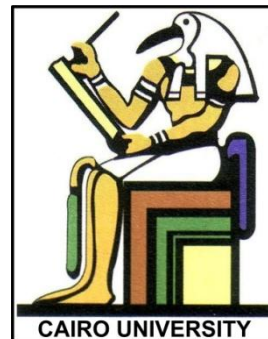


Medical Equipment I - 2009

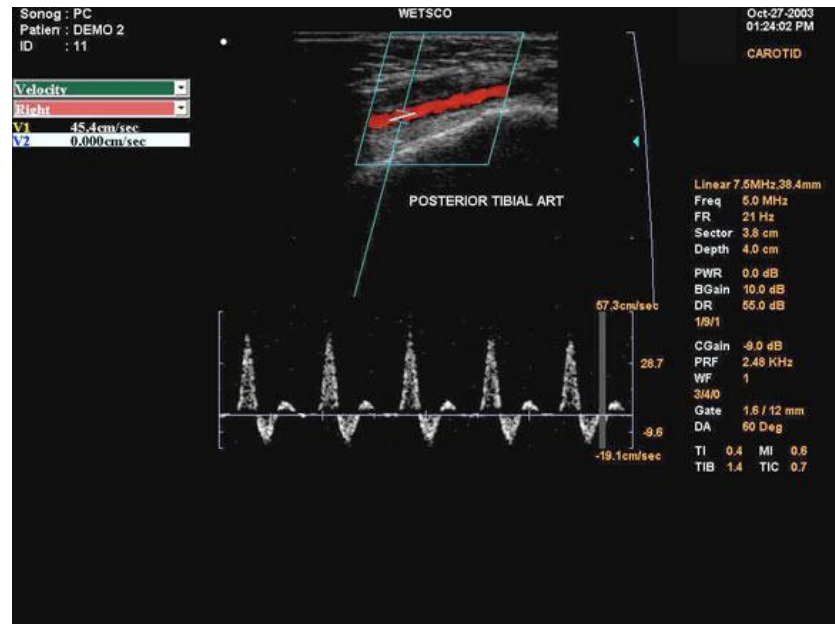
Part II: Ultrasound Imaging

Professor Yasser M. Kadah

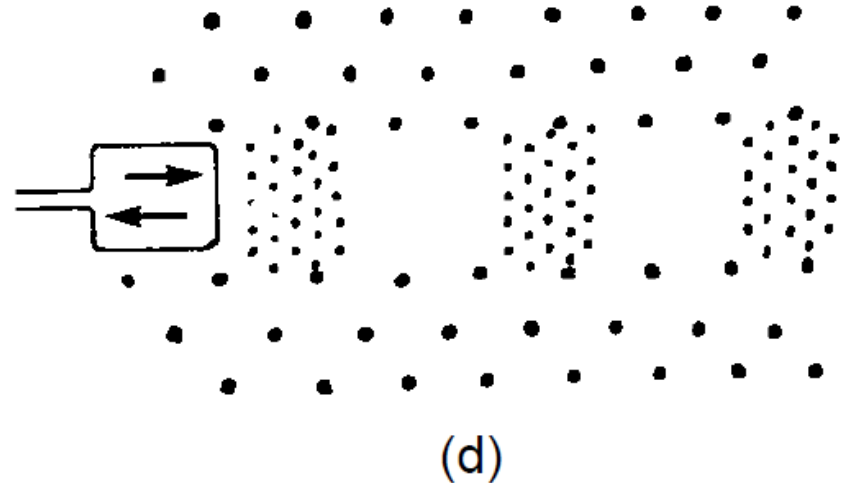
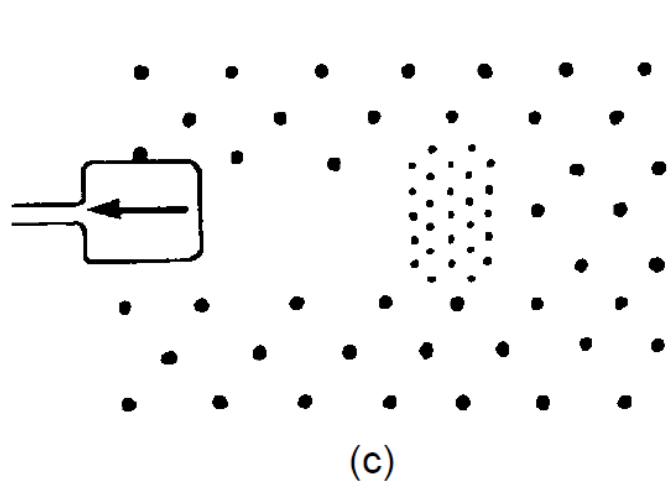
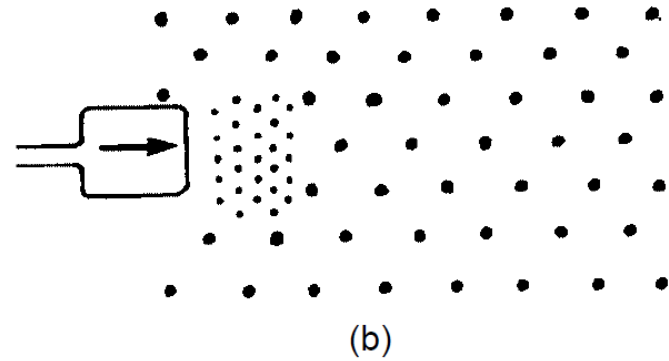
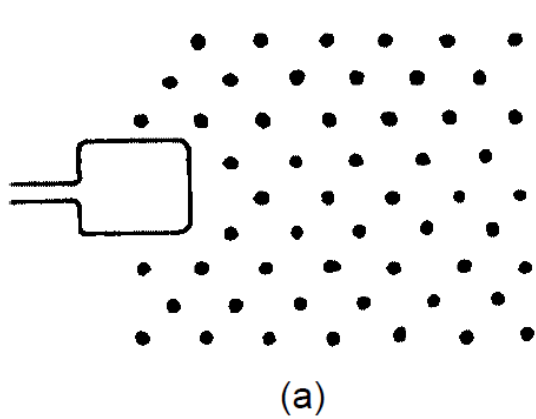
Web: <http://ymk.k-space.org/courses.htm>



Ultrasound Image Examples



[Ultrasound Wave Generation]



