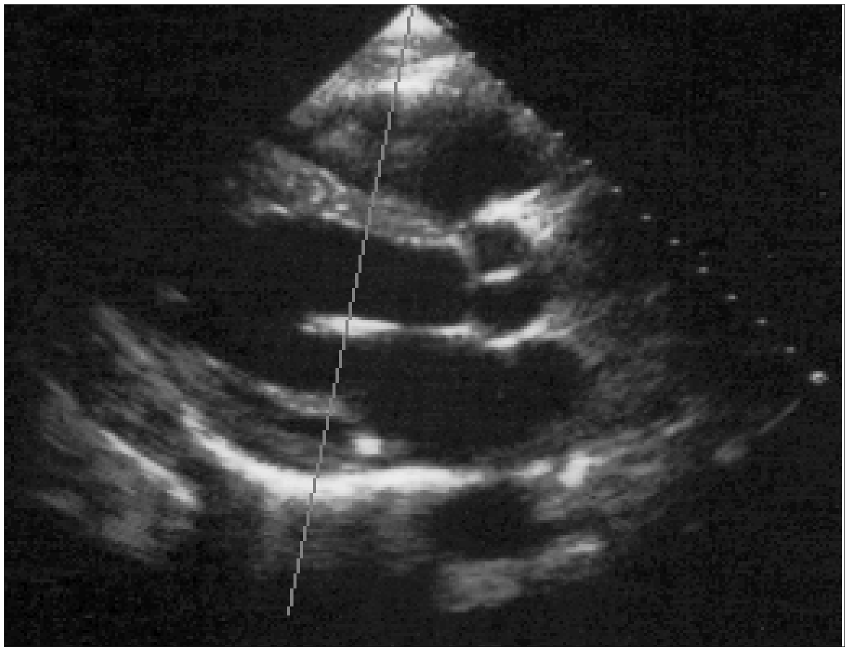
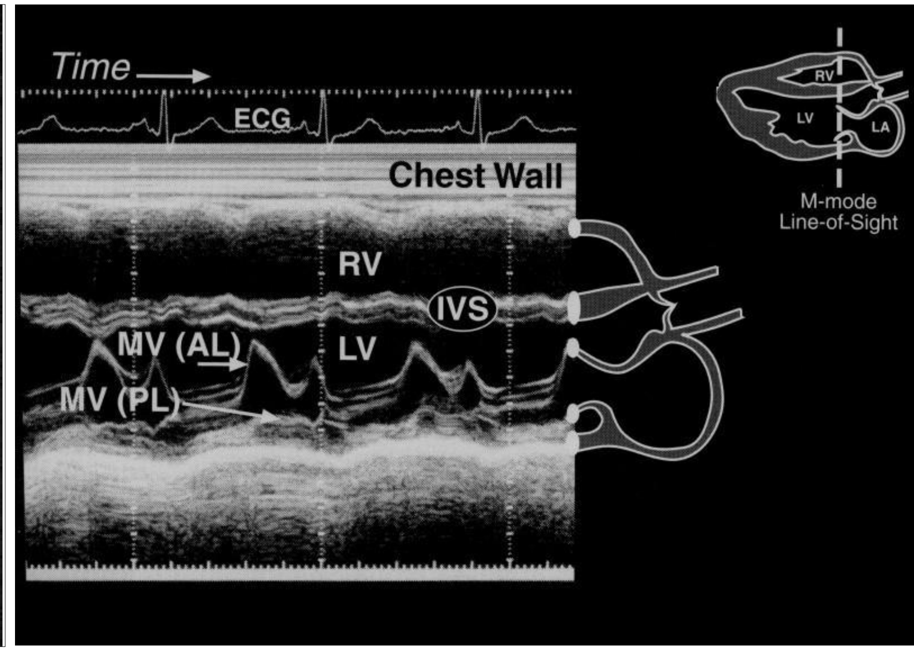
SONOGRAPHIC PHYSICS, INSTRUMENTATION & DOPPLER REVIEW

