PD233: Design of Biomedical Devices and Systems

Lecture-9 Medical Diagnostic Imaging Ultrasound and Thermography

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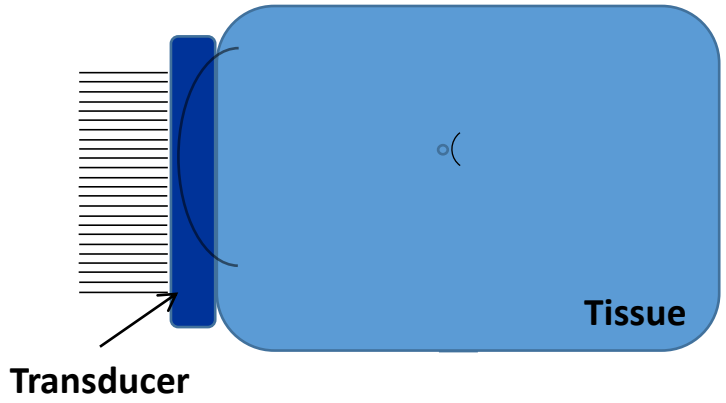
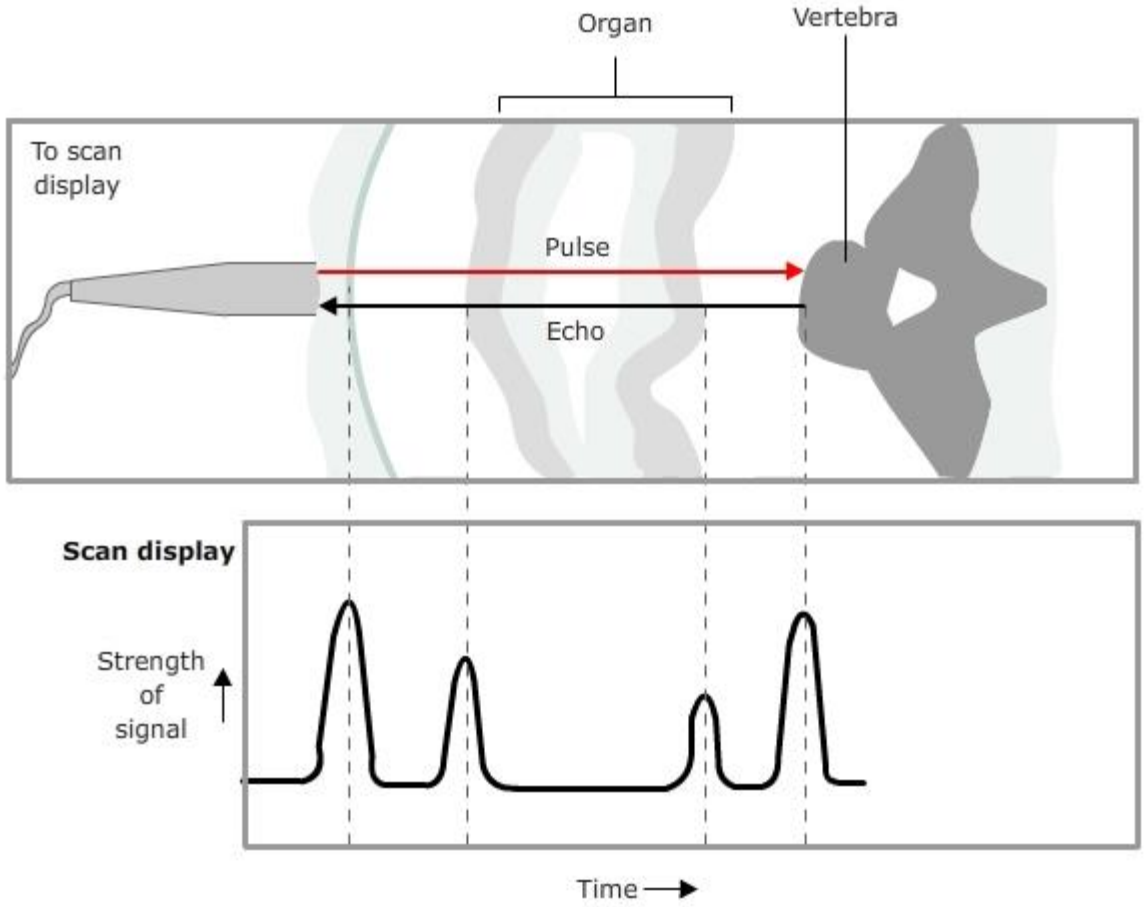
Course Website:
http://cpdm.iisc.ac.in/utsaah/courses/

