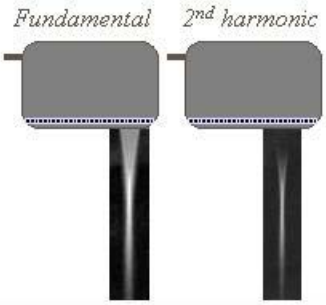
Recent Developments In Ultrasound Imaging



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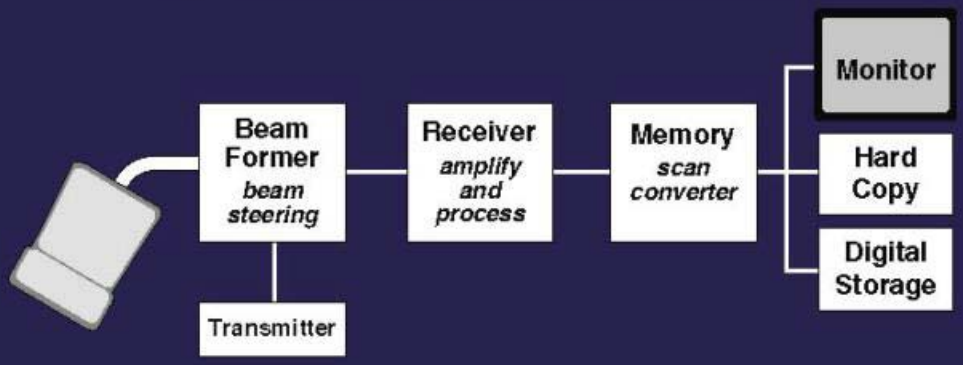
Recent Developments in Ultrasound Imaging

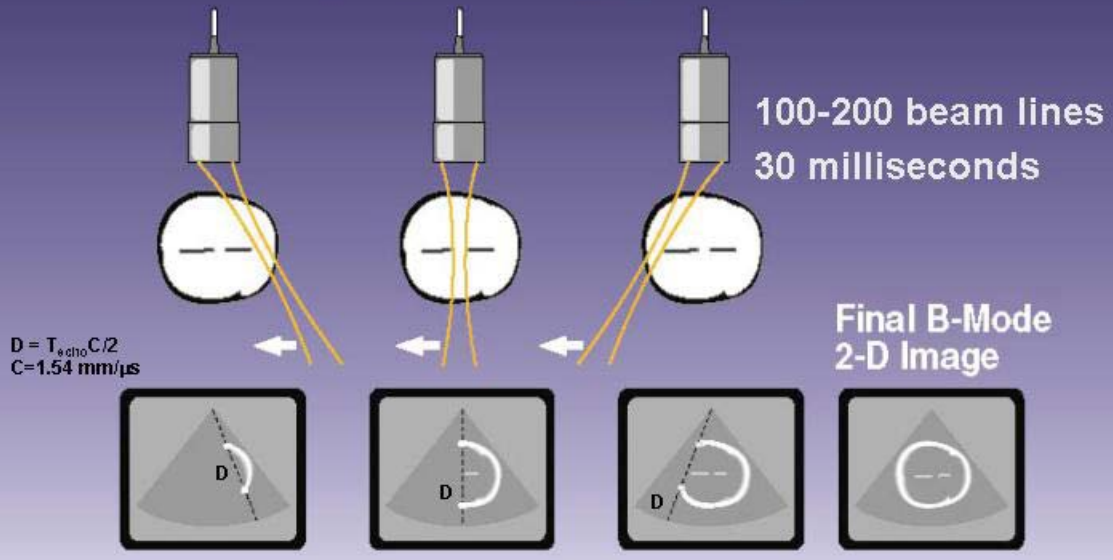
- Beam forming methods
  - 1 ½ D arrays
  - Dynamic transmit focusing
  - Zone acquisition
- Signal processing (Harmonics, codes, chirps)
- Acquisition strategies, format
  - Compound imaging; extended FOV; 3-D