[Ultrasound Frequencies]

Frequency Classification of Ultrasound

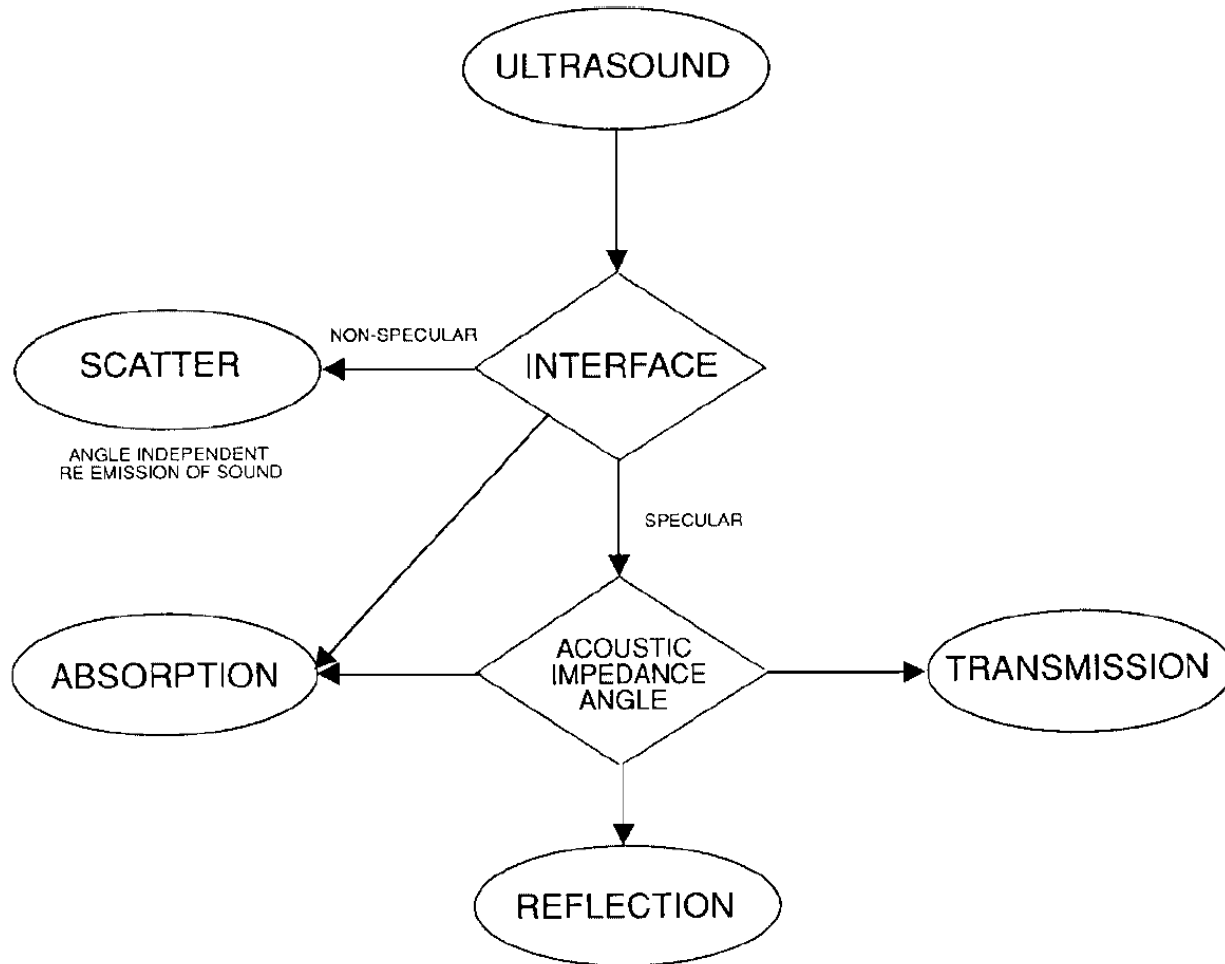
<i>Frequency (Hz)</i>	<i>Classification</i>
20–20,000	Audible sound
20,000–1,000,000	Ultrasound
1,000,000–30,000,000	Diagnostic medical ultrasound

[Ultrasound Velocity]

TABLE 19-3 Approximate Velocities of Ultrasound in Selected Materials

<i>Nonbiologic Material</i>	<i>Velocity (m/sec)</i>	<i>Biologic Material</i>	<i>Velocity (m/sec)</i>
Acetone	1174	Fat	1475
Air	331	Brain	1560
Aluminum (rolled)	6420	Liver	1570
Brass	4700	Kidney	1560
Ethanol	1207	Spleen	1570
Glass (Pyrex)	5640	Blood	1570
Acrylic plastic	2680	Muscle	1580
Mercury	1450	Lens of eye	1620
Nylon (6-6)	2620	Skull bone	3360
Polyethylene	1950	Soft tissue (mean value)	1540
Water (distilled), 25°C	1498		
Water (distilled), 50°C	1540		

Ultrasound Attenuation



Ultrasound Attenuation

TABLE 19-4 Attenuation Coefficients α for 1-MHz Ultrasound

<i>Material</i>	α (dB/cm)	<i>Material</i>	α (dB/cm)
Blood	0.18	Lung	40
Fat	0.6	Liver	0.9
Muscle (across fibers)	3.3	Brain	0.85
Muscle (along fibers)	1.2	Kidney	1.0
Aqueous and vitreous humor of eye	0.1	Spinal cord	1.0
Lens of eye	2.0	Water	0.0022
Skull bone	20	Caster oil	0.95
		Lucite	2.0

