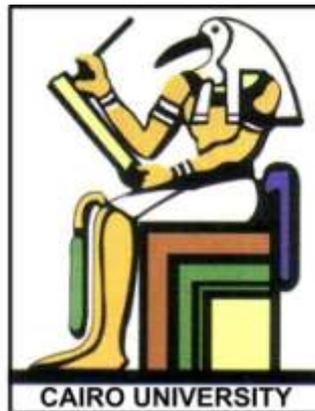
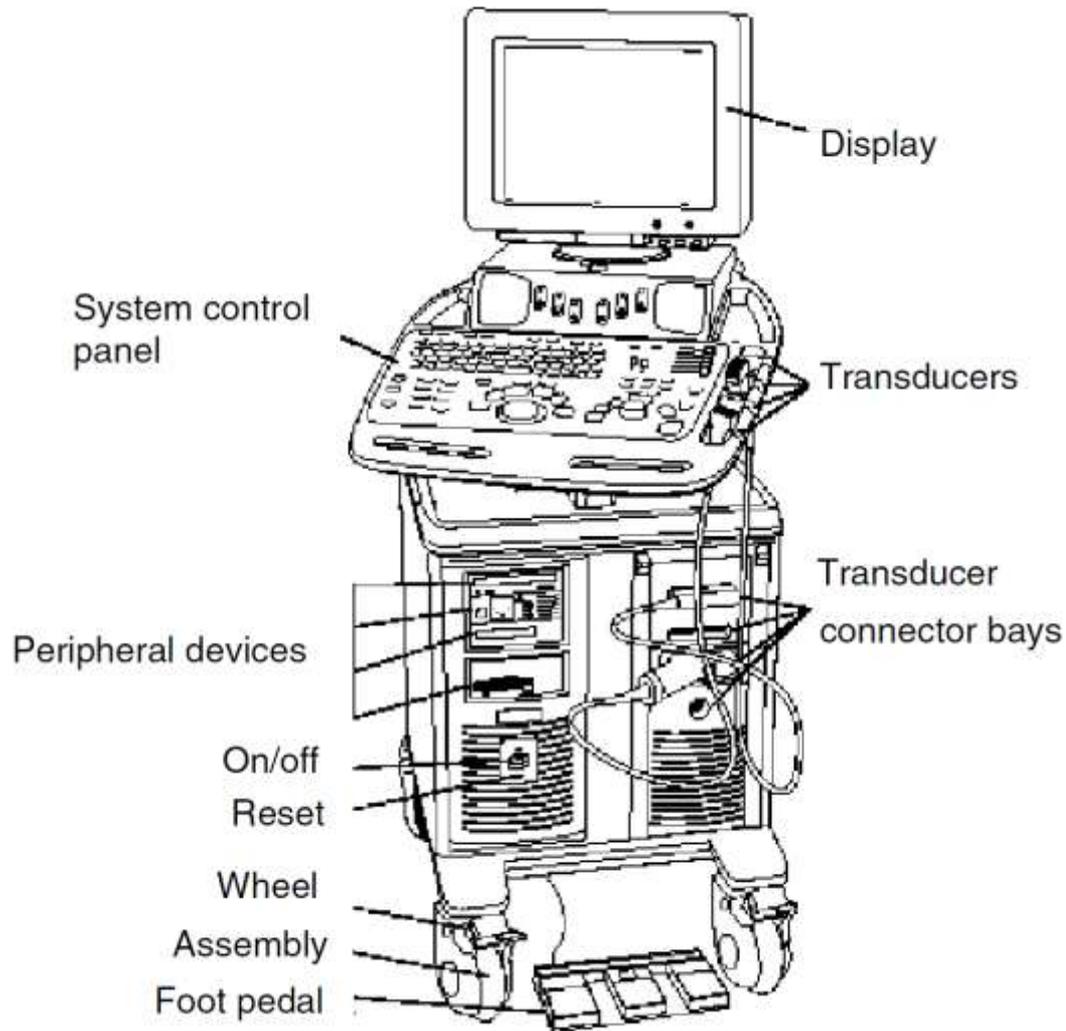


Ultrasound Bioinstrumentation

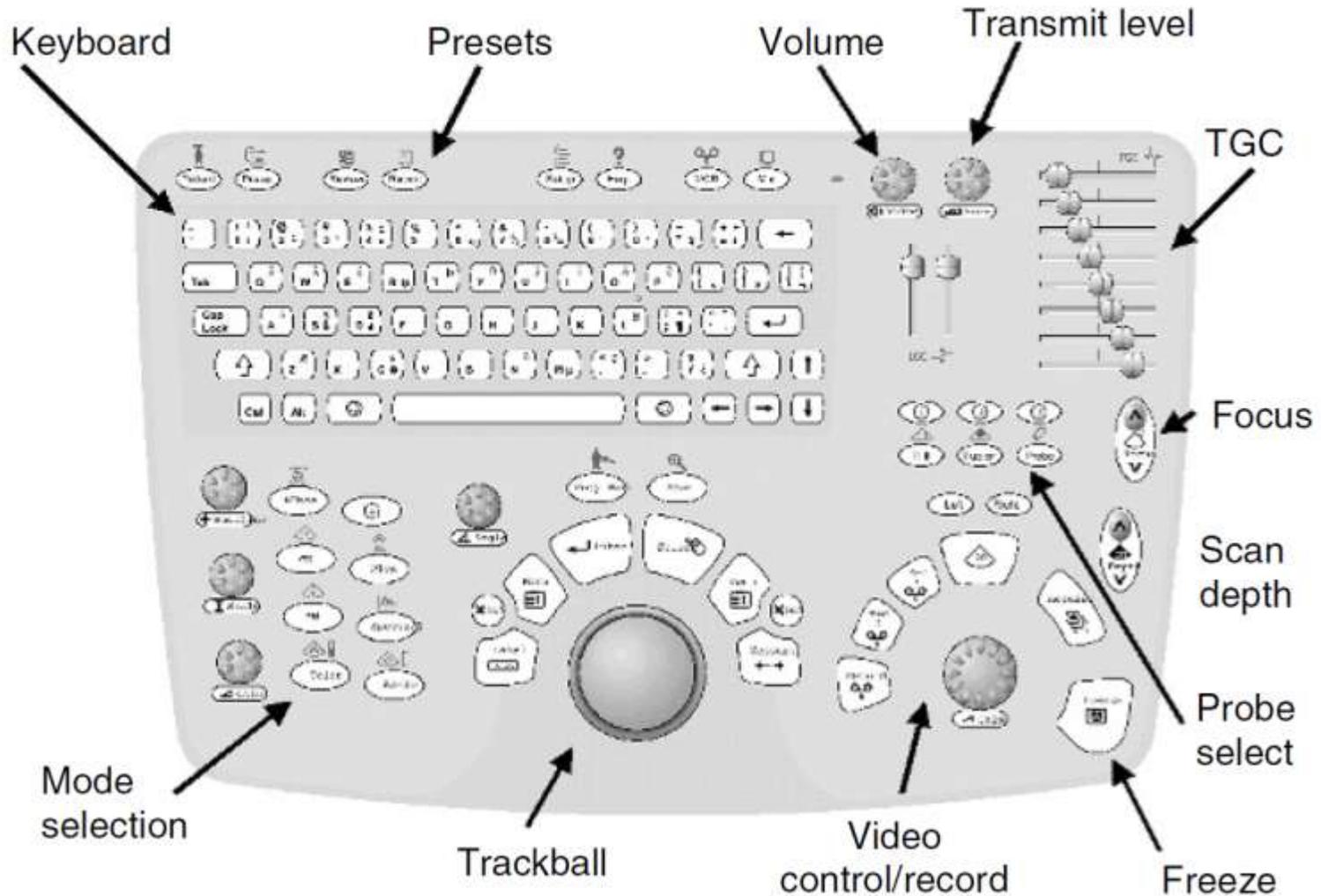
Topic 5: Lectures 9 Ultrasound System Design