2012
Part 4

Ultrasound Instrumentation

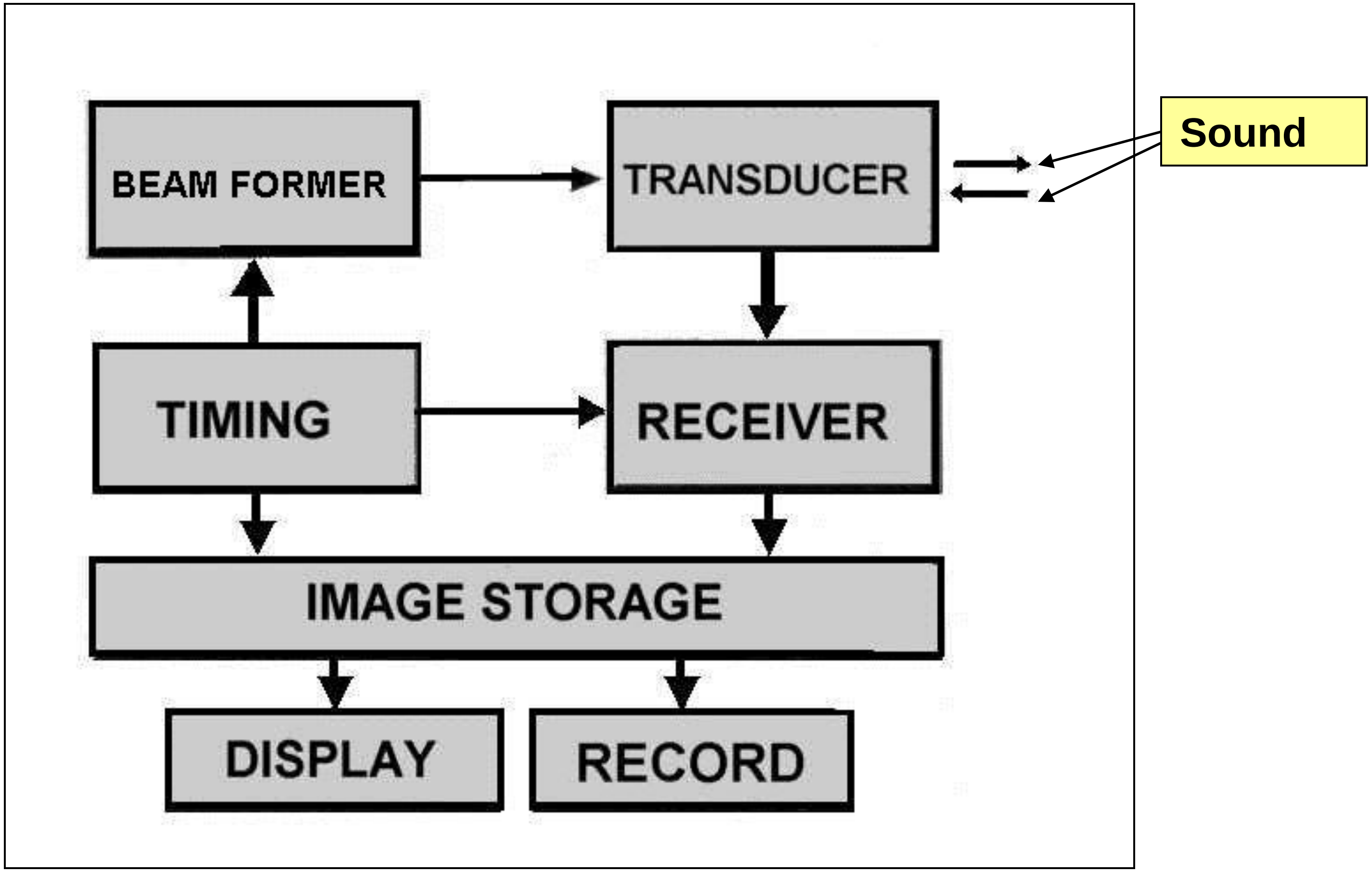
Display Modes



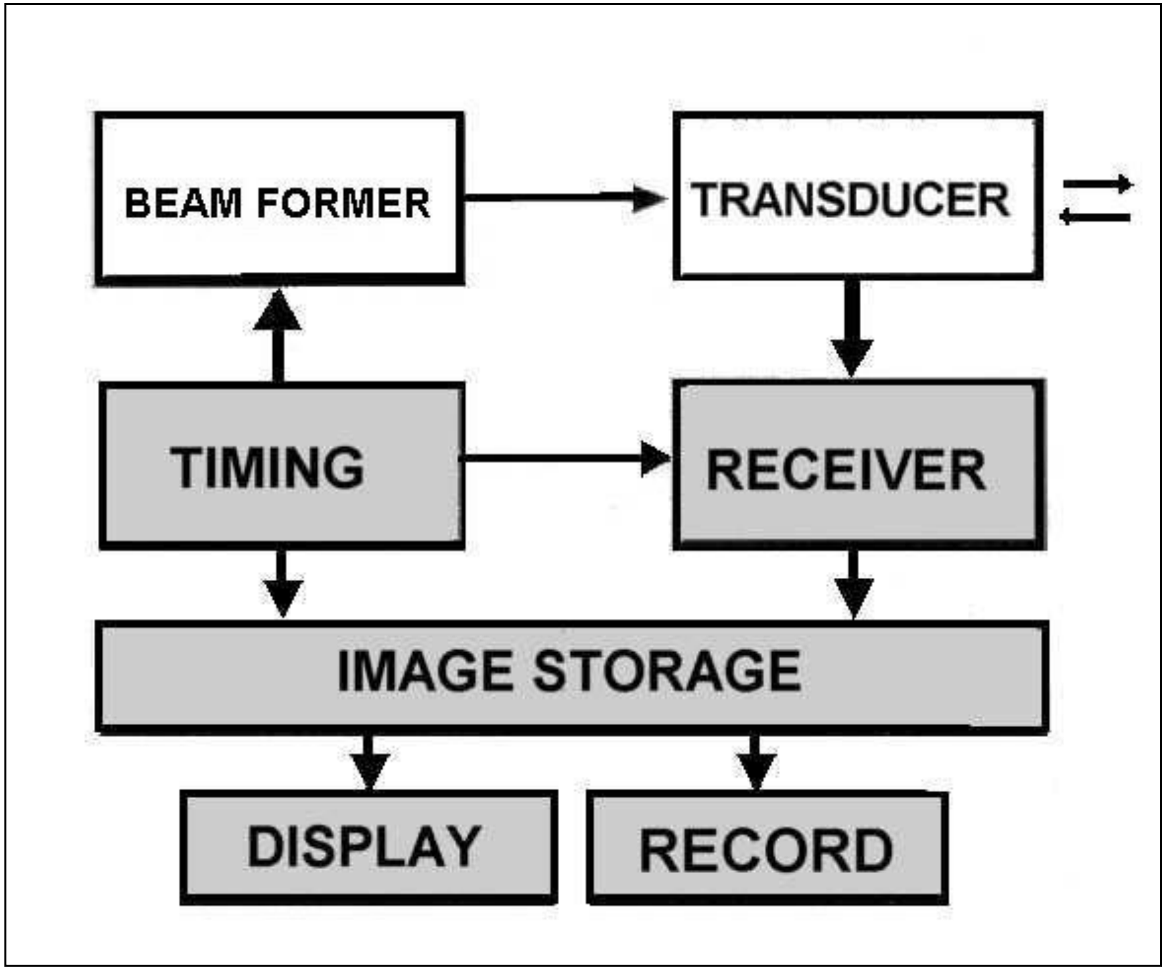


B-SCAN (2-D) **M-MODE**

Pulse-echo Imaging



TRANSDUCER EXCITATION AND OUTPUT POWER



TRANSMITTER

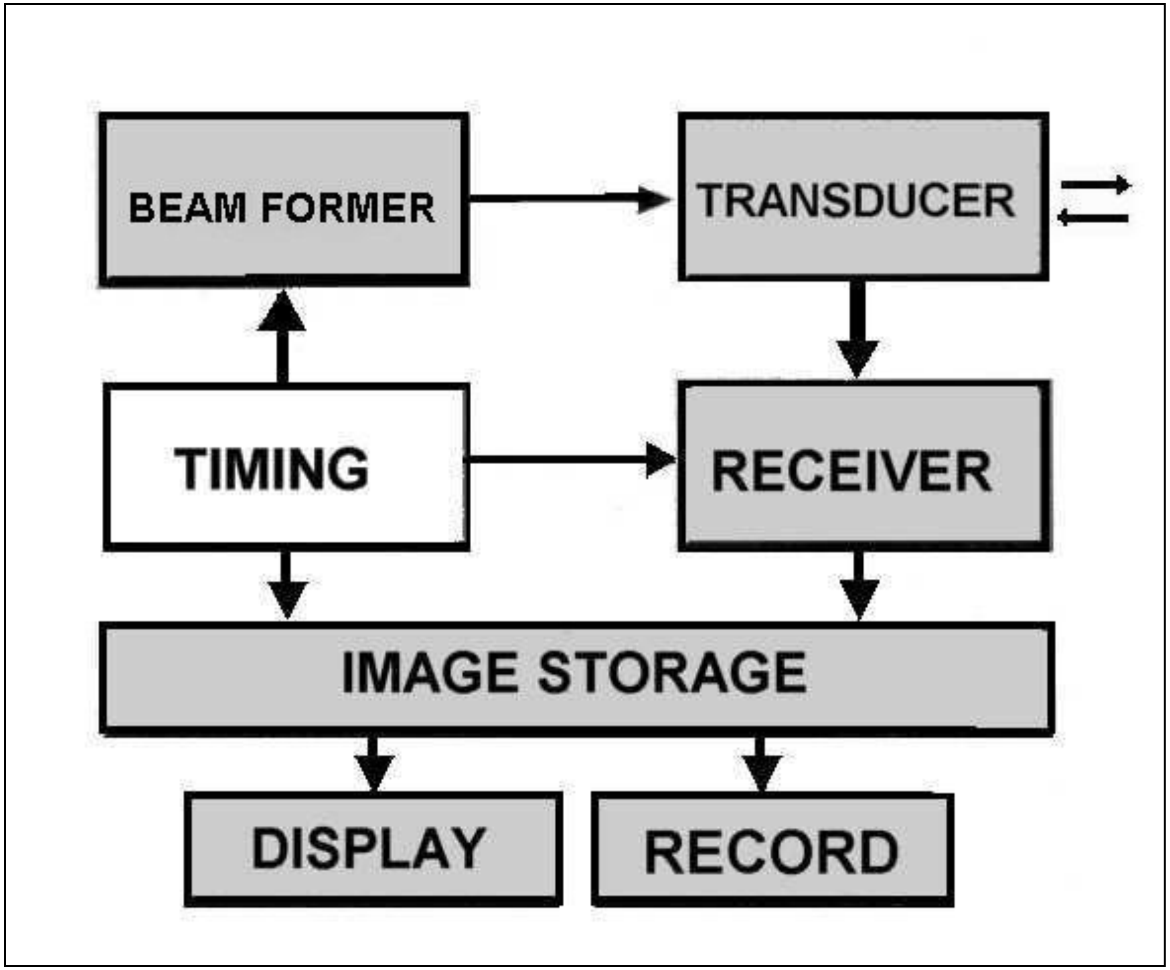
TRANSMIT POWER