Ultrasound Reflection

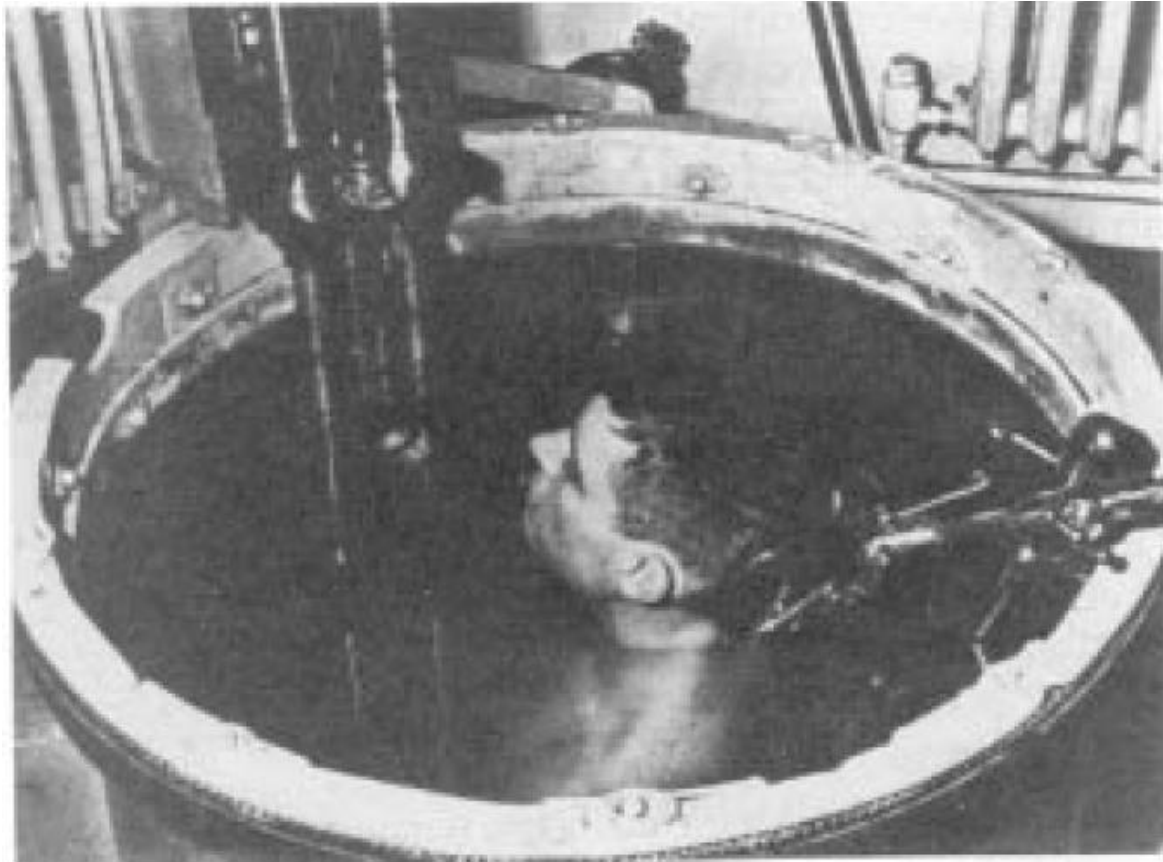
$$Z = \rho c$$

$$\alpha_R = \left(\frac{Z_2 - Z_1}{Z_2 + Z_1} \right)^2$$

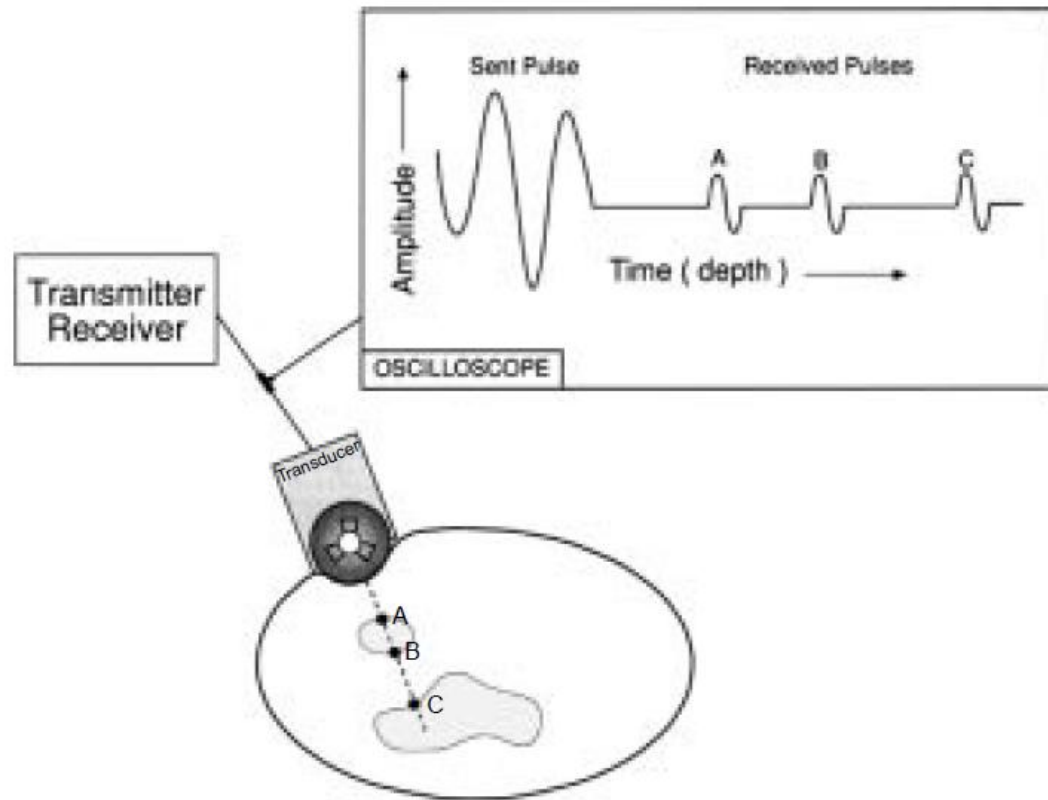
Approximate Acoustic Impedances of Selected Materials

<i>Material</i>	<i>Acoustic Impedance</i> ($\text{kg}\cdot\text{m}^{-2}\cdot\text{sec}^{-1}$) $\times 10^{-4}$
Air at standard temperature and pressure	0.0004
Water	1.50
Polyethylene	1.85
Plexiglas	3.20
Aluminum	18.0
Mercury	19.5
Brass	38.0
Fat	1.38
Aqueous and vitreous humor of eye	1.50
Brain	1.55
Blood	1.61
Kidney	1.62
Human soft tissue, mean value	1.63
Spleen	1.64
Liver	1.65
Muscle	1.70
Lens of eye	1.85
Skull bone	6.10