Ultrasound Imaging System: External Look



Keyboard Controls



Block Diagram

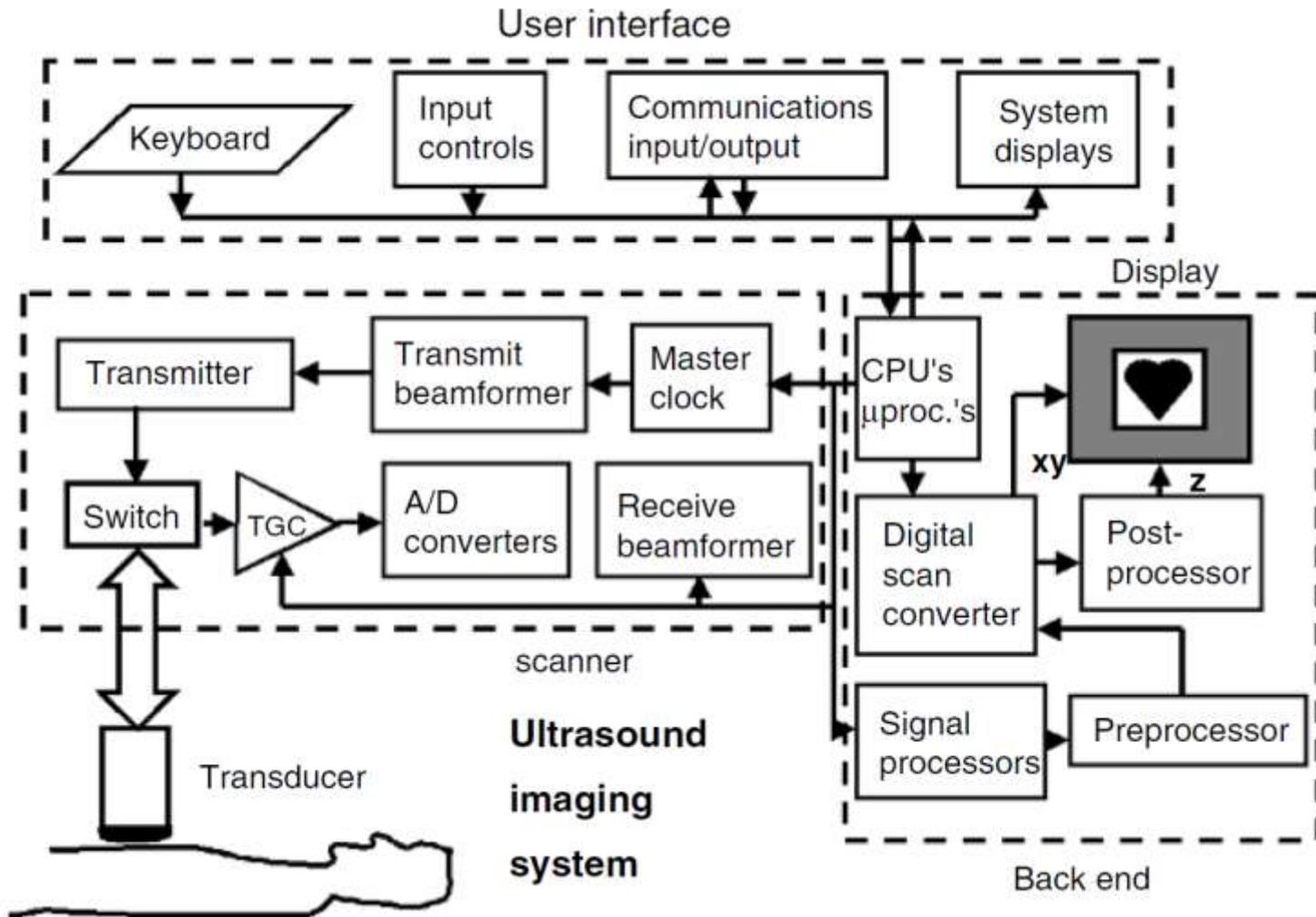
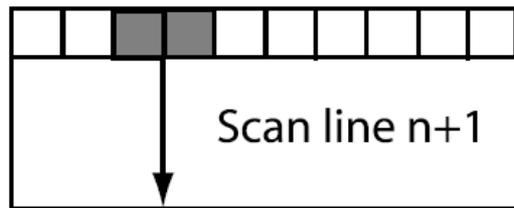
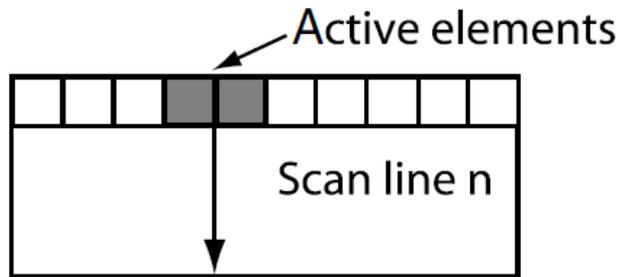
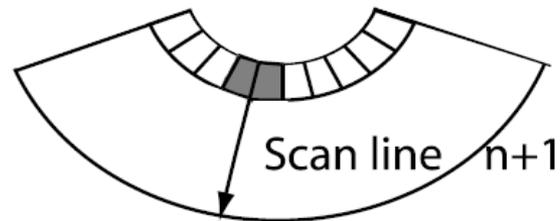
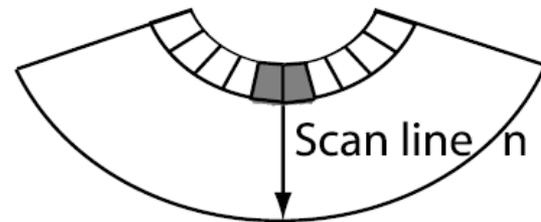