OUTPUT

ACOUSTIC POWER

ENERGY OUTPUT

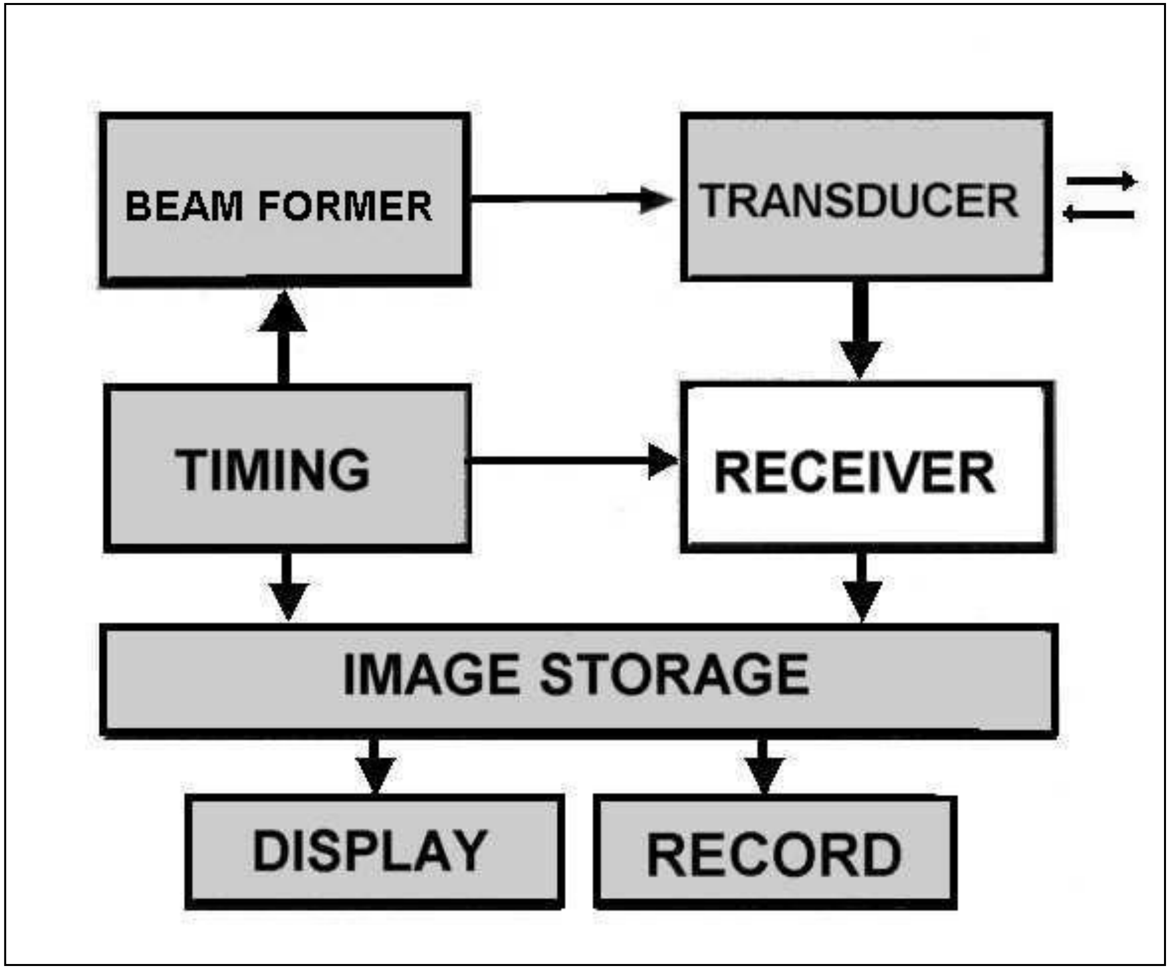
TIMING



PRF

>1000 Hz

RECEIVER



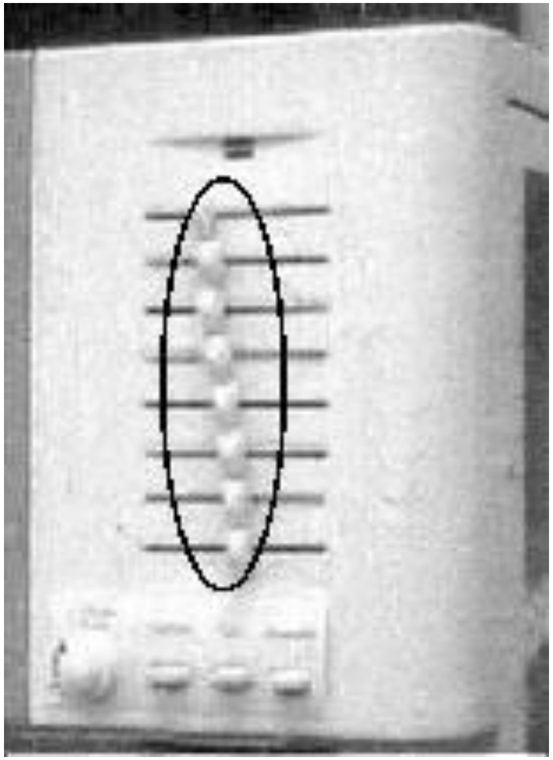
TGC

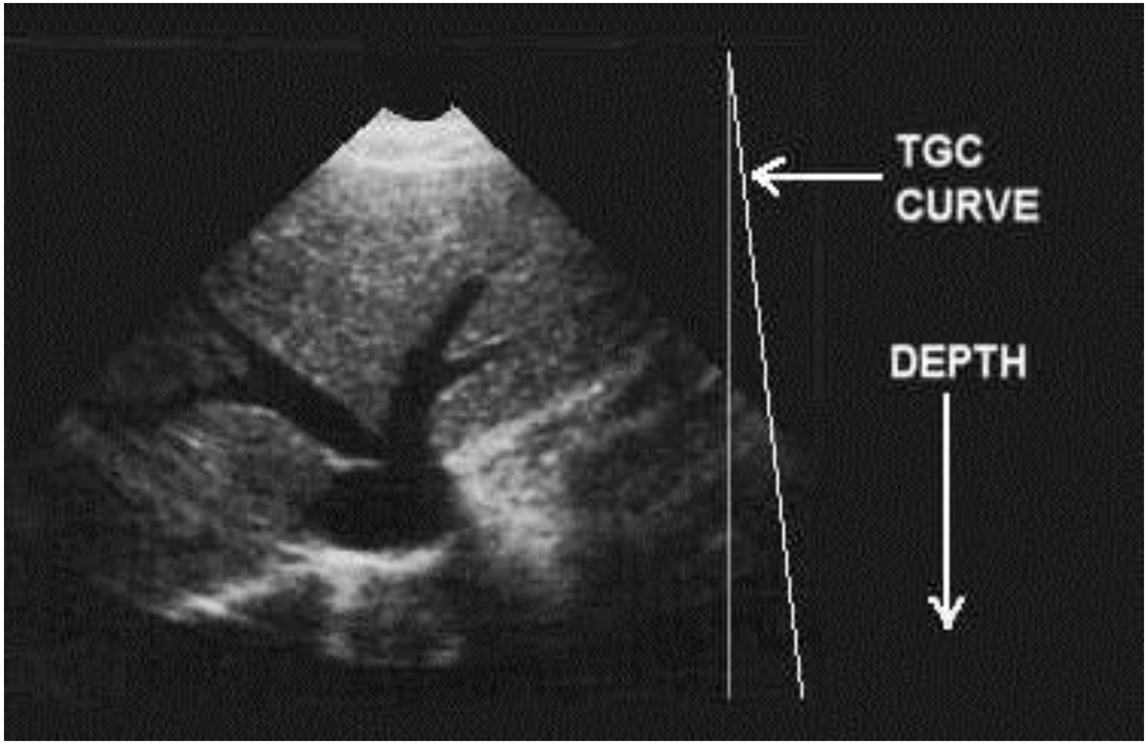
GAIN

MASTER GAIN

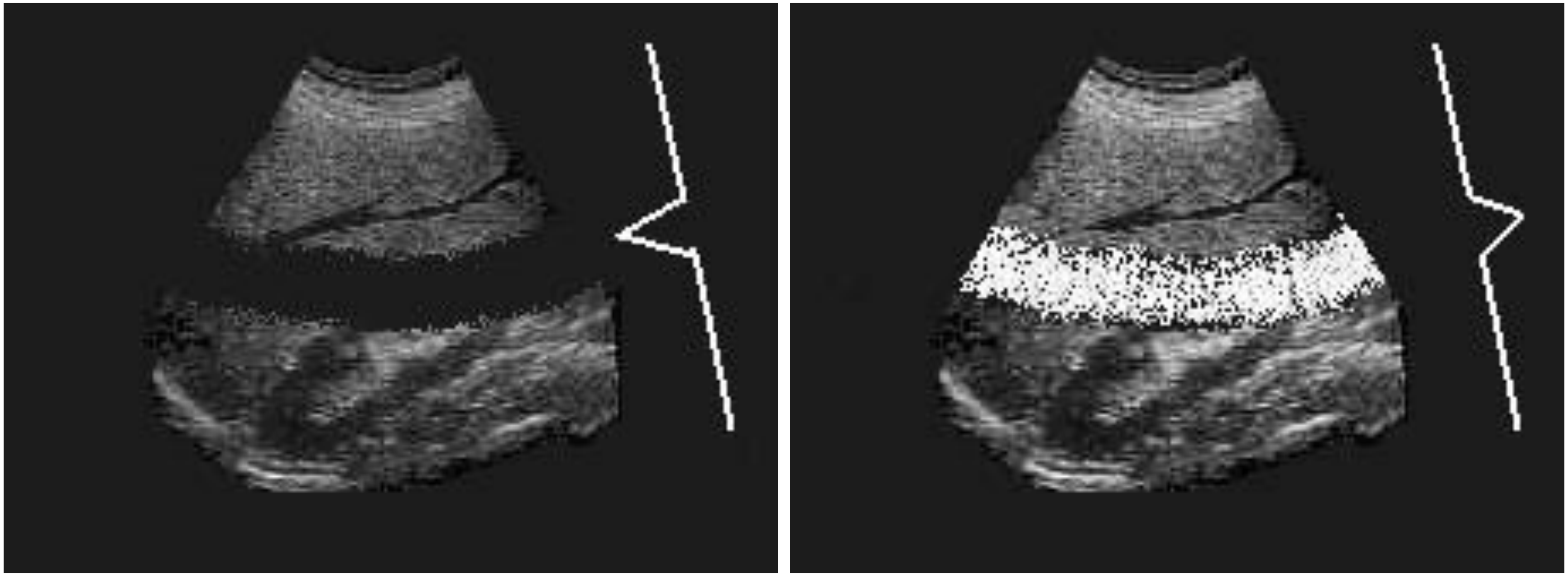
OVERALL GAIN