All are available on commercial machines

PARTS OF AN ULTRASOUND SCANNER

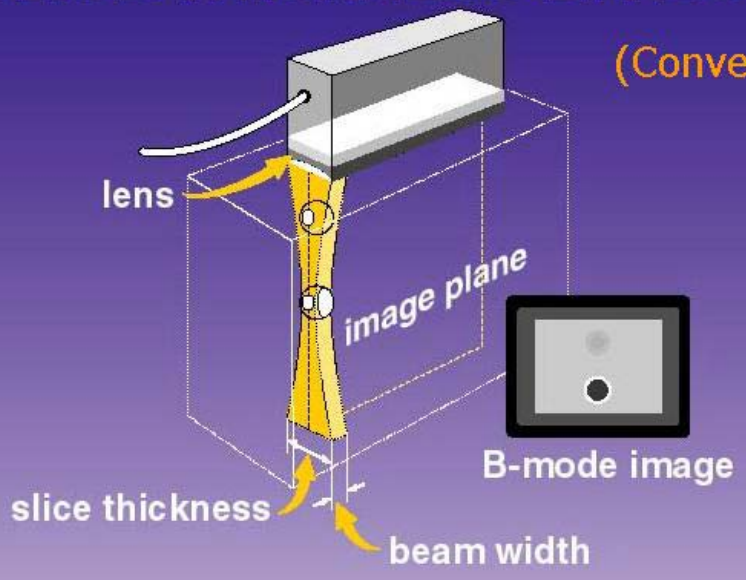


B-MODE IMAGING

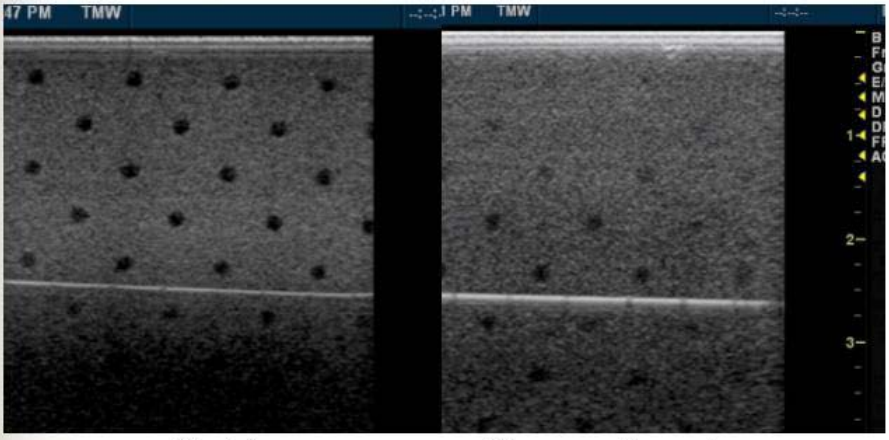


SLICE THICKNESS EFFECTS

(Conventional)