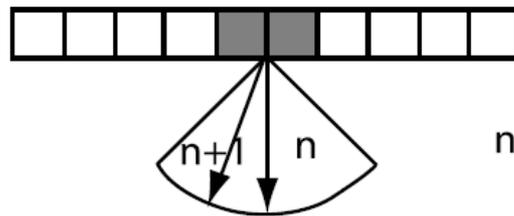
Image Formats



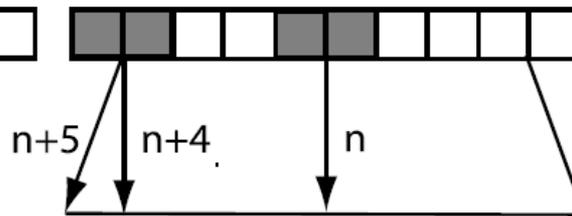
A Linear (translation)



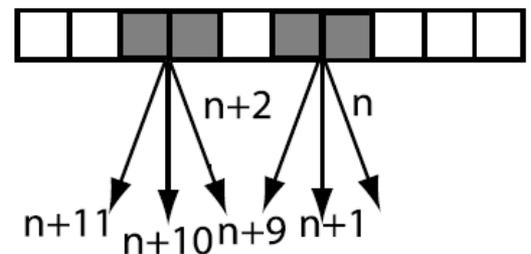
B Convex (translation)



C Sector (rotation)

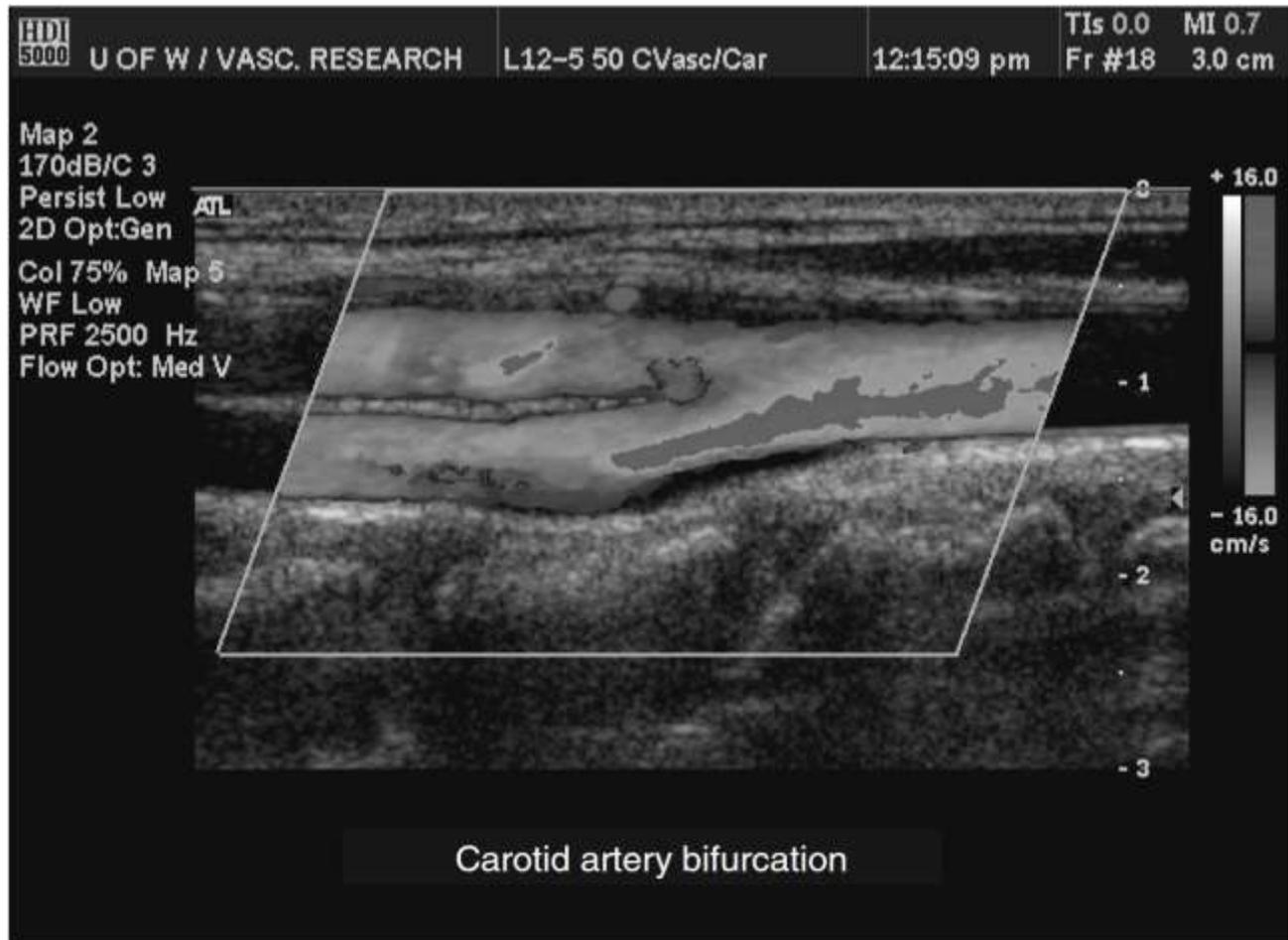


D Trapezoidal (contiguous)



E Compound

[Example Images]



Example Images



Major Imaging Categories

- Breast
 - Imaging of female (usually) breasts
- Cardiac
 - Imaging of the heart
- Obstetrics/Gynecologic (OB/GYN)
 - OB: Imaging of fetuses in vivo
 - GYN: Imaging of the female reproductive organs
- Abdominal (Radiology)
 - Imaging of the internal organs of the abdomen
- Pediatrics
 - Imaging of children
- Vascular
 - Imaging of the arteries and veins of the vascular system