TIME GAIN COMPENSATION



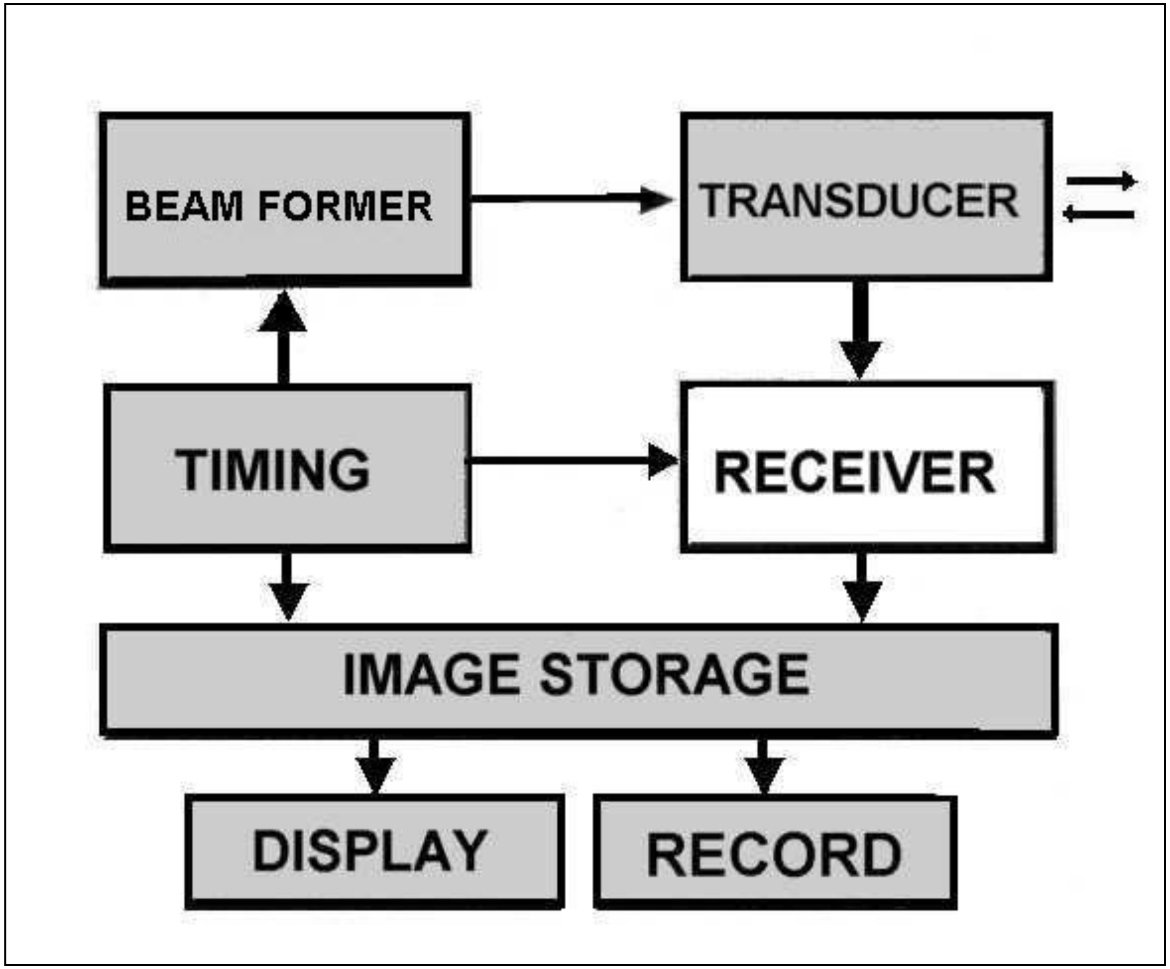


TGC



INCORRECT SETTINGS

DYNAMIC RANGE



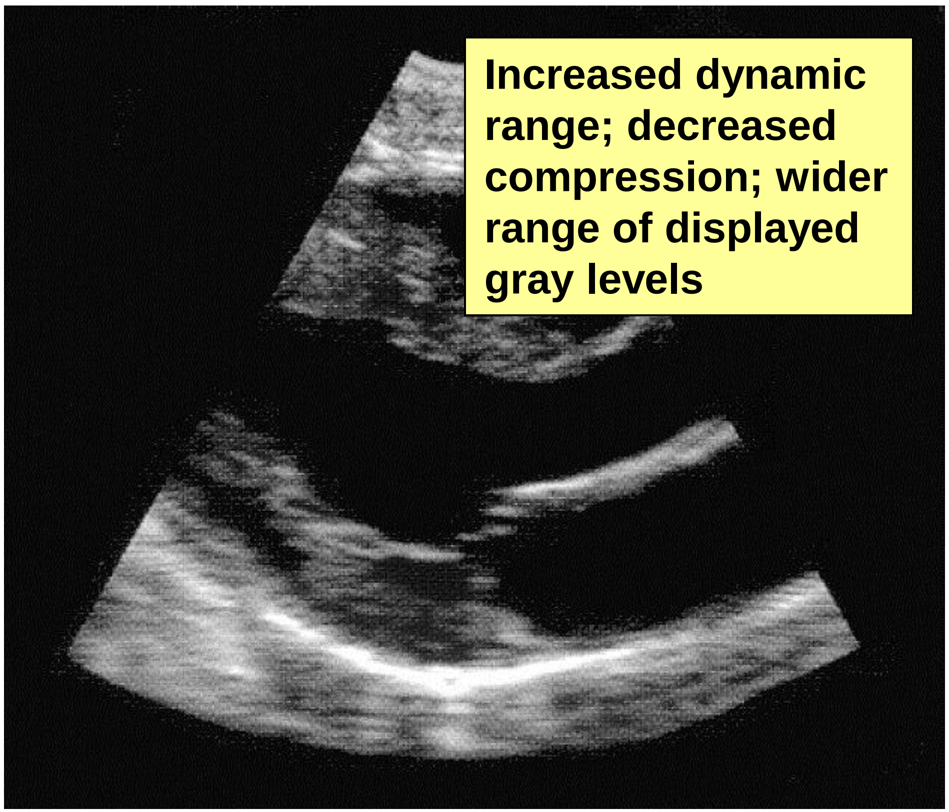
DYNAMIC RANGE

COMPRESSION

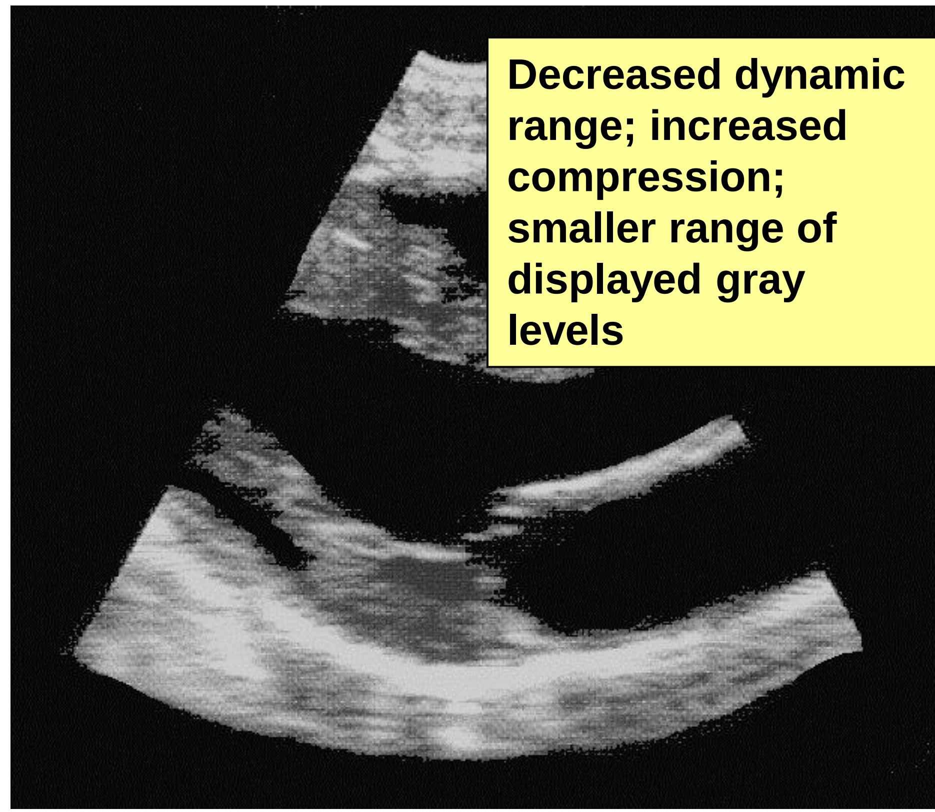
LOG-COMPRESSION

COMPRESS

DYNAMIC RANGE

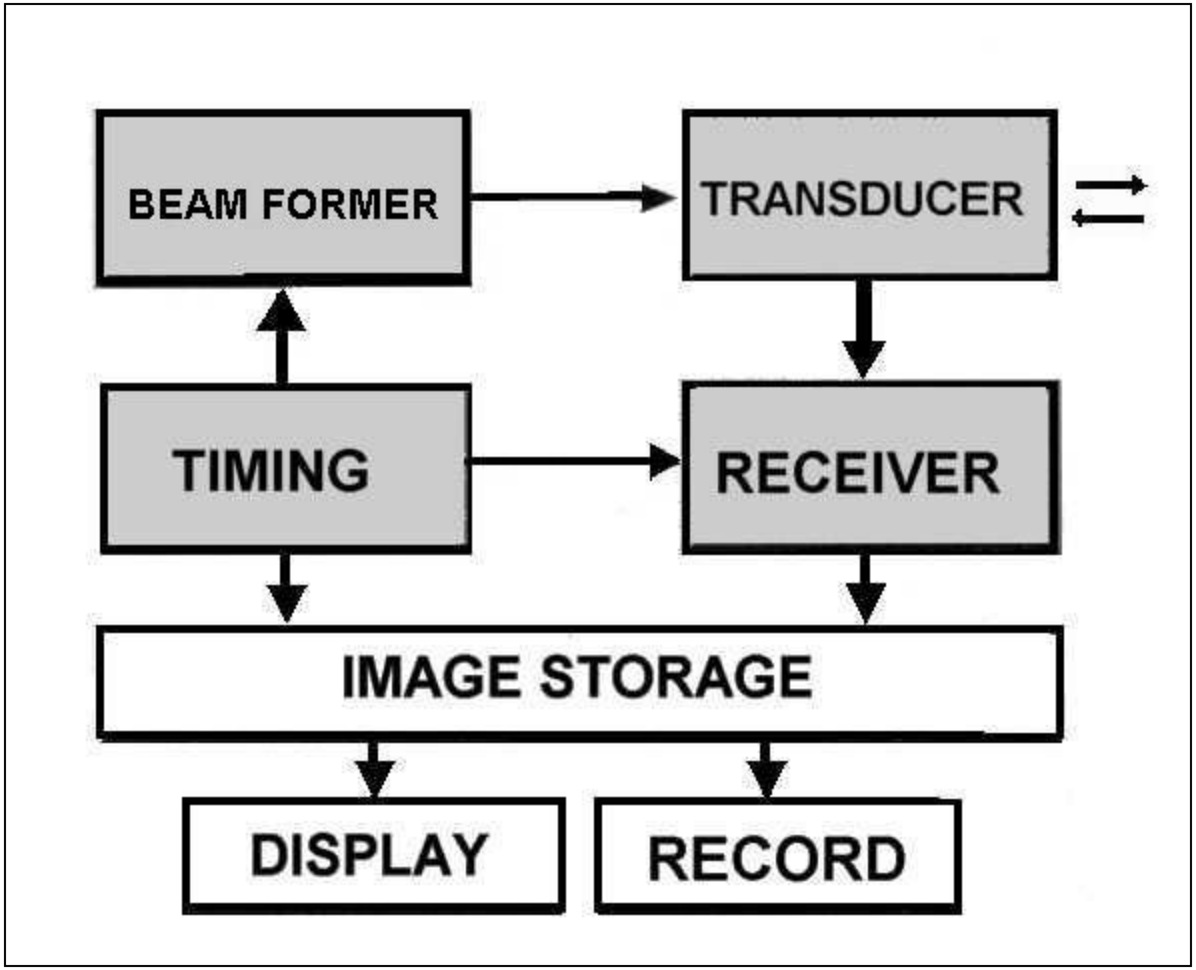


