Each number represents the value of the image at that location



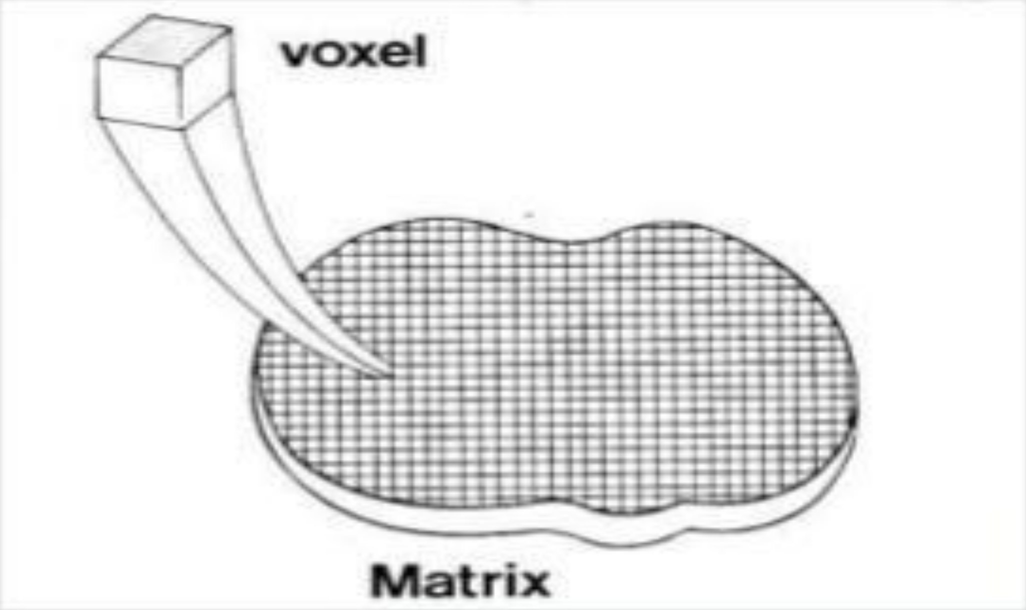
PIXEL

- The VOXEL is represented in the image as a **two-dimensional** element called PIXEL - (picture element)



VOXEL

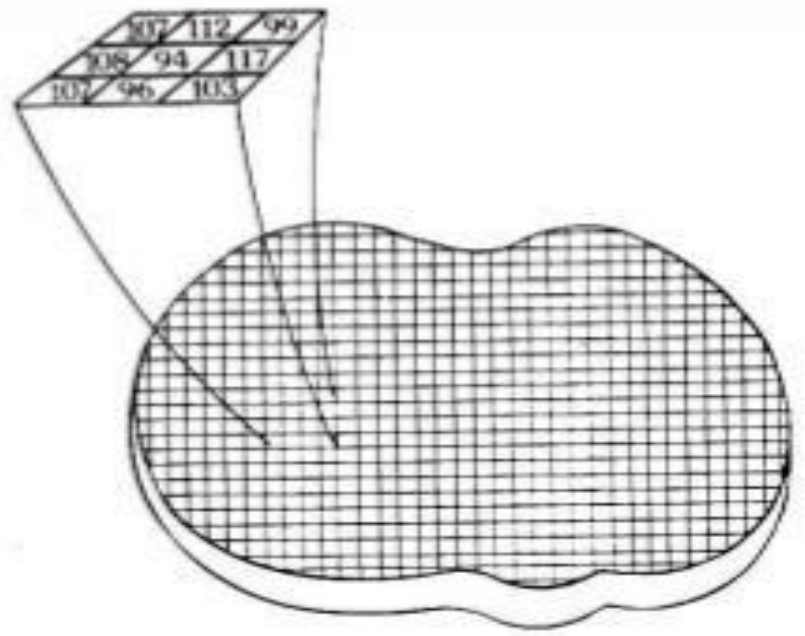
- Each individual element or number in the image matrix represents a **three dimensional** volume element in the object, called a VOXEL



CT numbers

- The numbers in the image matrix are called CT numbers.

- Each pixel has a number which represents the x-ray attenuation in the corresponding voxel of the object



CT Numbers

Window Width

The window width determines the number of Hounsfield units represented on a specific image. The software assigns shades of gray to CT numbers that fall within the range selected. All values higher than the selected range appear white, and any value lower than the range appears black. By increasing the window width, usually referred to as "widening the width," more numbers are assigned to each shade of gray.

Window Level

The window level selects the center CT value of the window width (Fig. 4-3). The terms window level and window center are often used interchangeably. The window level selects which Hounsfield numbers are displayed on
the image.

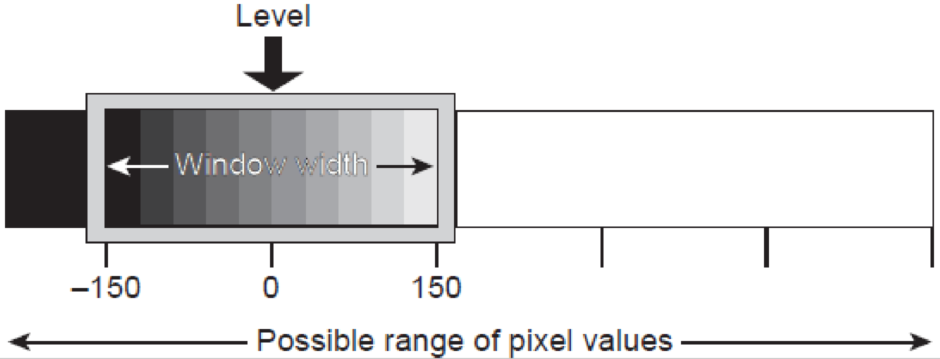


FIGURE 4-4 If the window width is 300 and 0 is chosen as the window level, the Hounsfield values that are represented as a shade of gray on this image will range from −150 to 150.