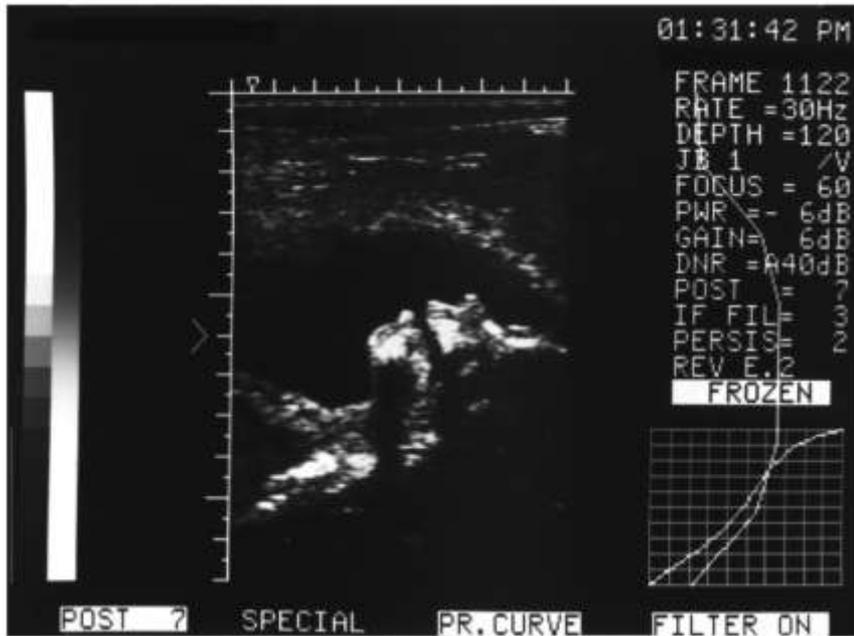
Ultrasound Applications (1)

- Endovaginal
 - Imaging the female pelvis using the vagina as an acoustic window
- Intracardiac
 - Imaging from within the heart
- Intraoperative
 - Imaging during a surgical procedure
- Intravascular
 - Imaging of the interior of arteries and veins
- Laproscopic
 - Guide and evaluate laparoscopic surgery
- Musculoskeletal
 - Imaging of muscles, tendons, and ligaments

Ultrasound Applications (2)

- Small parts
 - High-resolution imaging applied to superficial tissues, musculature, and vessels near the skin surface
- Transcranial
 - Imaging through the skull (through temple or eye) of the brain
- Transesophageal
 - Imaging of internal organs (especially the heart) from specially designed probes that go inside the esophagus
- Transorbital
 - Imaging of the eye or through the eye as an acoustic window
- Transrectal
 - Imaging of the pelvis using the rectum as an acoustic window
- Transthoracic
 - External imaging from the surface of the chest

[Transmit Focal Zones]



Single Zone

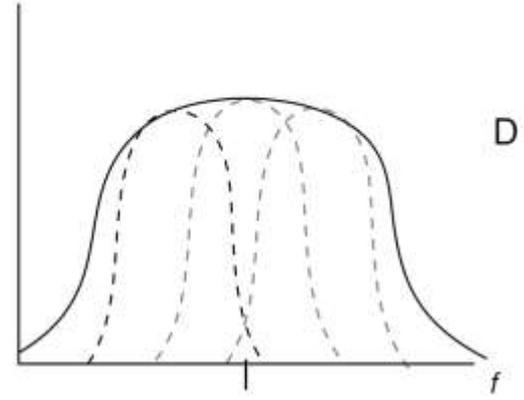
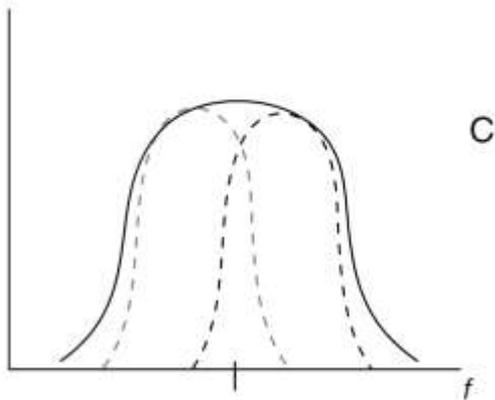
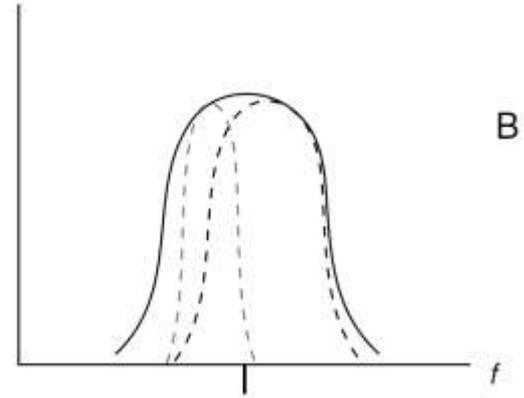
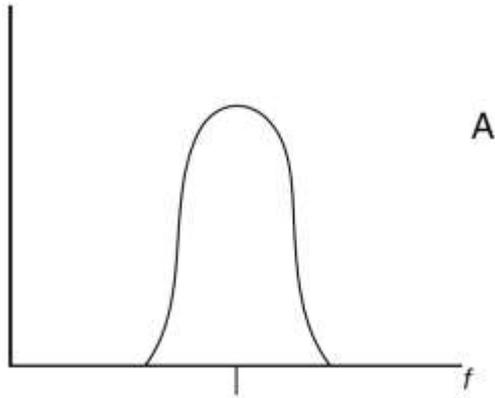