50 dB

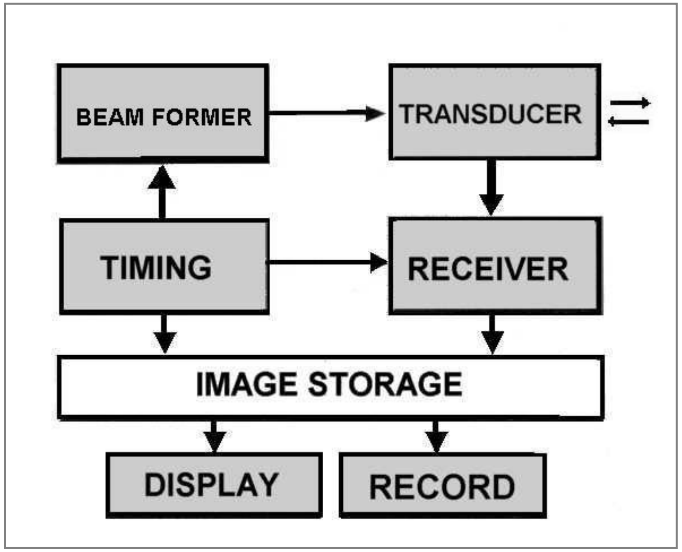


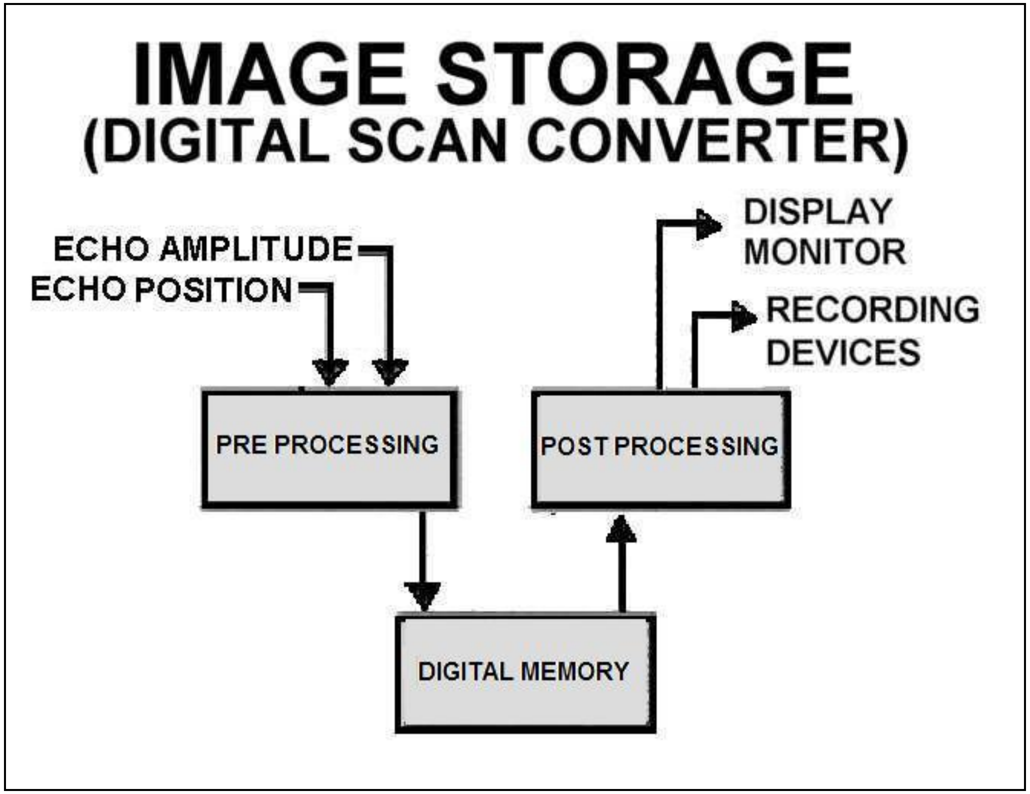
30 dB

Image Storage, and Processing

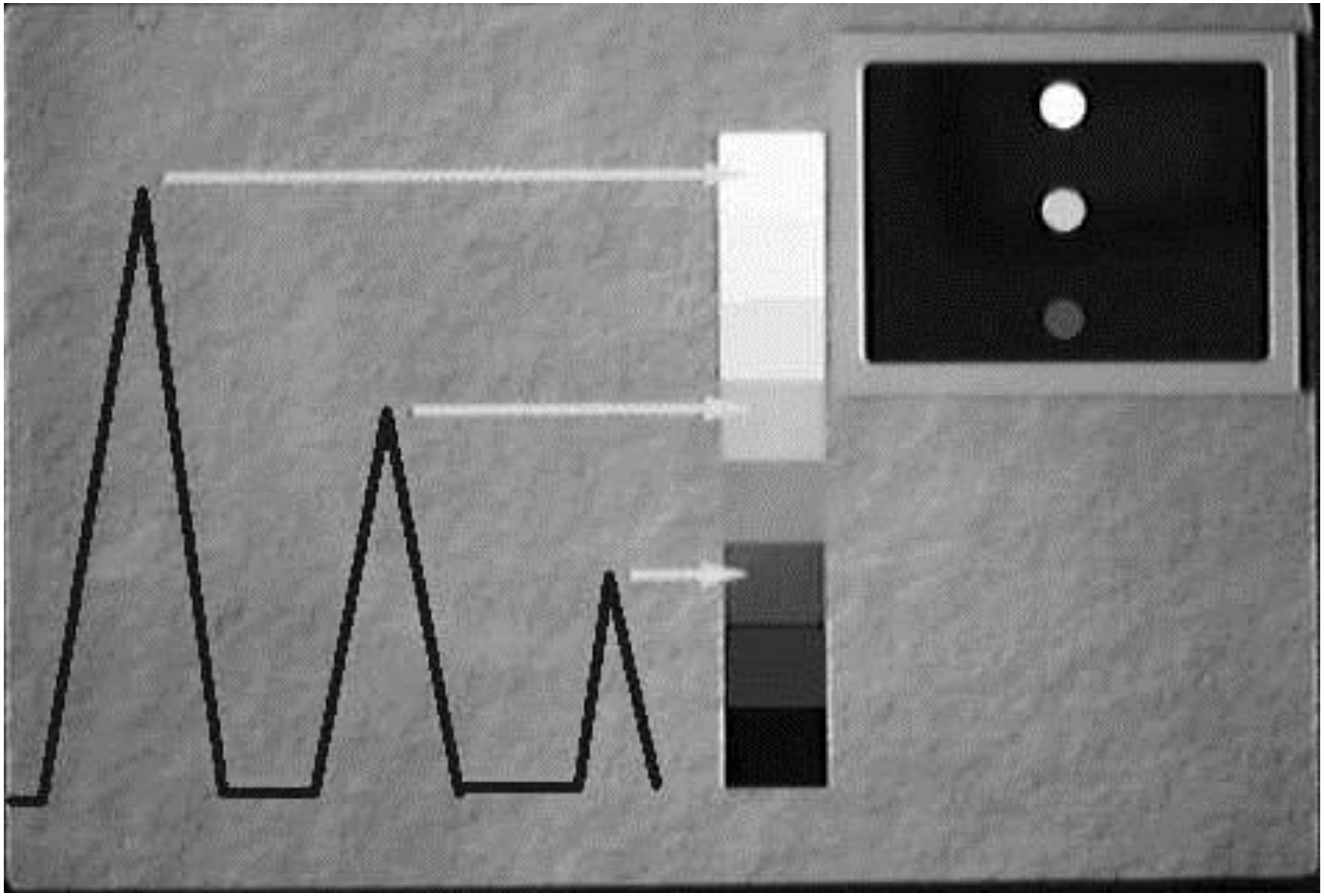


Digital scan converter





Pre processing



NUMBER OF BITS IN A DIGITAL MEMORY AND NUMBER OF GRAY SHADES

(based on 2^n)