1 ½ D (Matrix) Transducer



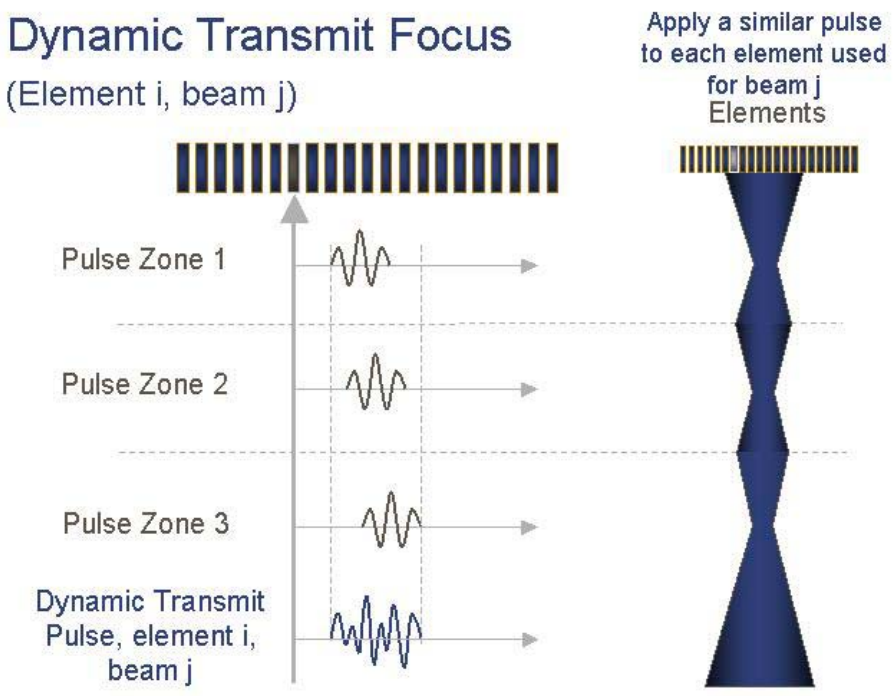
Matrix Conventional

1 ½ D (Matrix) Transducer

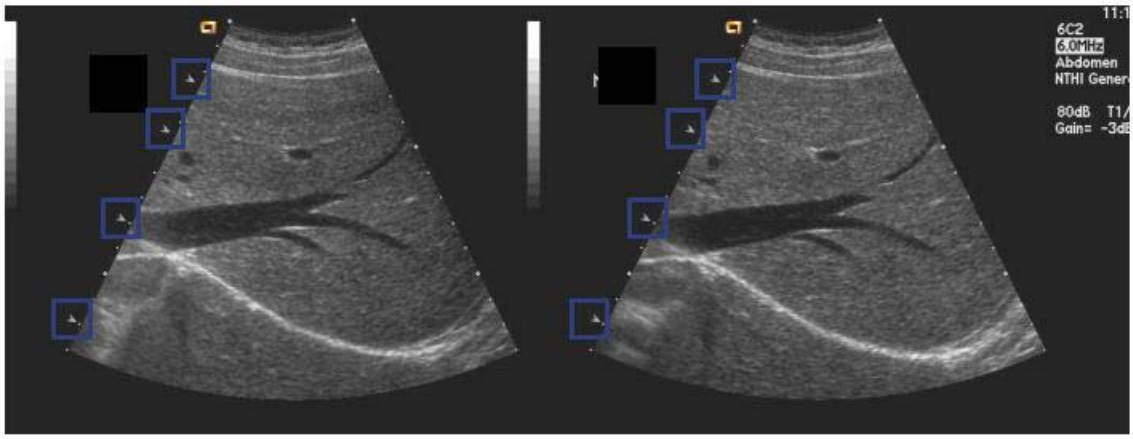
- Best control over slice thickness
- Disadvantage is lower sensitivity, especially in Doppler, color
- Available on most high frequency probes
- Available on some general purpose transducers
  - GE: M7; M12
  - Antares: C5-2; 7 MHz linear; 12 MHz linear

Dynamic Transmit Focus

(Element i, beam j)



Dynamic Transmit Focus



4 Standard Focal Zones

Frame Rate
12 Hz

Dynamic Focal Zones

Frame Rate
24 Hz

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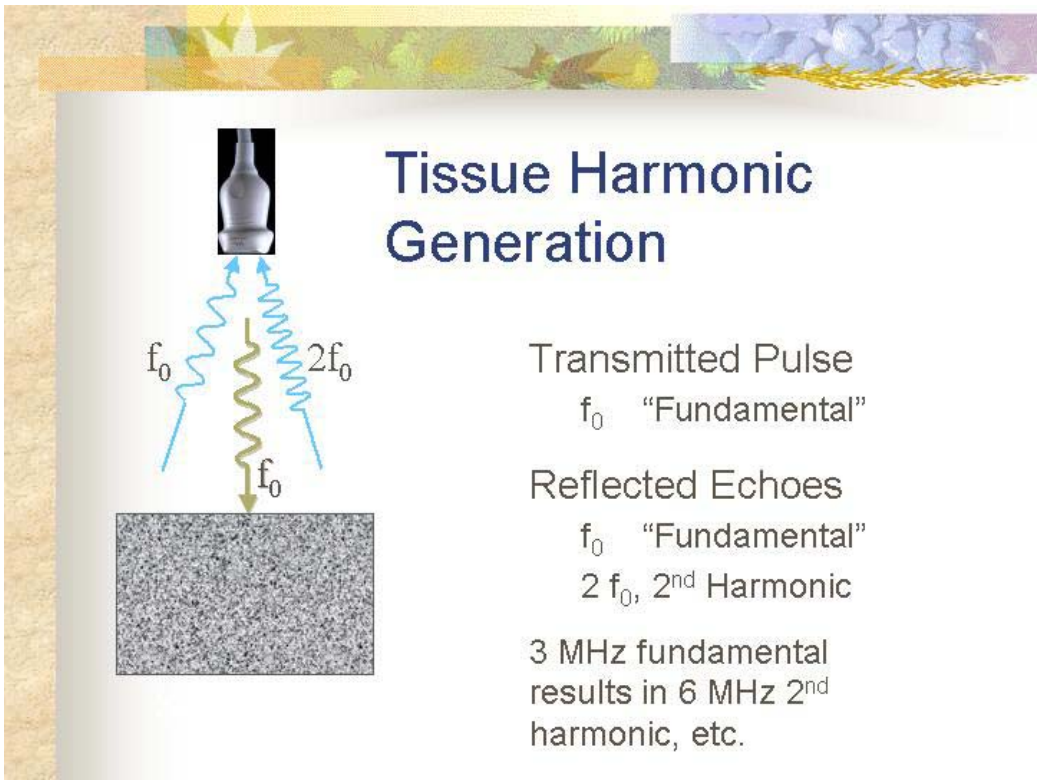
Acuson Corporation