Multiple Zones

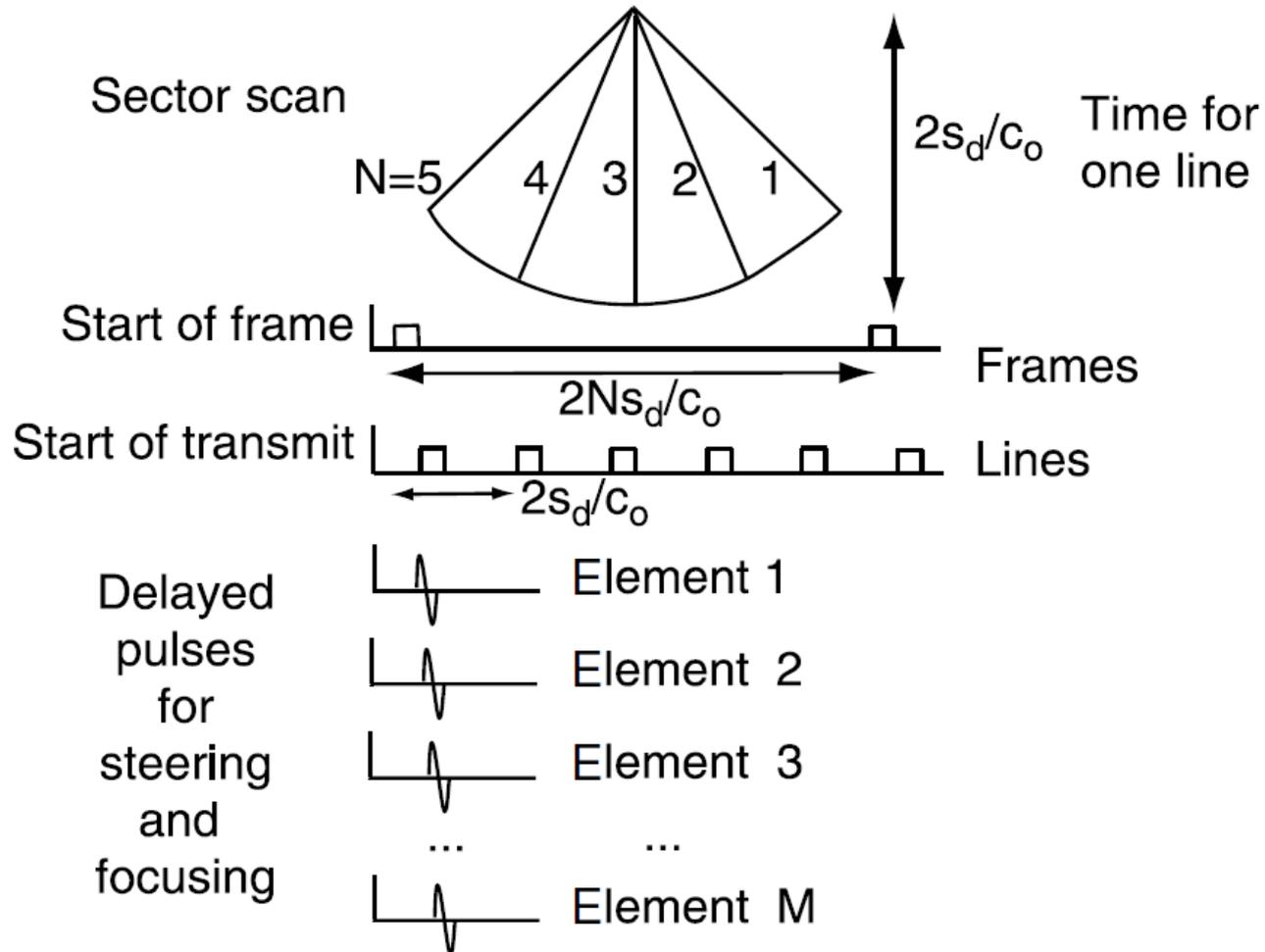
[Ultrasound Transducers]



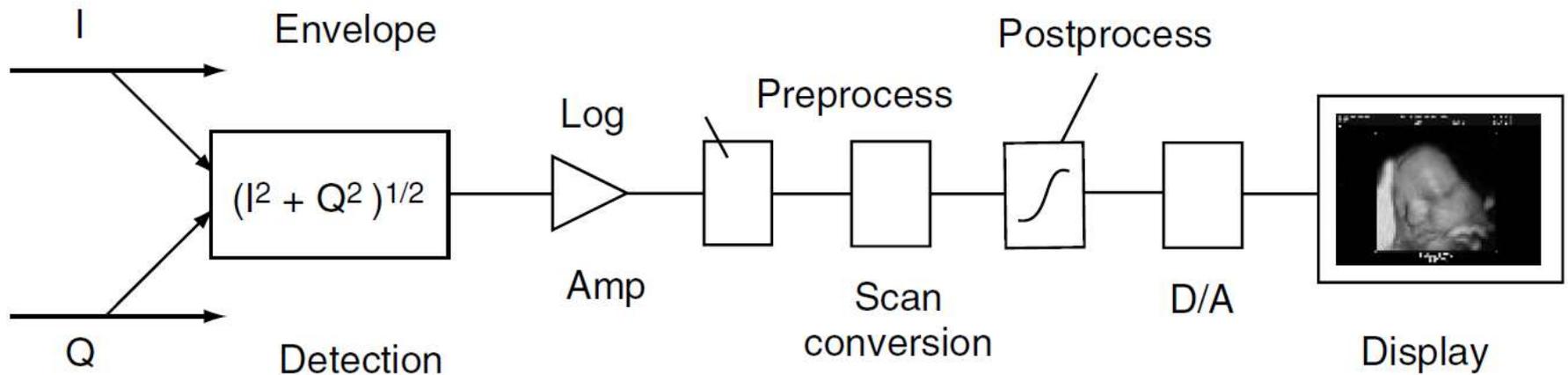
[Multi-Frequency Probes]