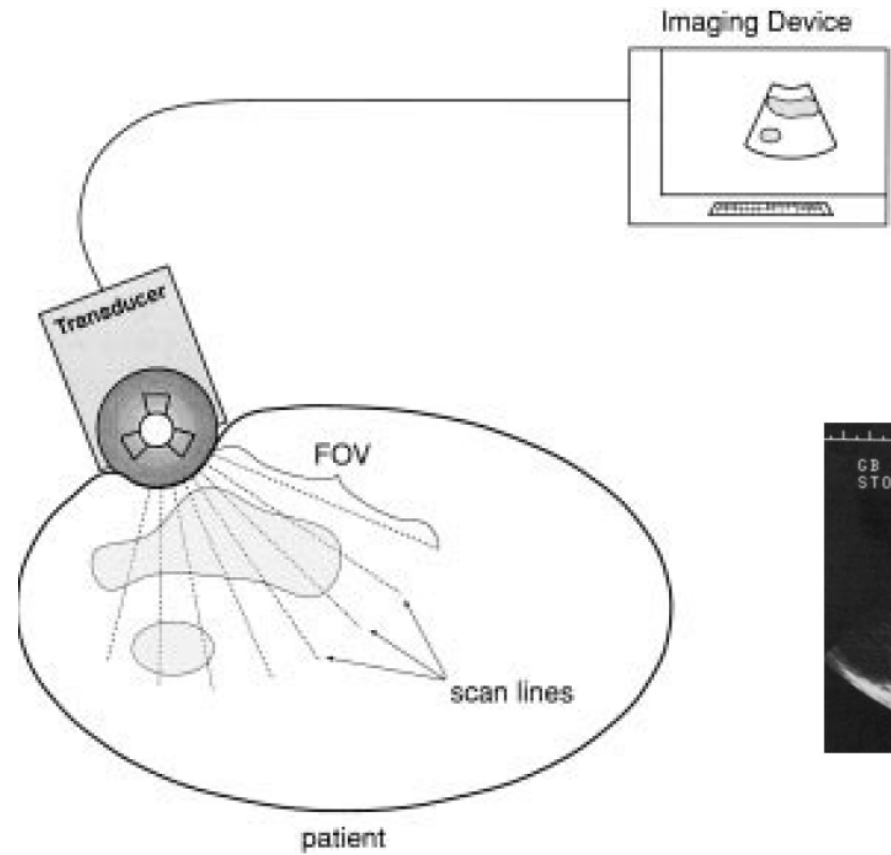
[Ultrasound Scanning]



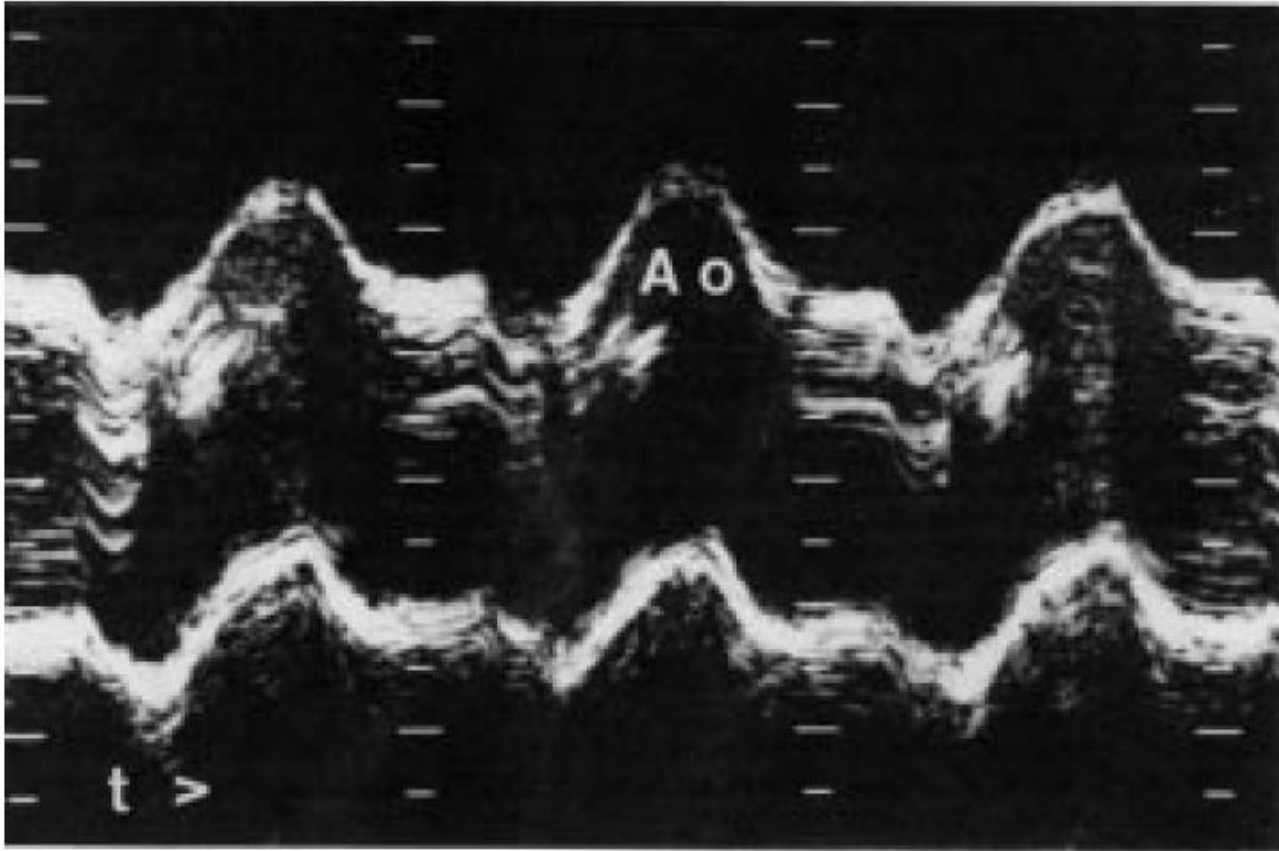
[A-Mode Ultrasound]