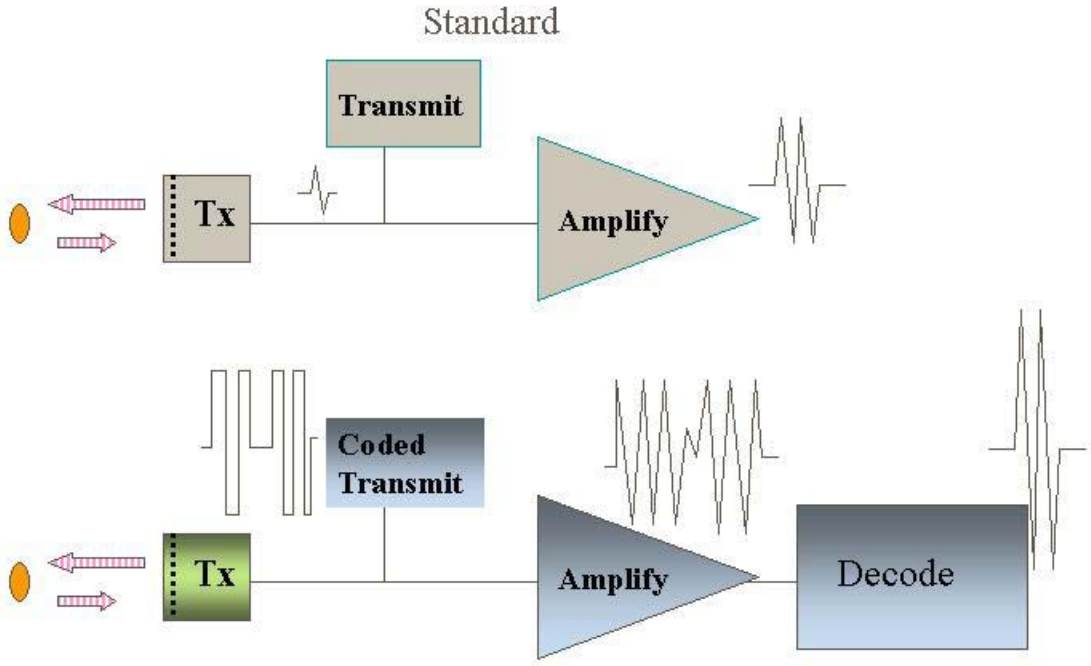


NTHI Impact

- Increases contrast resolution
  - Reduces body wall artifacts
  - Suppresses side lobes
- Originally (1998) only offered with low frequency probes
- Now available with most transducers in high-end machines

Coded Excitation

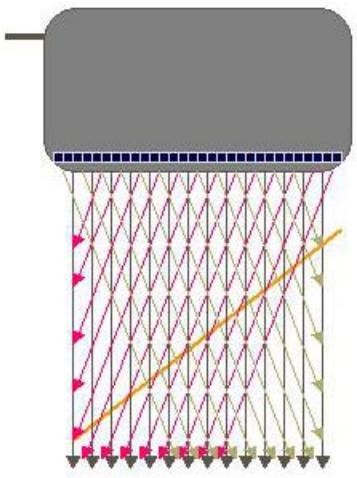
- High ultrasound frequencies are severely attenuated by tissue.
  - dB/cm proportional to frequency
  - Tradeoff between resolution and penetration
- Transmit pulse amplitude is limited by FDA and by safety considerations.
  - Current limit for MI = 1.9
- Solution: use a longer pulse duration?