Ultrasound Physics

- Acoustic wave with frequency > 20kHz
- Part of ultrasound waves are reflected by interfaces and scatters
  - Basis for Ultrasonic Imaging



A-Mode Ultrasound



Distance of interface = Time of flight * Speed of Sound / 2

Applications: Measurement of thicknesses of cornea

Image credit: http://www.rcemlearning.co.uk

B-mode ultrasound

(Brightness mode)

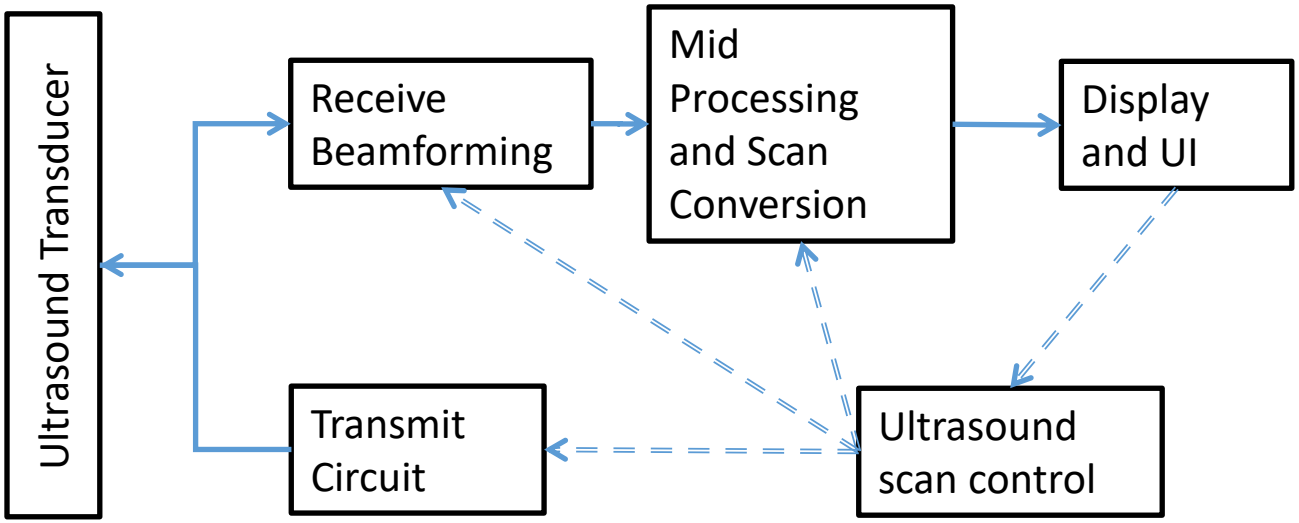
Mechanical Scanning

Electronic Scanning

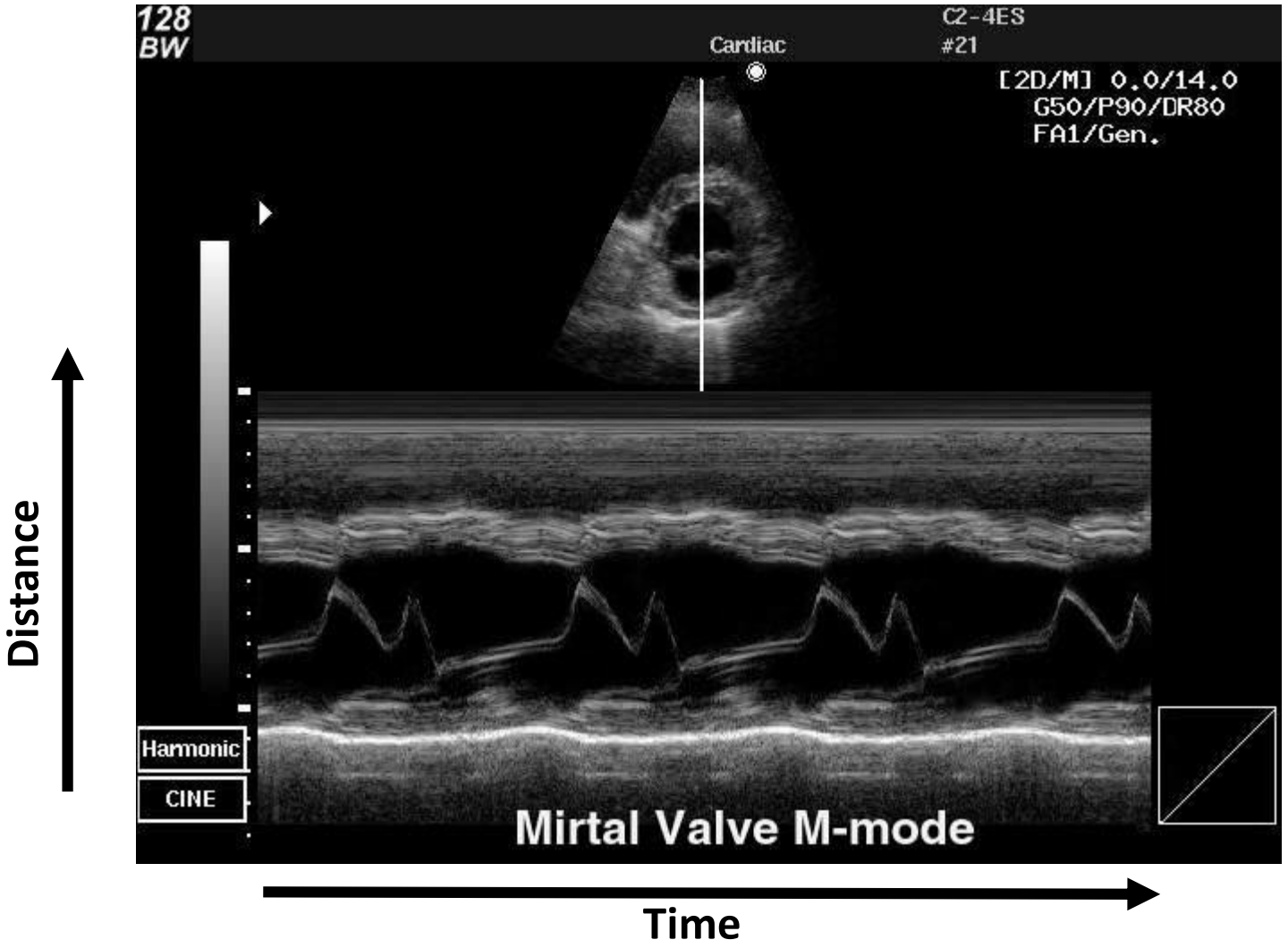