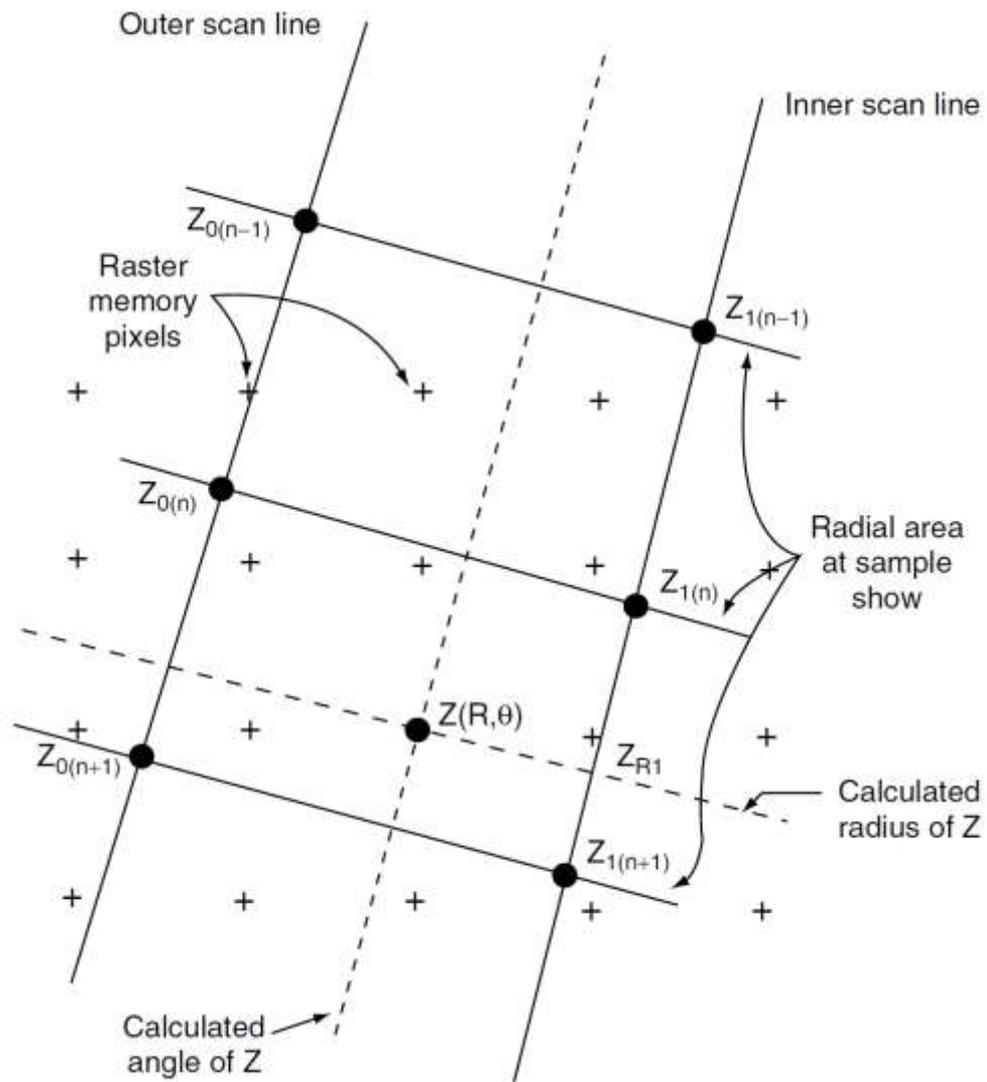
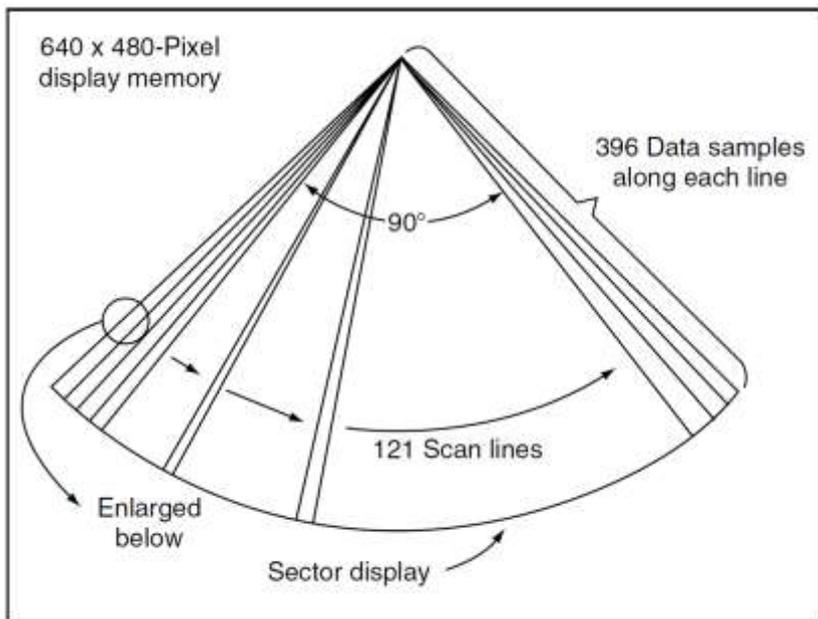
Ultrasound Pulse Sequencing



Ultrasound Imaging Back-End



Ultrasound Image Reconstruction



[Frequency Compounding]