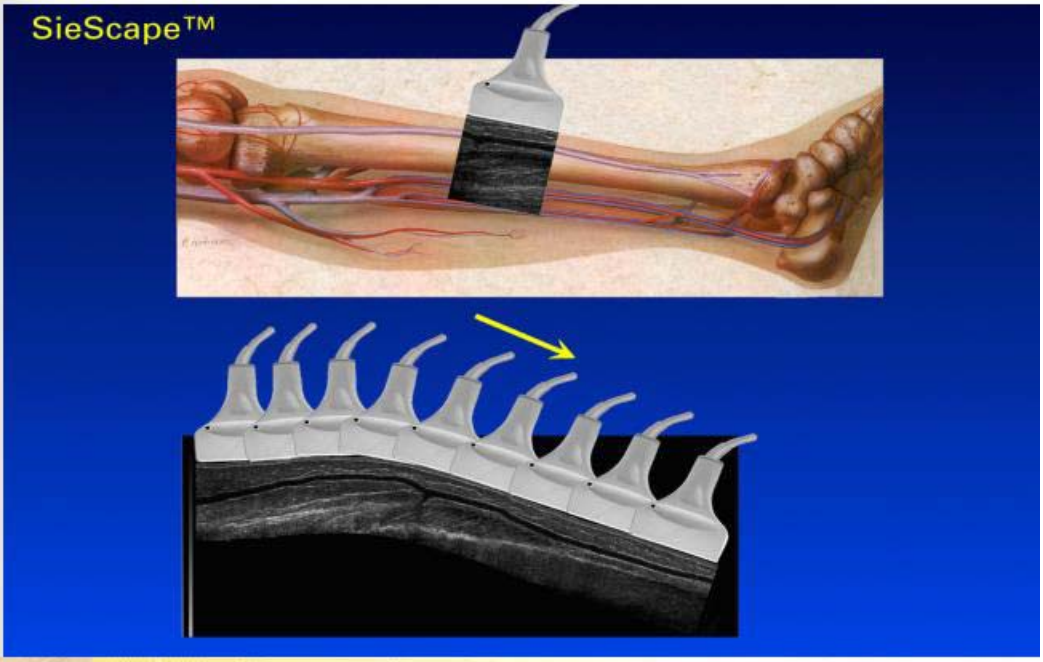
Coded Excitation

Spatial Compounding

- Uses “beam steering” technology
- Combines scans from different angles
- Smoothes random dots called speckle
- More completely outlines interfaces that are not perpendicular to primary beam direction
- Available on most high-end scanners