CRL
CRL
GA


9.1

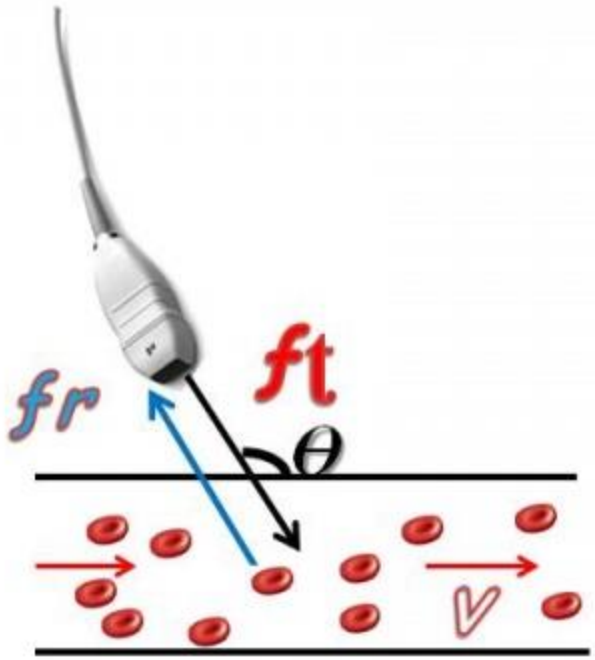
Imaging Ultrasound System Signal-chain



M –Mode Ultrasound



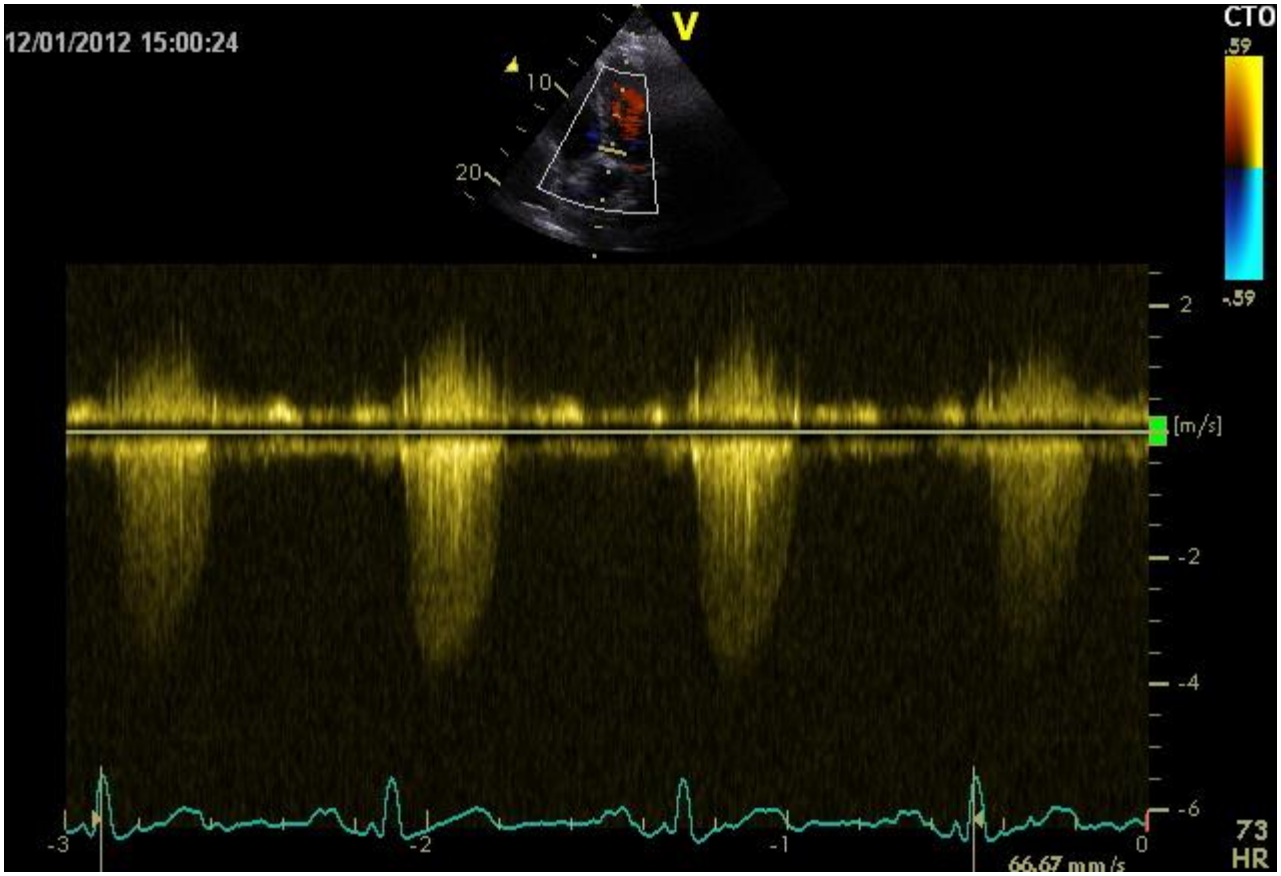
CW Doppler



$$\Delta f = f_t - f_r = \frac{2 f_t \bullet v \bullet \cos\theta}{c}$$