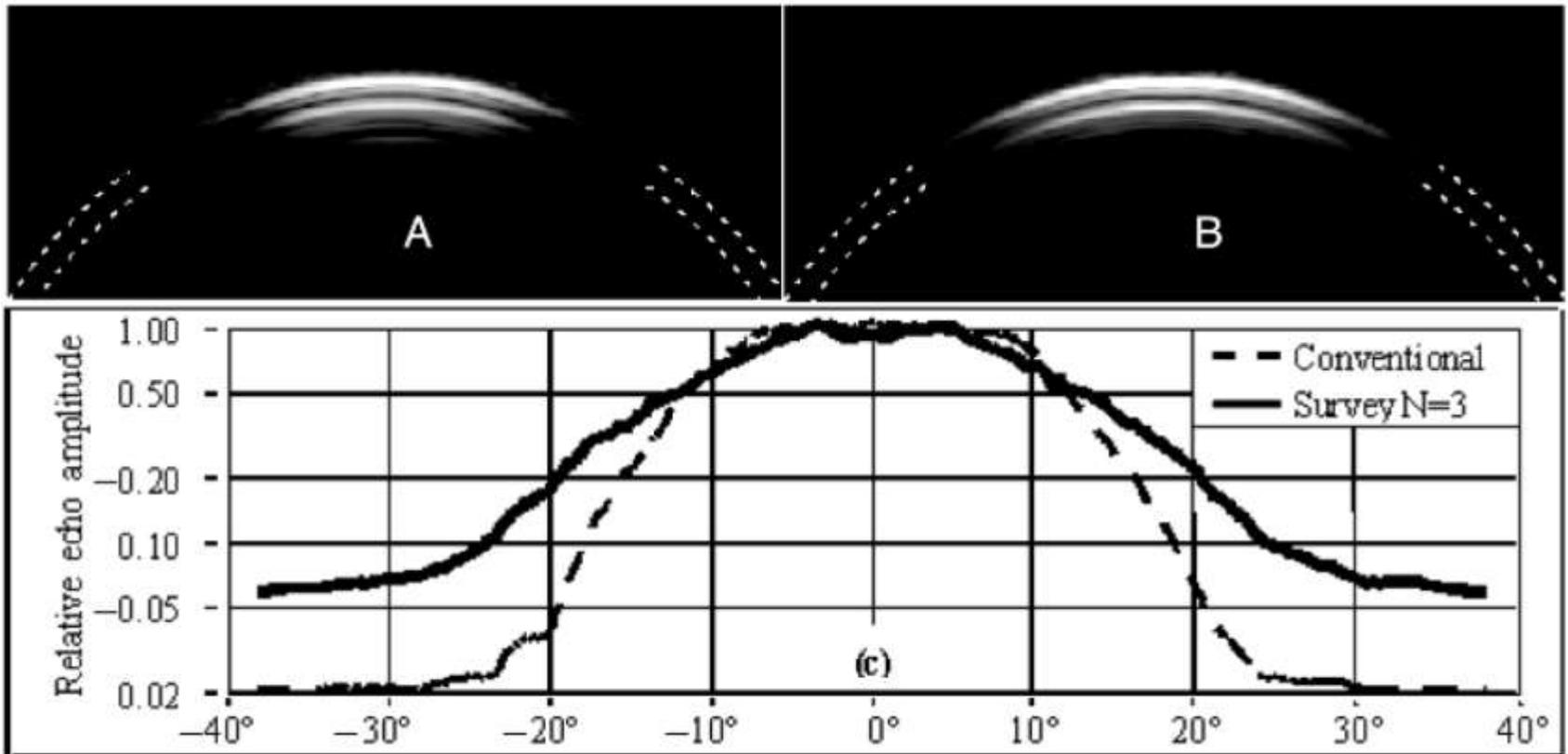


Conventional Imaging

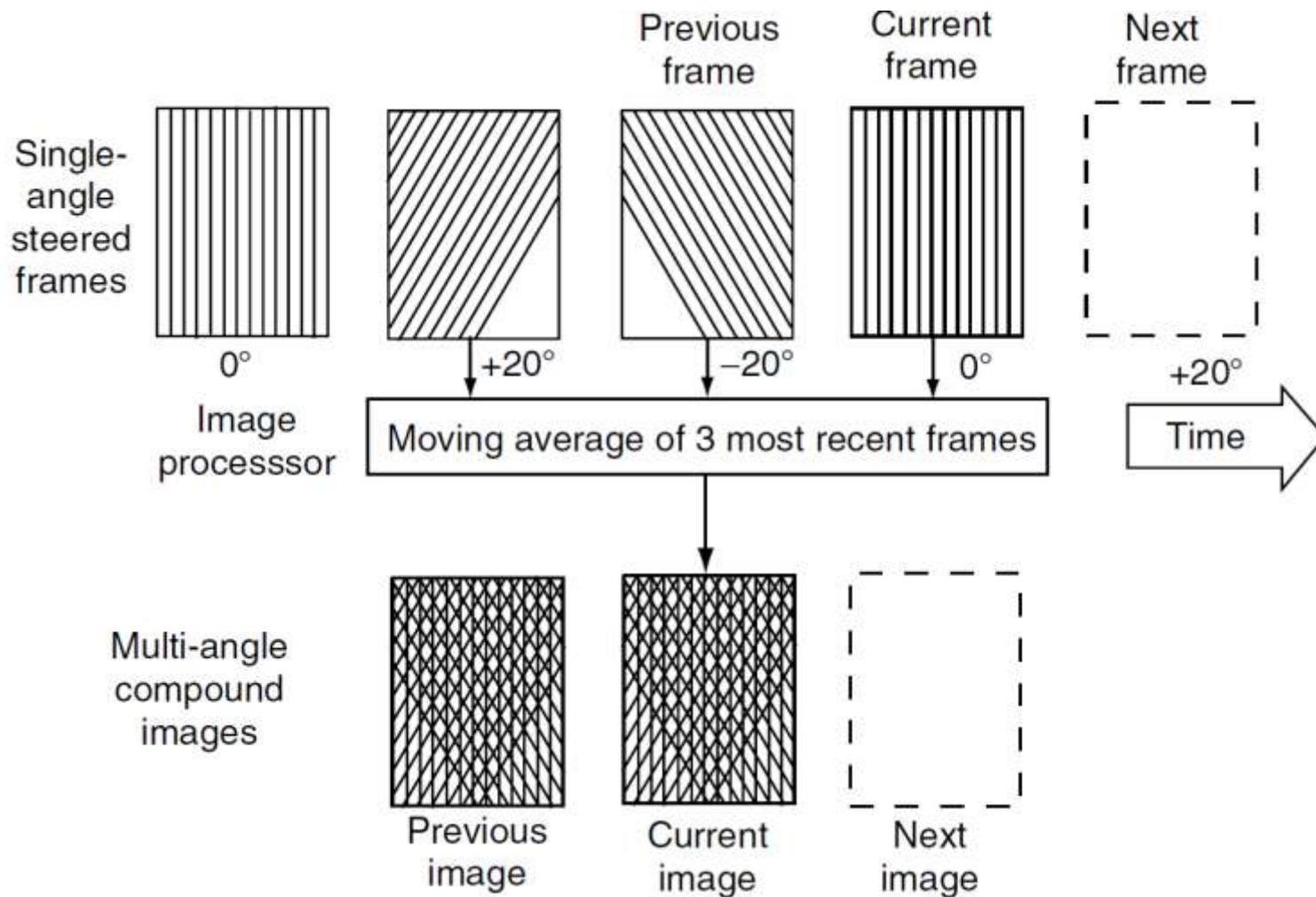


Frequency Compounding

Spatial Compounding



Spatial Compounding



Spatial Compounding Example



Conventional Imaging



Spatial Compounding

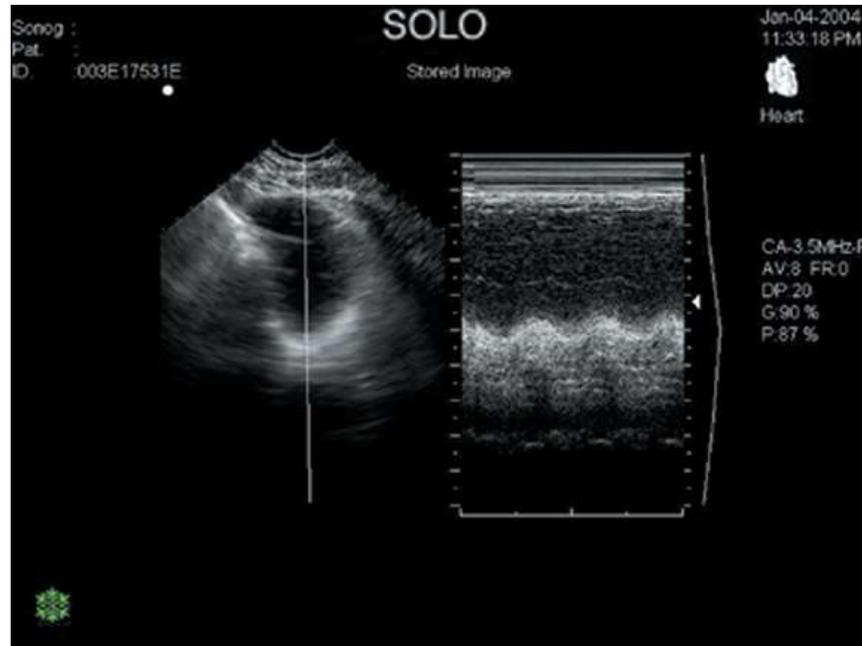
Major Modes: B-Mode (2D Mode)

- Brightness-modulated image in which depth is along the z axis and azimuth is along the x axis.
 - The position of the echo is determined by its acoustic transit time and beam direction in the plane.



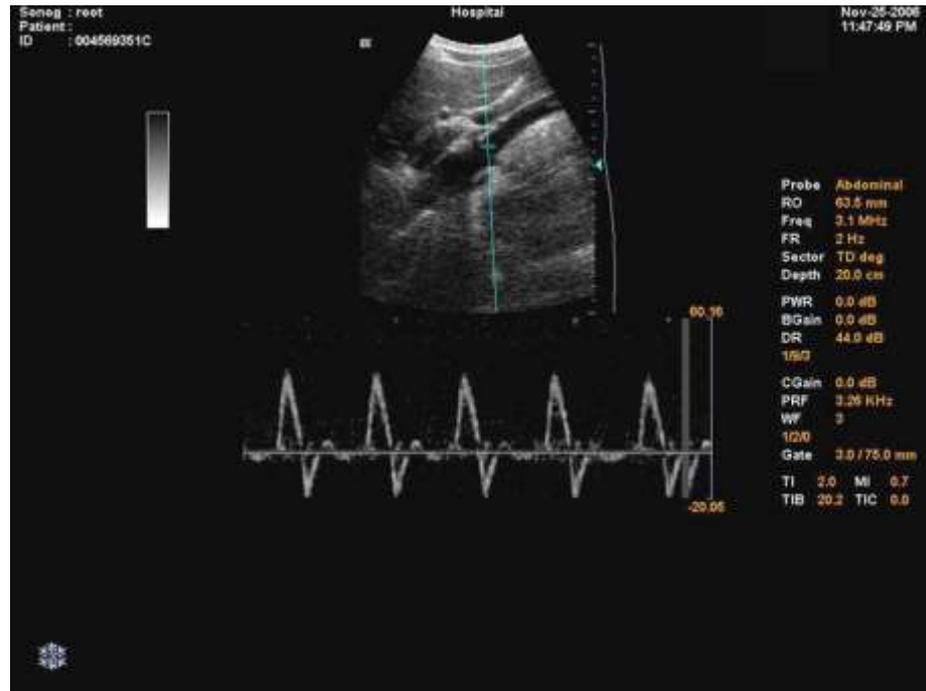
Major Modes: M-Mode

- Brightness modulated, where depth is the y deflection (fast time), and the x deflection is the same imaging line shown as a function of slow time.
 - Time history of single line at the same position over time



Major Modes: Doppler-Mode

- This is the presentation of the Doppler spectrum
 - Continuous wave (CW) Doppler
 - Pulsed wave (PW) Doppler



