Ultrasound Imaging

Piezoelectric transducers
Convert electrical to acoustic energy

Acoustic impedance
Tissue resistance to sound propagation
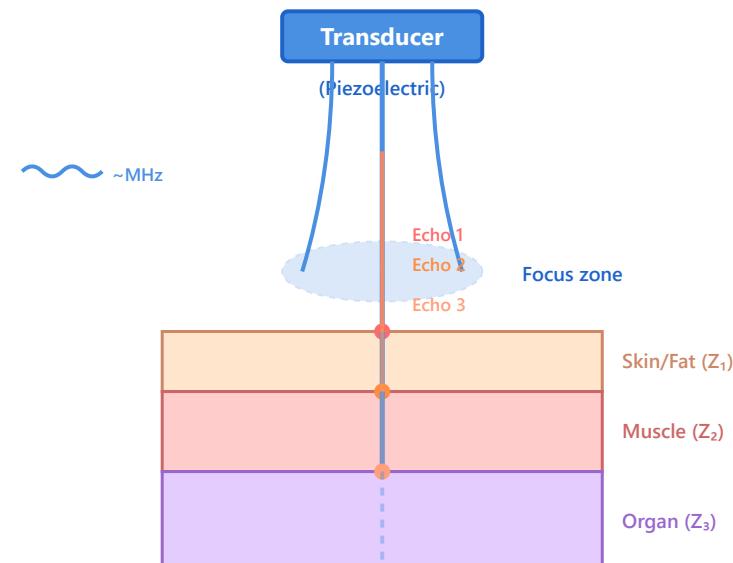
Reflection and refraction
Interface properties determine echoes

Beamforming
Focusing and steering ultrasound beam

Harmonic imaging
Higher frequencies improve resolution

Transducer
(Piezoelectric)

~MHz

Echo 1
Echo 2
Echo 3

Focus zone

Skin/Fat (Z_1)

Muscle (Z_2)

Organ (Z_3)

Acoustic Impedance

$$Z = \rho \times c$$

ρ = density, c = sound speed

Reflection Coefficient

$$R = (Z_2 - Z_1)^2 / (Z_2 + Z_1)^2$$

Larger $\Delta Z \rightarrow$ Stronger echo