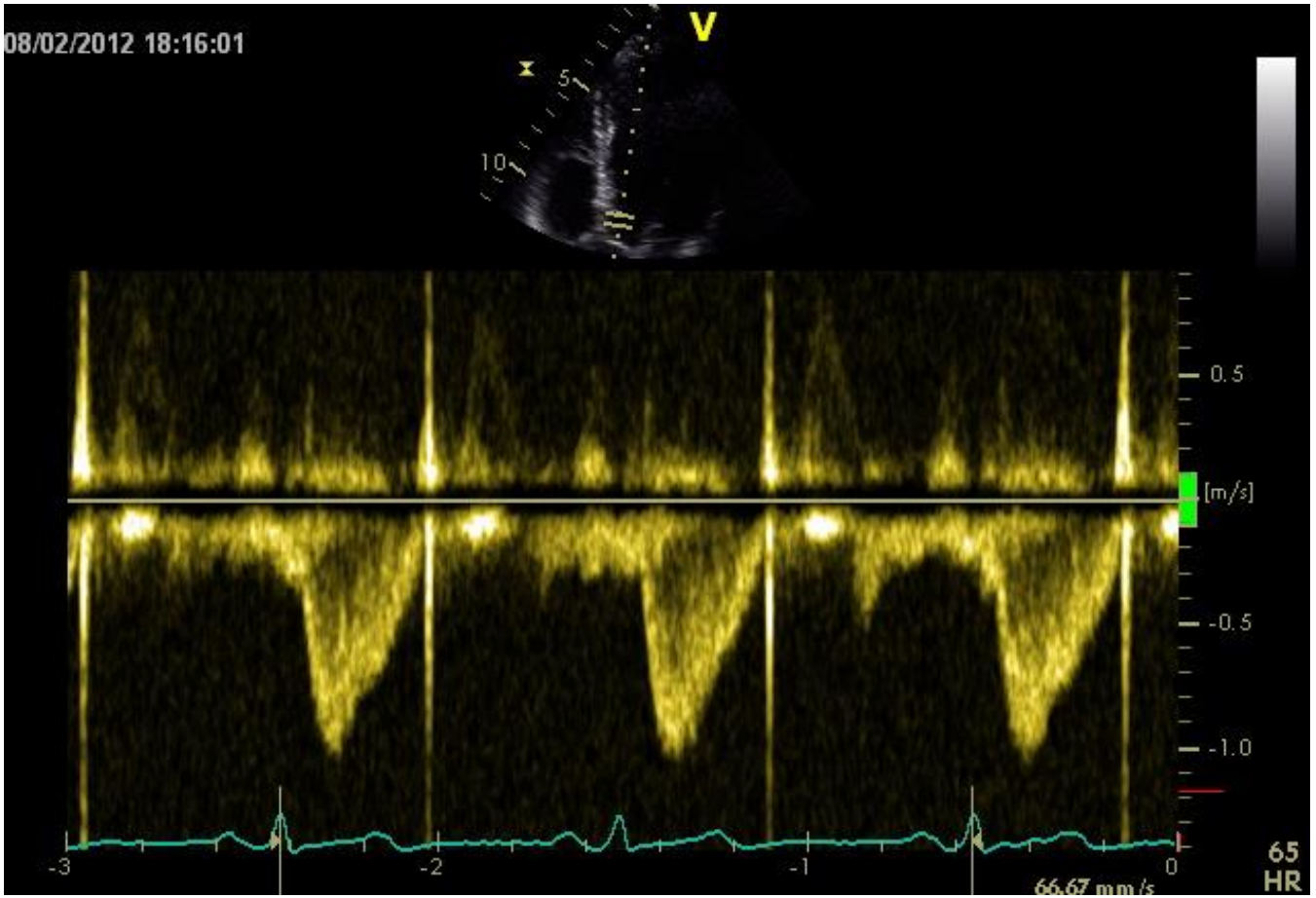
Image source: http://www.wikiecho.org

CW Doppler



CW excitation and receive (half of transducer for each)
B-mode not available when doing CW Doppler
No depth information