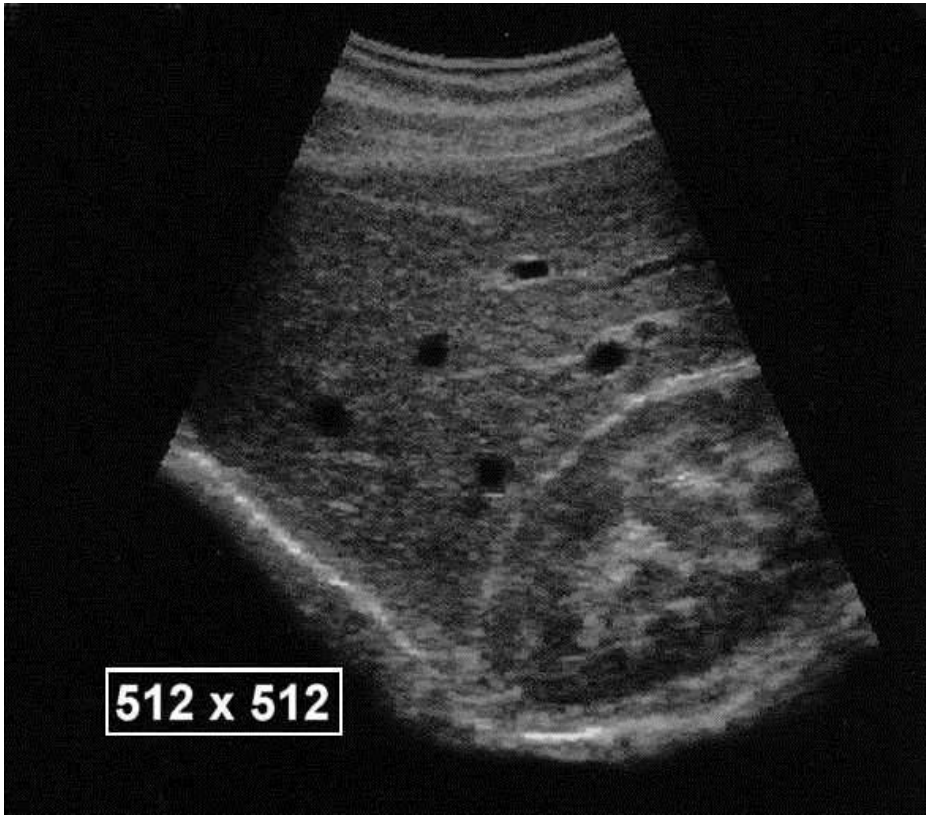
bits	**gray shades**
4	16
5	32
6	64
7	128
8	256
9	512
10	1024