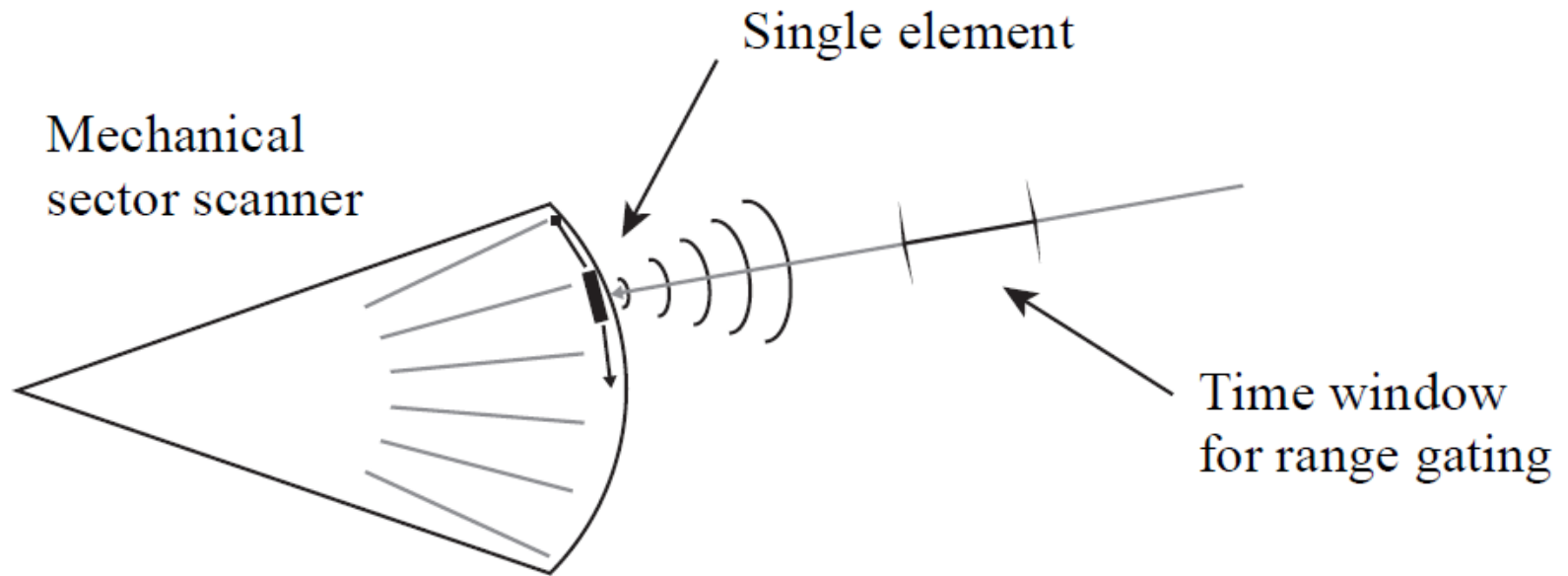
[B-Mode Ultrasound]



[M-Mode Ultrasound]

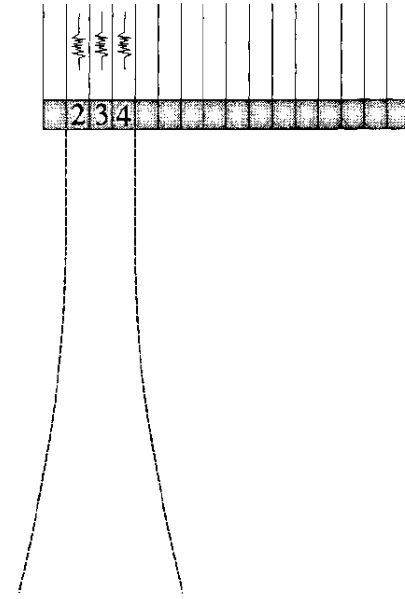
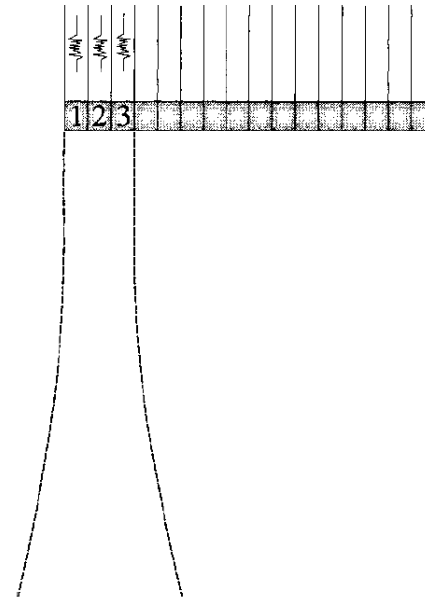
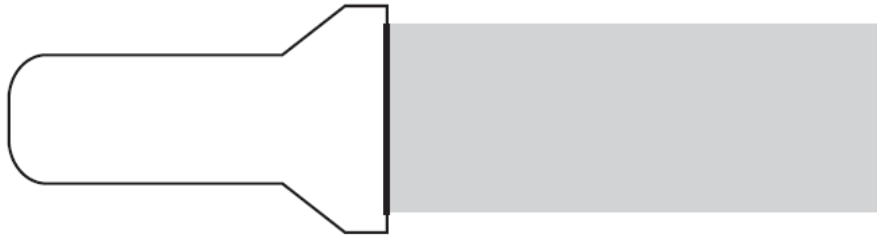