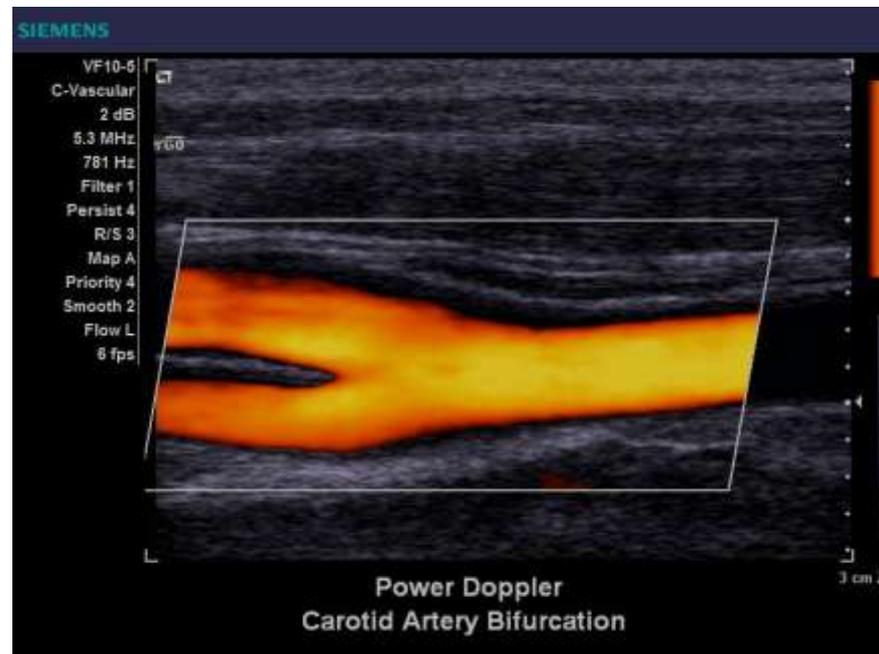
Major Modes: Color Flow Mapping Mode (CFM)

- Spatial map overlaid on a B-mode gray-scale image that depicts an estimate of blood flow mean velocity
 - Direction of flow encoded in colors (blue away from the transducer and red toward it)
 - Amplitude of mean velocity by brightness, and turbulence by a third color (often green).



Major Modes: Power Doppler Mode

- This color-coded image of blood flow is based on intensity rather than on direction of flow, with a paler color representing higher intensity.
 - It is also known as “angio”



Secondary Modes

- Duplex
 - Presentation of two modes simultaneously: usually 2D and pulsed (wave) Doppler
- Triplex
 - Presentation of three modes simultaneously: usually 2D, color flow, and pulsed Doppler
- 3D
 - Display or Surface/volume rendering used to visualize volume composed of multiple 2D slices.
- 4D
 - A 3D image moving in time

[Next Lecture]

- Unconventional ultrasound applications