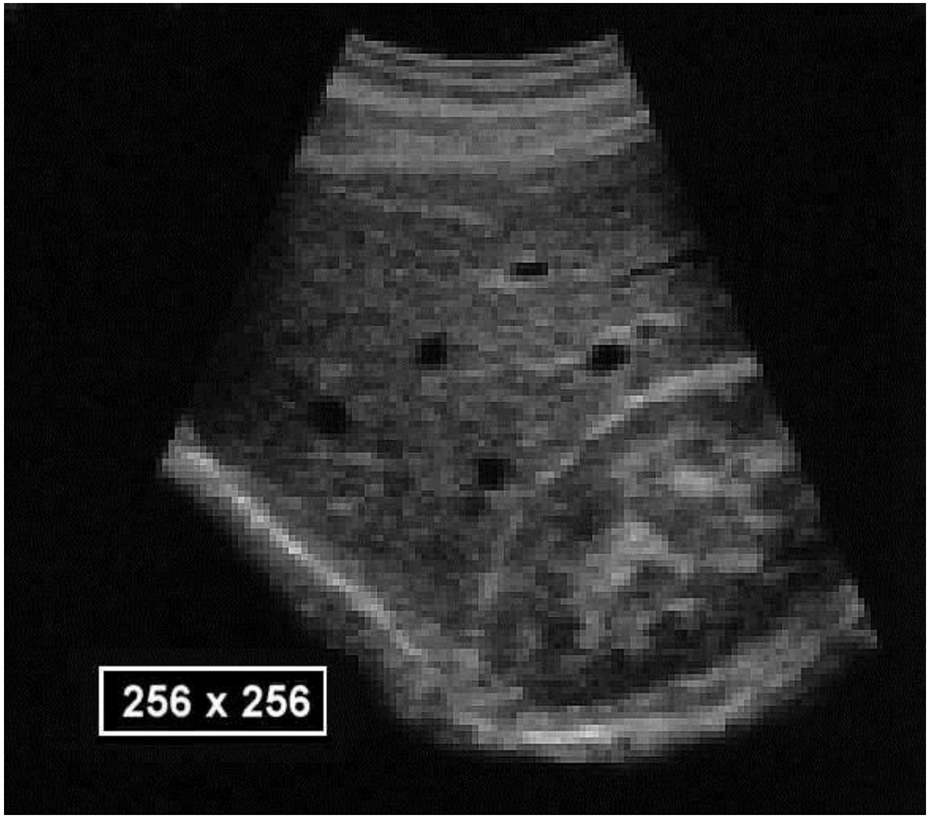
BITS

4 BITS (16 GRAY SHADES)

8 BITS (256 GRAY SHADES)

MATRIX

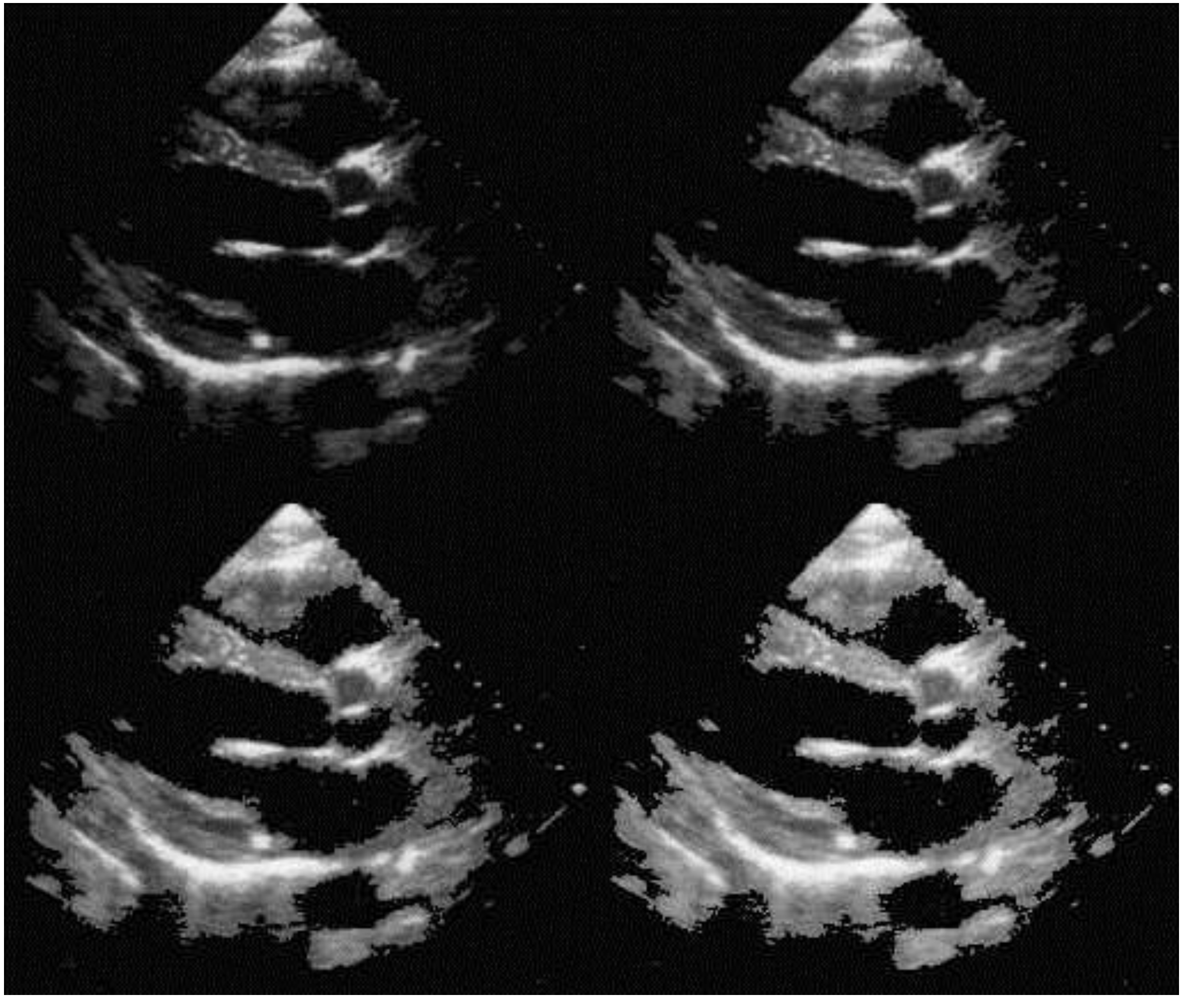




262,144 PIXELS

65,536 PIXELS

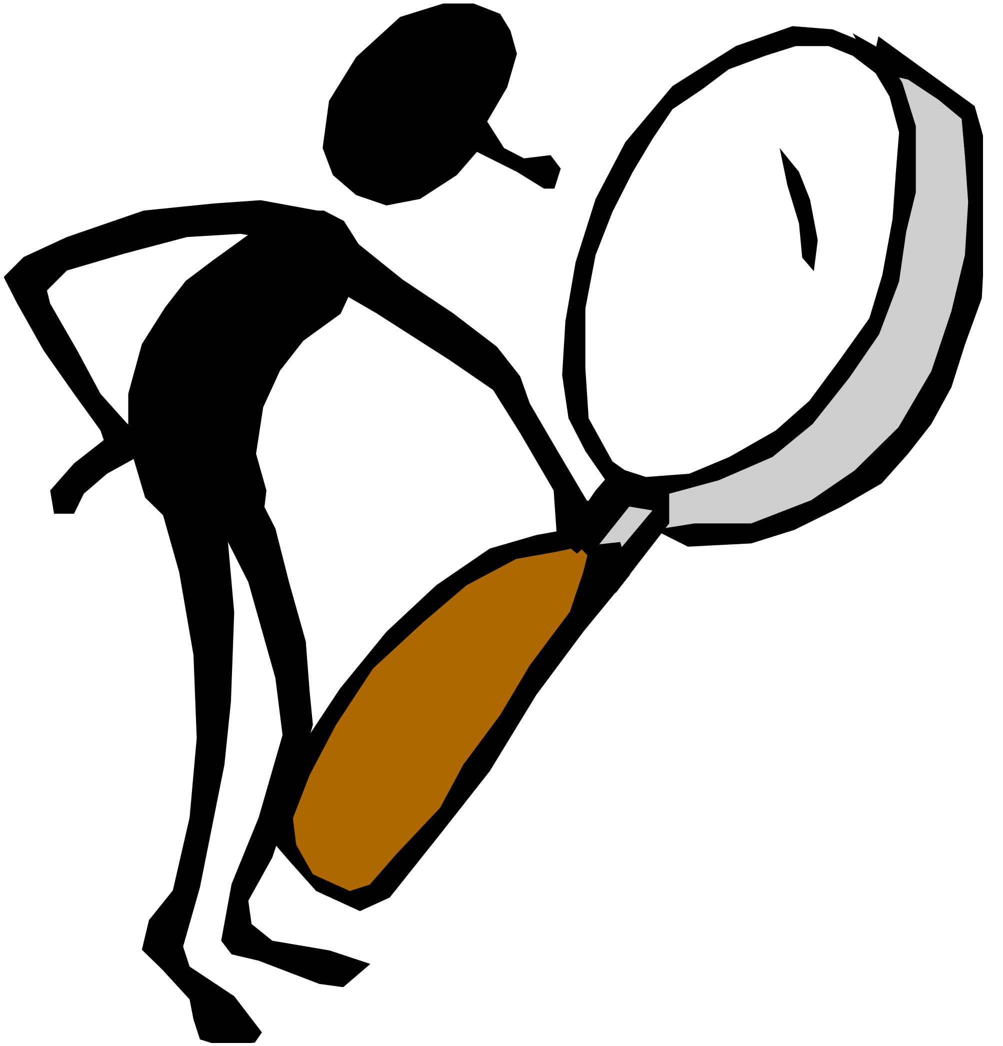
Post processing



MAGNIFICATION

WRITE

READ



ZOOM

MAG

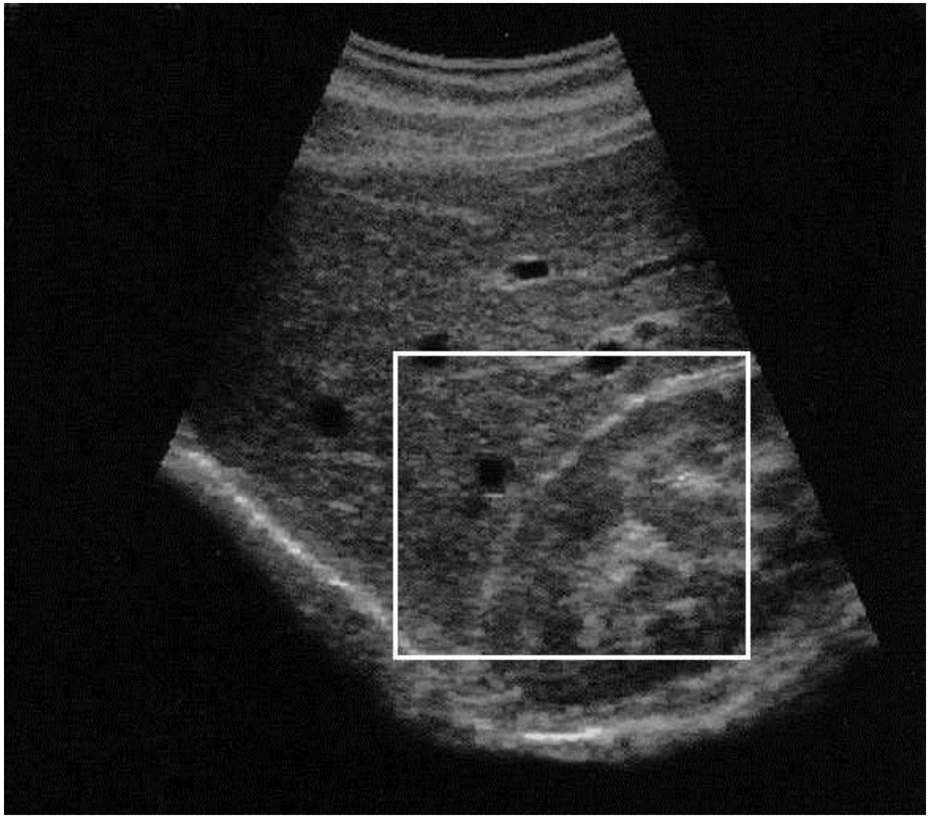
RES

SCALE

SIZE

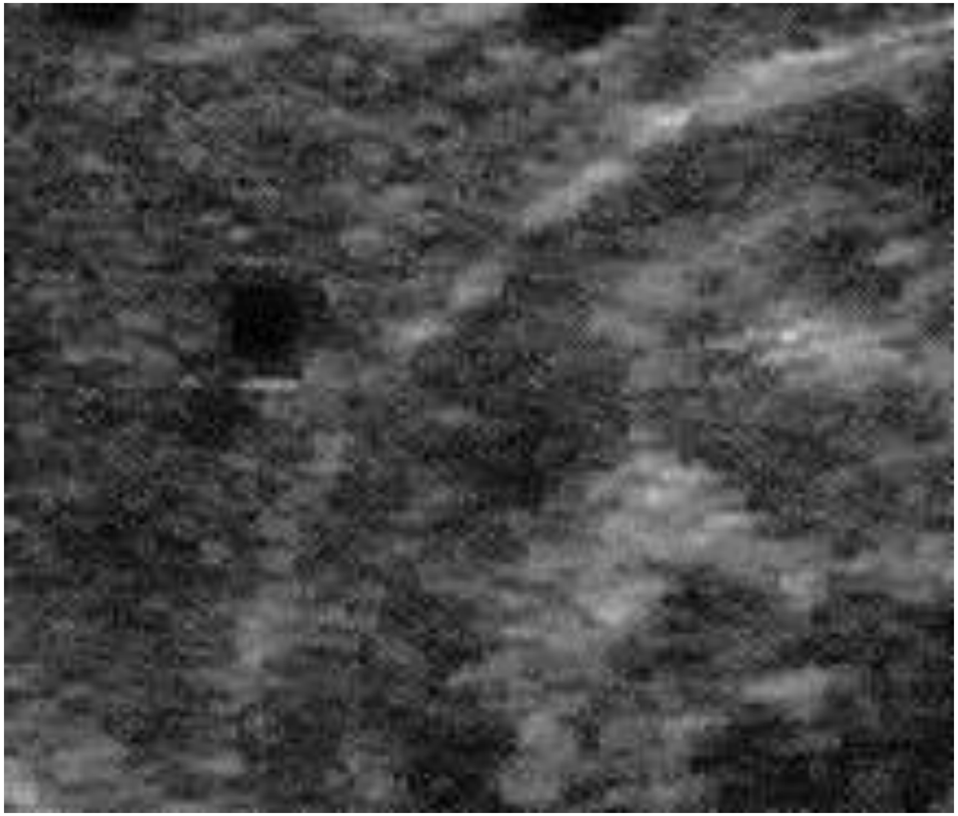
FOV

WRITE MAGNIFICATION



NORMAL SIZE

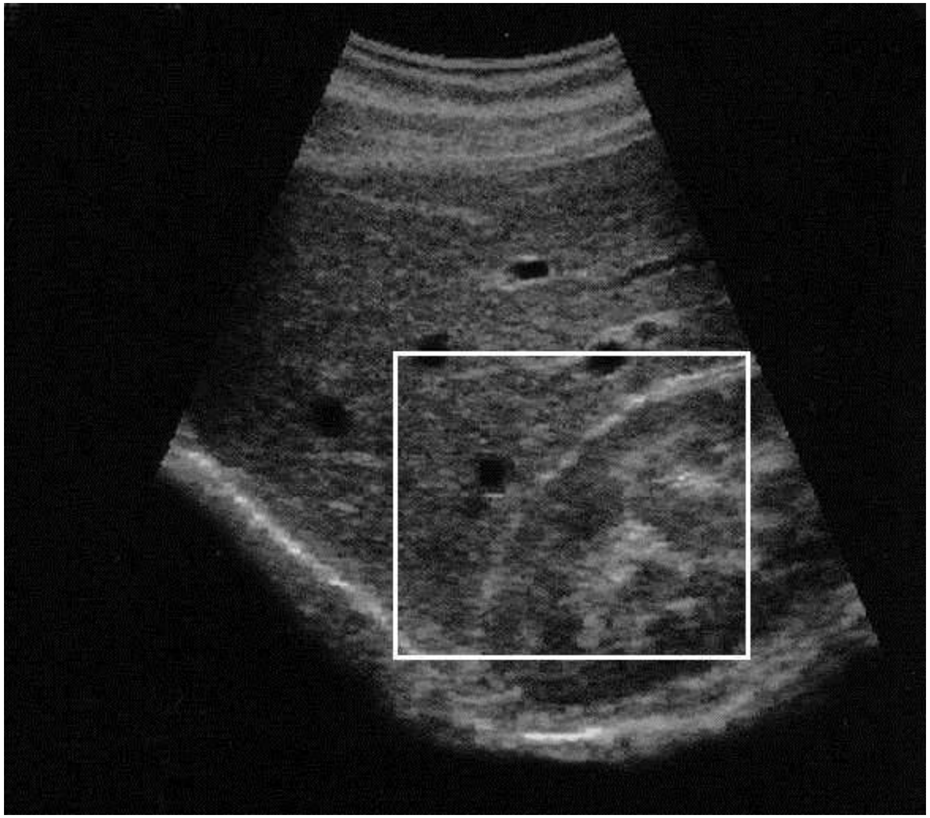
PRIOR TO MAGNIFICATION

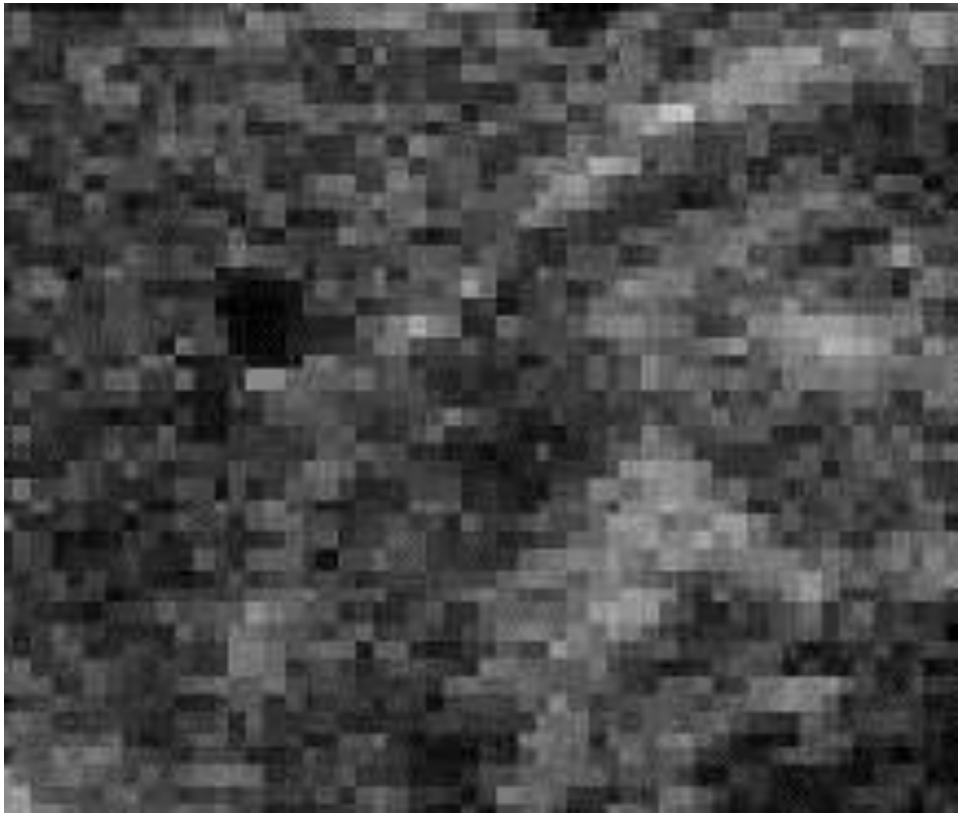


AFTER WRITE MAGNIFICATION

NO CHANGE IN THE NUMBER OF DISPLAYED PIXELS

READ MAGNIFICATION





NORMAL SIZE

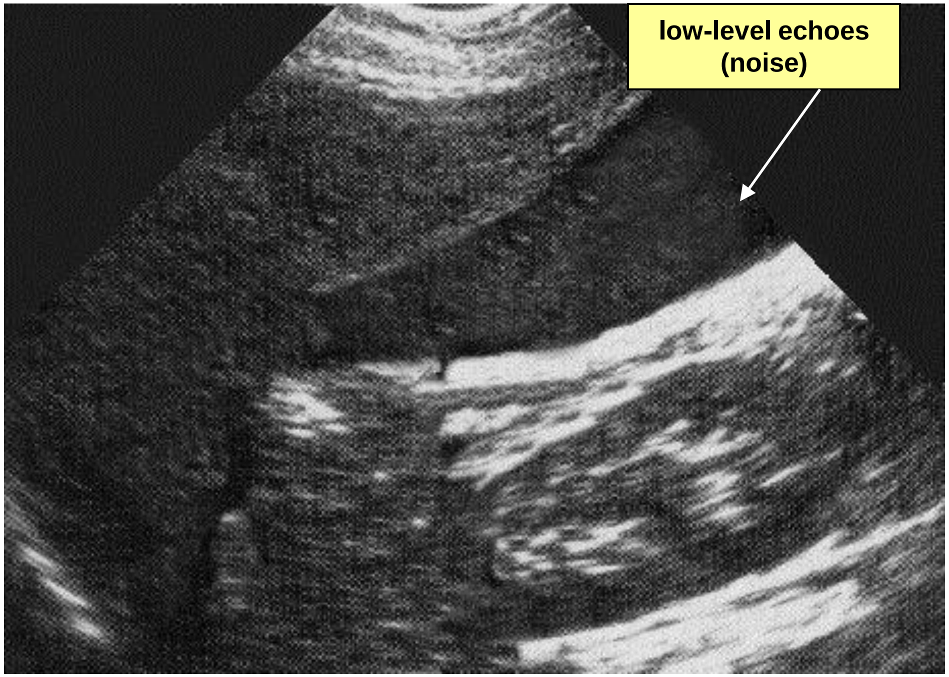
PRIOR TO MAGNIFICATION

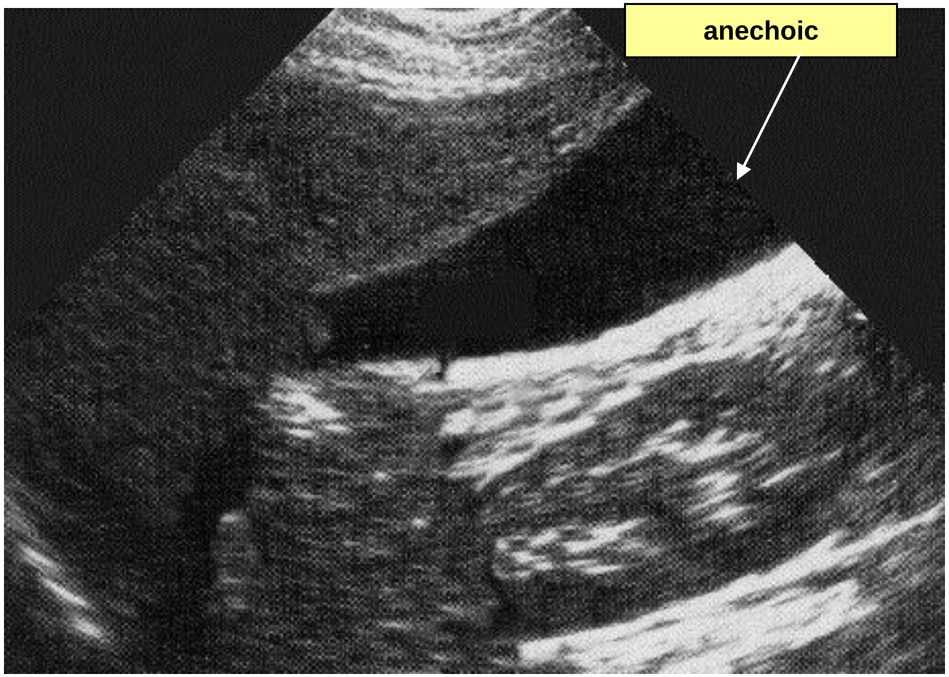
AFTER READ MAGNIFICATION

A REDUCTION IN THE NUMBER OF DISPLAYED PIXELS

Image Noise Reduction

NOISE REDUCTION
USING REJECT





BEFORE REJECT **AFTER REJECT**

NOISE REDUCTION (Other methods)

Frame averaging (persistence), which reduces image noise by averaging and overlapping sequential real-time frames to provide *spatial smoothing* of the image.

NOISE REDUCTION (Other methods)

Frequency compounding, which is a method of transmitting a single broadband pulse and then using different receive frequency sub-bands. It reduces speckle and electronic noise to improve axial and contrast resolutions.

NOISE REDUCTION (Other methods)

Spatial compounding, which is the process of steering ultrasound beams “off-axis” to provide multiple transmit angles, or “lines of sight” while combining them in real-time during a single cross-sectional scan. Tissue interfaces are encountered from numerous directions rather than from a single direction. This helps eliminate certain artifact patterns to provide a more realistic anatomic representation. Reducing the acoustic shadows enables the scanner to essentially “see around” obstructions.

HARMONICS

Harmonic echoes are non-linear, high frequency signals created when a contrast agent or tissue interacts with ultrasound energy during pulse-echo and Doppler studies. Some harmonics are "native" to specific types and characteristics of tissue and are often produced without the use of a contrast agent. These tissue harmonics are decreased when lower transmit power is used.

HARMONIC IMAGING

Harmonic imaging is a procedure in which the receiver detects only echoes at the *second* harmonic, which is twice the fundamental (transmitted) frequency. Harmonic imaging, to be effective, requires the use of broadband transducers. Harmonic imaging, by reducing unwanted artifacts caused by interaction with the fundamental frequency sound waves, provides improved contrast resolution, and reduced visible noise