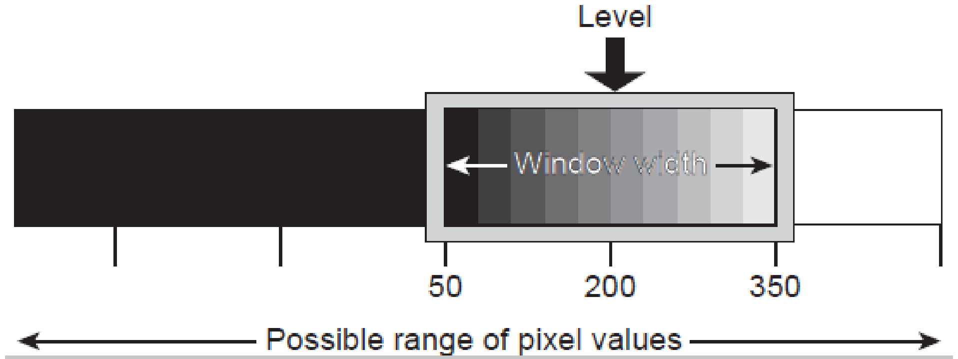


FIGURE 4-5 The width stays unchanged at 300, but the center is moved to 200. The new range of Hounsfield numbers to be included in the gray scale is from 50 to 350. Determining the range of Hounsfield values requires only simple arithmetic. First, divide the window width in half. Next, subtract the quotient from the window level to determine the lower limit of the range, and add the quotient to the window level to determine the upper limit.

Suggestions for Setting Window Width and Level

The software assigns shades of gray to CT numbers that fall within the range selected. All values higher than the selected range (in the current example, 350) will appear white, and any value lower than 50 will appear black (Fig. 4-6). If we increase the window width, a wider range of values will be included in the grayscale range; more values will be assigned to each shade of gray (Fig. 4-7).

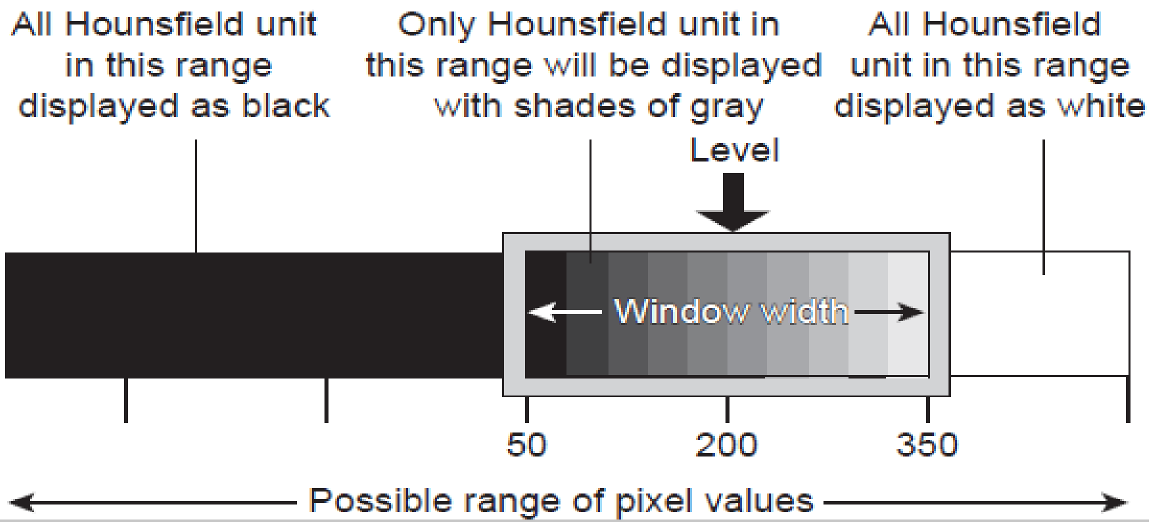


FIGURE 4-6 The software assigns shades of gray to CT numbers that fall within the range selected. All values higher than the selected range (in the current example, 350) will appear white, and any value lower than 50 will appear black.

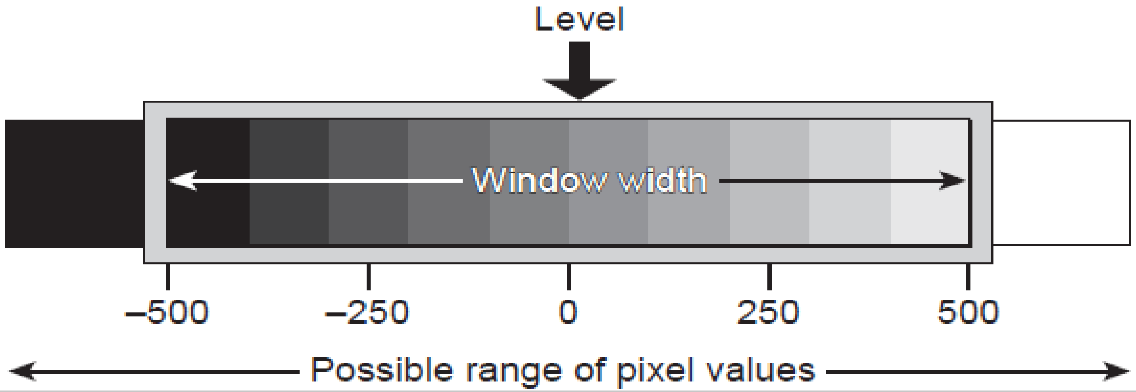


FIGURE 4-7 Widening the window width will include a wider range of values by placing more Hounsfield units into each shade of gray.