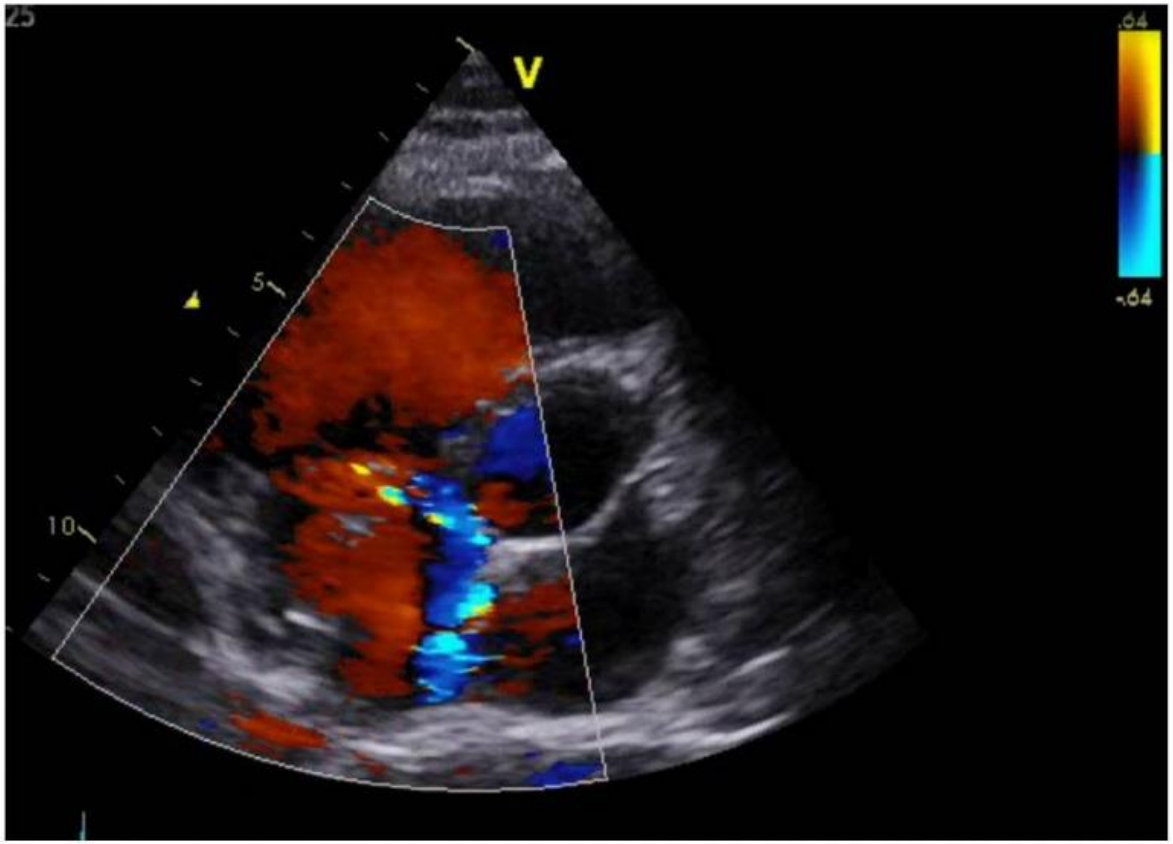
PW Doppler



Doppler analysis in small window (range gated)

B-Mode available in Duplex mode

Color Doppler




Surface
Th33/Qual low
B108°/V85°
Mix24/76
V-SRI 5
3D Static
3D

Wireless probes

Siemens

Clarius

Wuhan Tianyi Electronic Co., Ltd.

Back to single element probe…

http://wiki.echopen.org/images/8/8c/Neasham2.jpg

Biological effects

Thermal Effects

-Tissue heating due to adsorption of Ultrasound

Thermal index (T.I.)

$= W_p/W_{deg}$

W_p= relevant (attenuated) acoustic power at depth of imaging

W_{deg}=estimated power for 1°C temperature rise.

Mechanical effects

- Due to cavitation – formation, oscillation and collapse of bubble due to high intensity pressure wave

-Mechanical index (M.I.)

=peak rarefaction pressure/sqrt(centre frequency)

Pressure in MPa and frequency in MHz