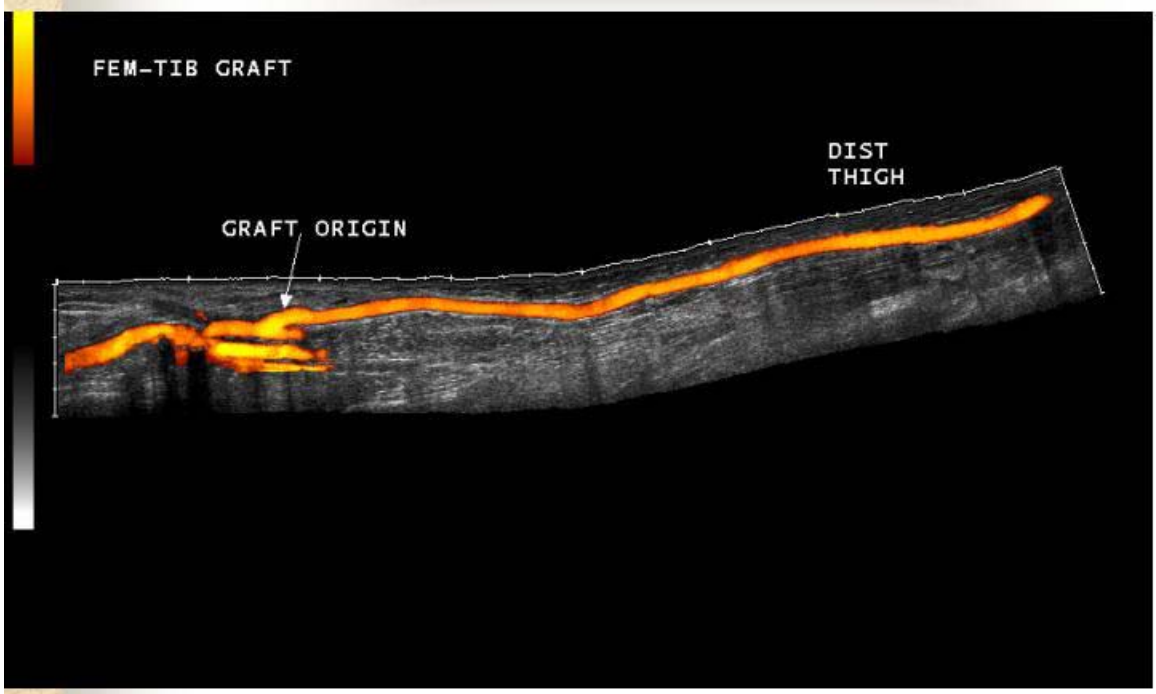


Extended Field of View



Principles of Extended FOV

- Motion estimation by registration of sequential images as transducer is translated;
- By co-registering common parts of the images, motion is tracked;
- Requires fast image processor for real-time viewing
- Now exists on all high end scanners

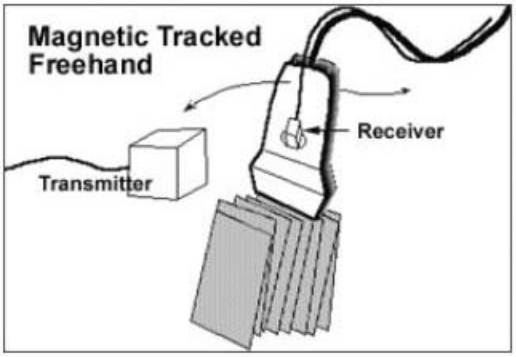


3-D Acquisition

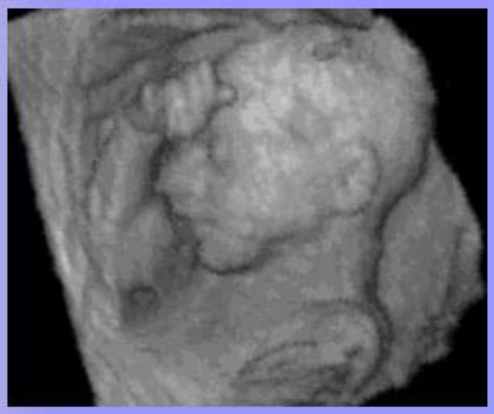
- Motor driven scan head (Medsonics; Kretz)
- Full 2-D array (Philips Sonus 7500 cardiology)
- "Free-hand" manipulation of probe

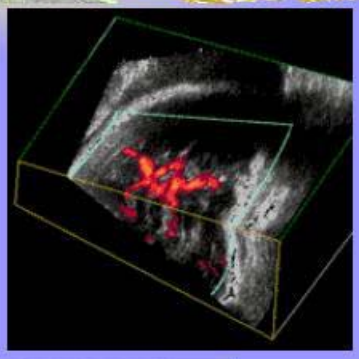
External detection of scan plane with an electromagnetic sensor

Detection of scan plane motion from image correlations



3-D examples





Conclusions

- There are many emerging technologies that will impact this modality soon.
  - Offline image analysis
  - Advanced 3-D
  - Phase aberration corrections
  - Elasticity imaging
  - Contrast agent modes
  - Integration with other modalities
- Research modes
  - Access to raw echo data
  - User control of many acquisition functions