Ultrasound Transducers: Mechanical

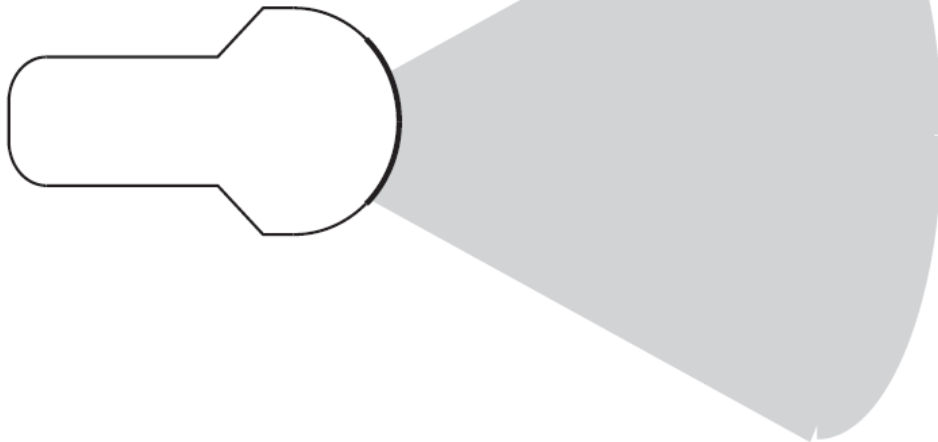


Ultrasound Transducers: Electronic Array

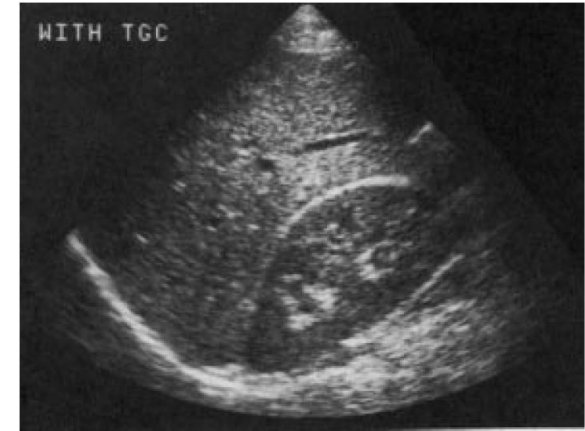
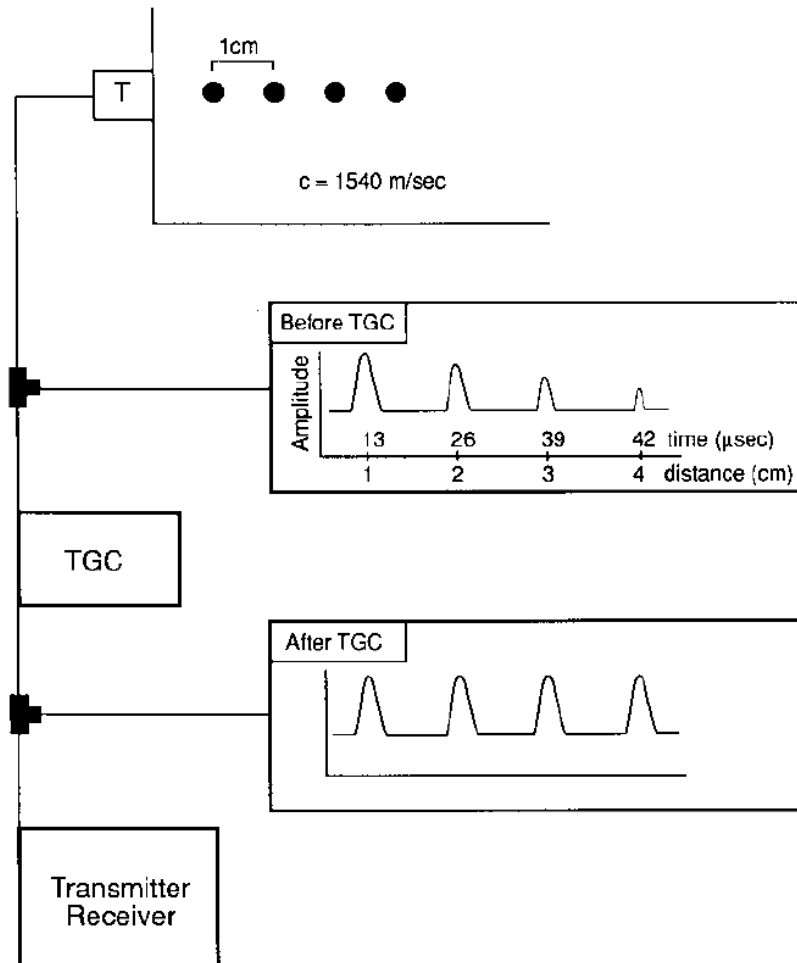
Linear array: small parts, superficial vascular, obstetrics



Curved array: abdominal, obstetric, transabdominal,
or for transvaginal or transrectal, or pediatric imaging



Time-Gain Compensation (TGC)

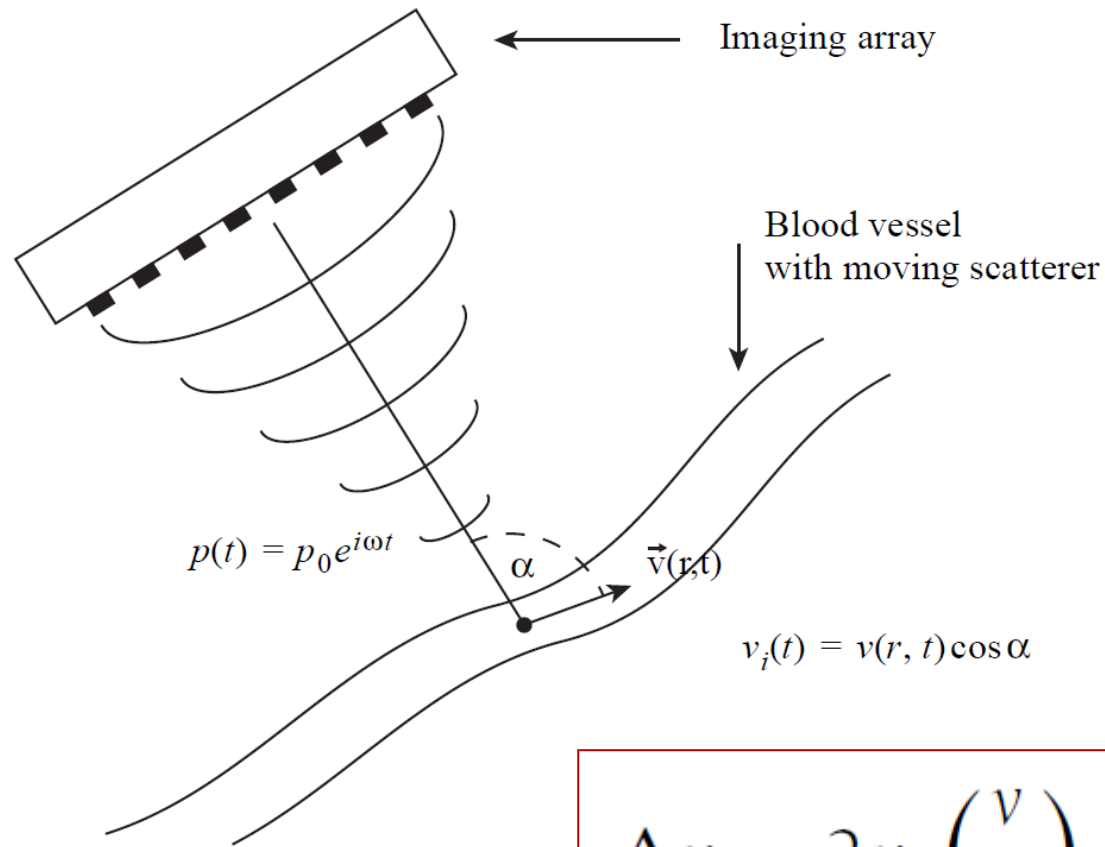


(a)



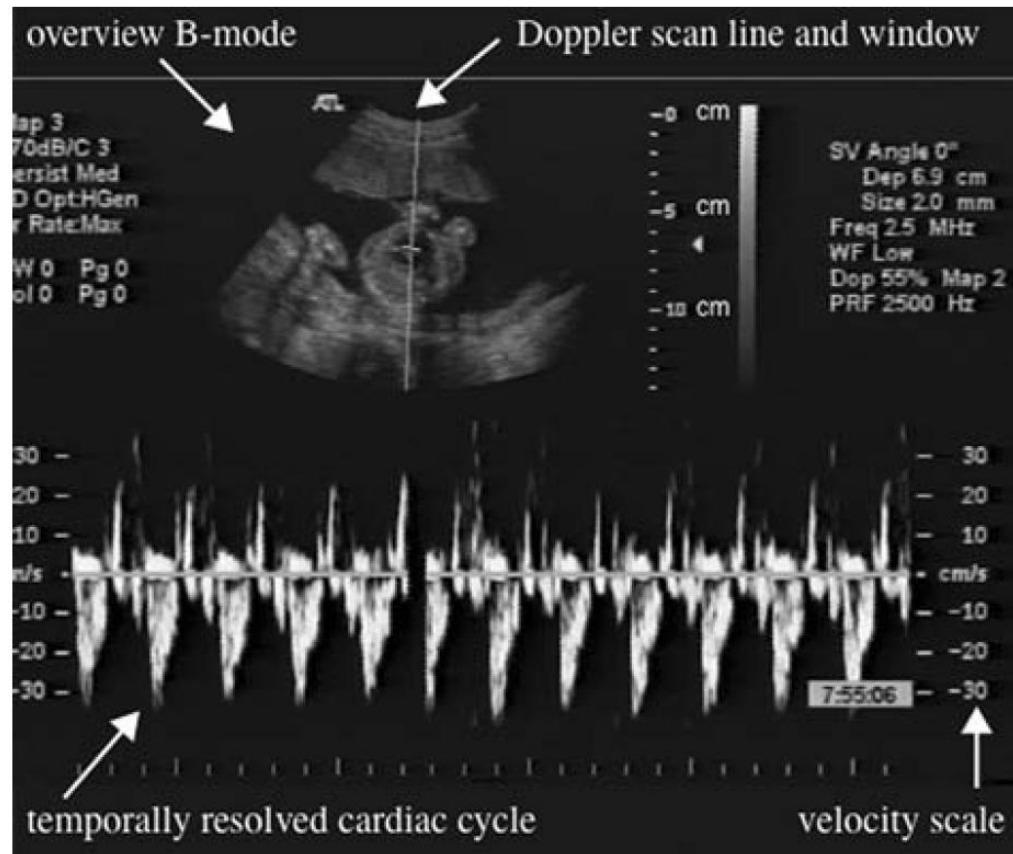
(b)

Doppler Mode

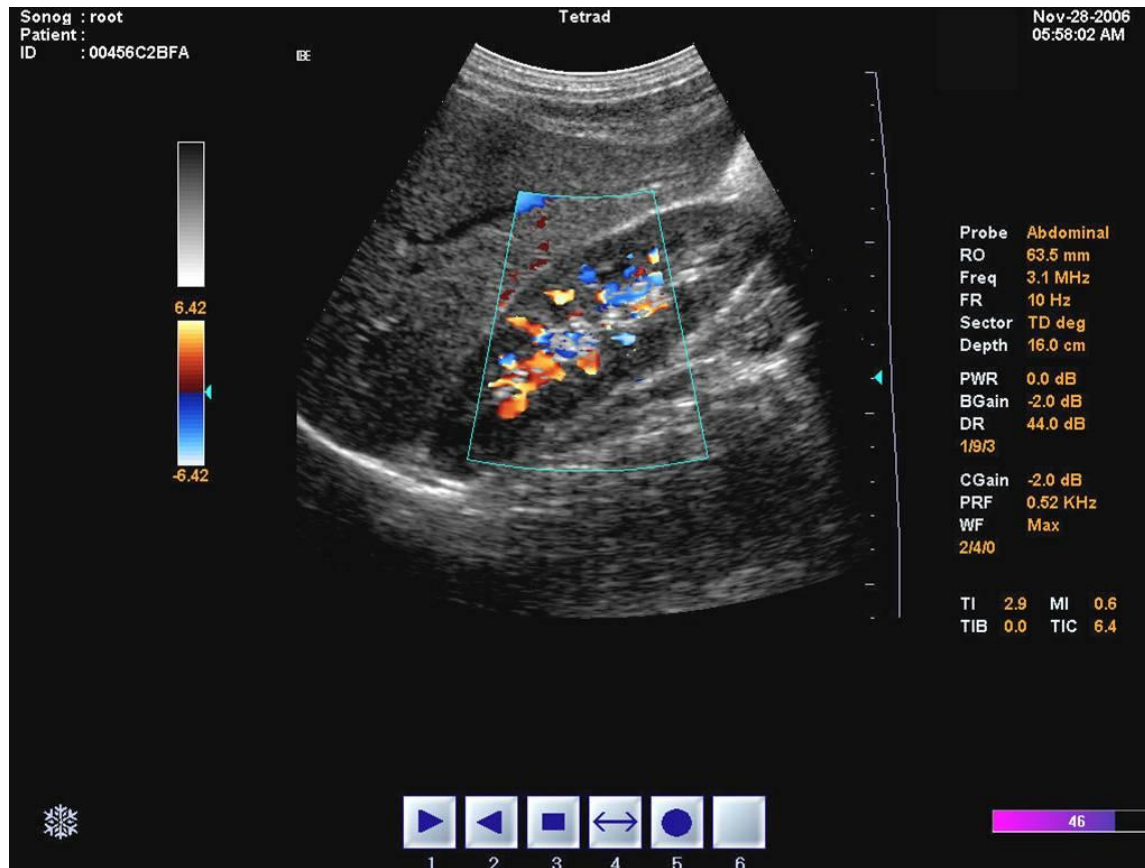


$$\Delta \nu = 2\nu_0 \left(\frac{v}{c} \right) \cos \theta$$

Pulse Wave (PW) Doppler Mode

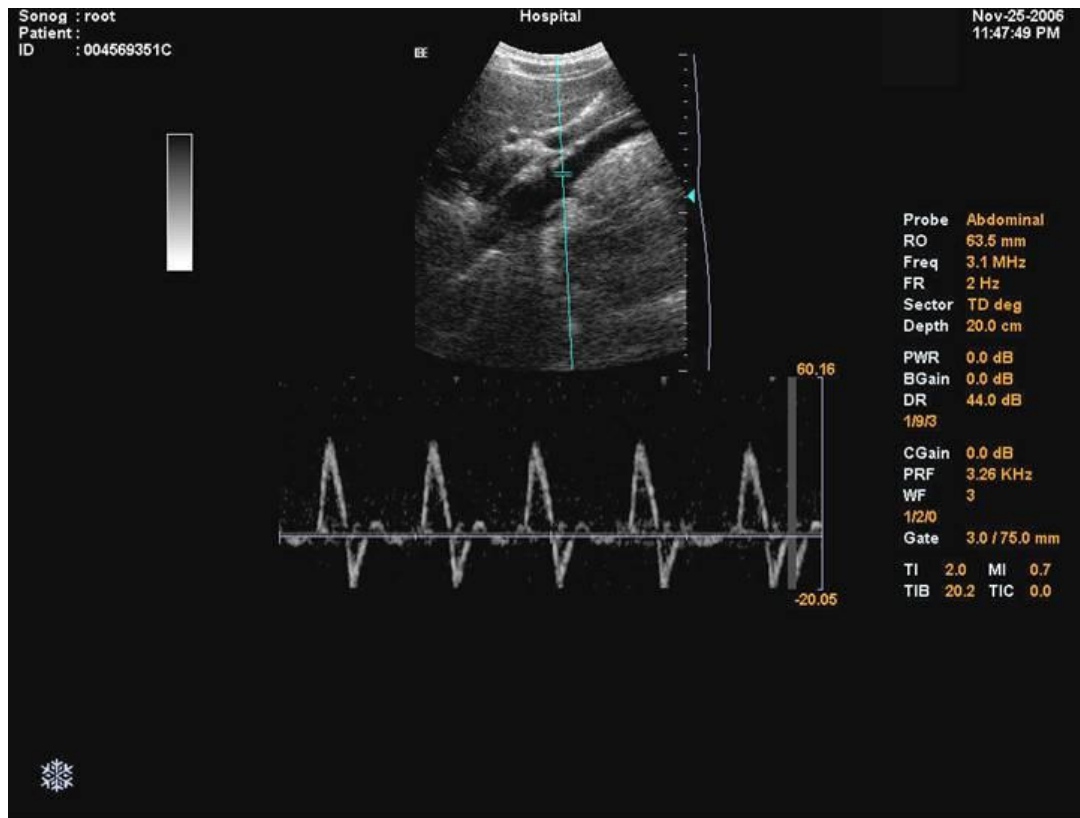


[Color Doppler]



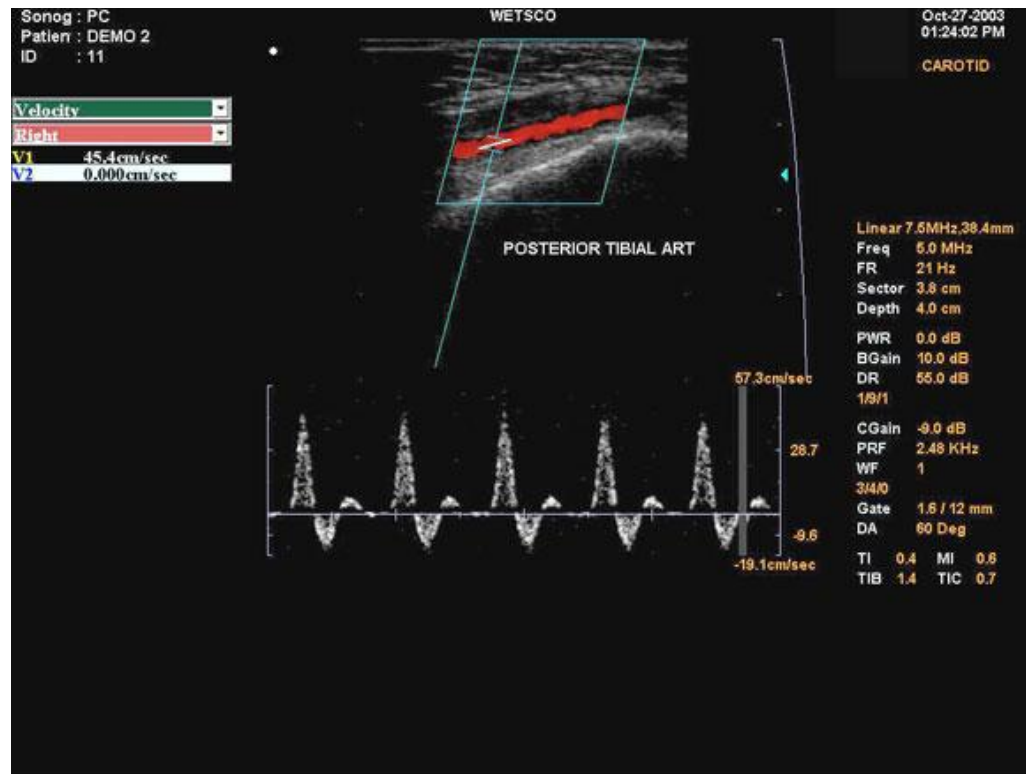
[Duplex Mode]

- B-Mode + PW-Doppler



Triplex Mode

- B-Mode + PW-Doppler + Color Doppler



[Presentation Download]

- Posted on class web site
- References also posted there
- You are required to study only what was given in the lecture

Web: <http://ymk.k-space.org/courses.htm>