Specular reflection occurs in only one direction in an organized manner after sound strikes a smooth boundary.

As sound strikes a boundary between two media with different acoustic impedance, a portion of the sound wave's energy may be redirected or reflected back toward the transducer.

Two forms of reflection occur: 1. Specular and 2. Diffuse.

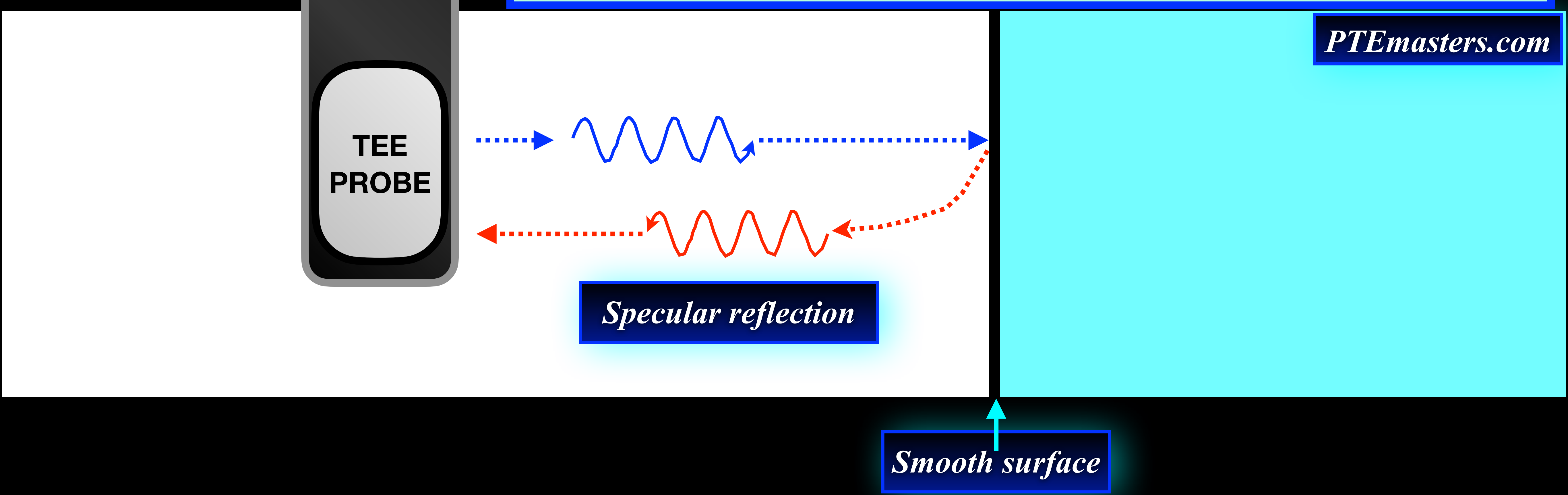
The type of reflection that occurs at the boundary (specular or diffuse) depends on the nature of the interface that the sound wave strikes.

Smooth boundary = specular reflection.

Rough boundary = diffuse reflection. (also known as backscatter)

Specular reflection occurs when light waves strike a smooth mirror.

In order for specular reflection to return to the transducer the object must be aligned perfectly with the beam (90 degrees to the beam).

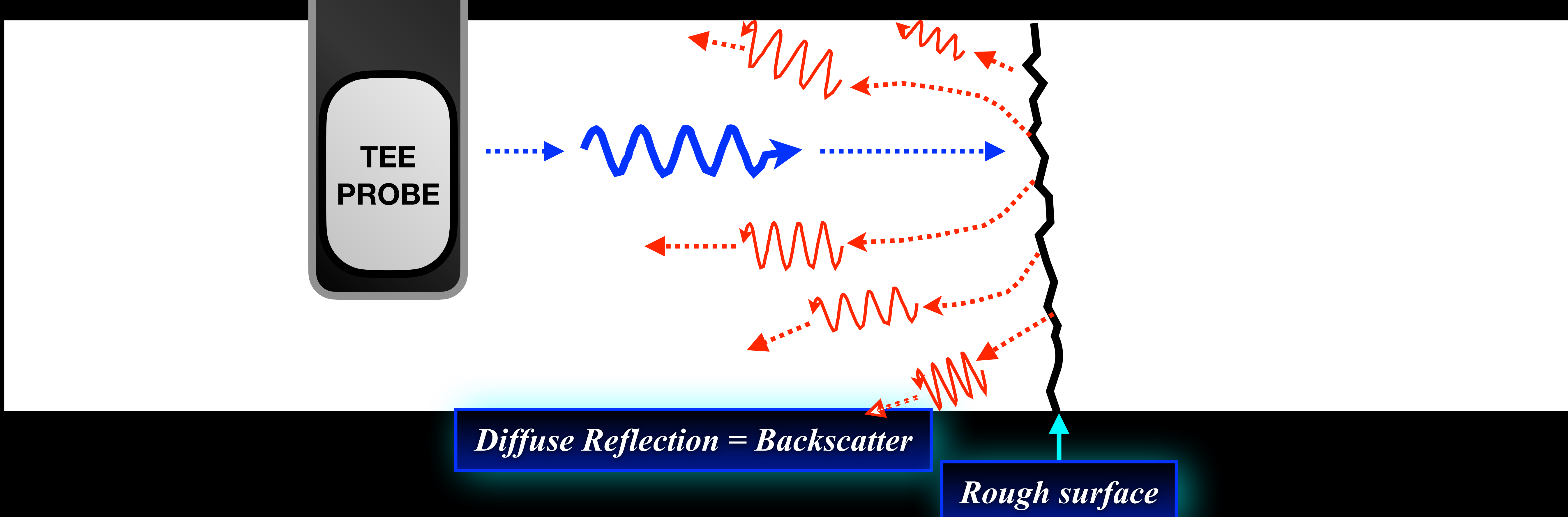


Diffuse reflection = backscatter **results when the boundary between the two media is rough and irregular.**

<u>Diffuse reflection</u> (also called <u>backscatter</u>) occurs when sound strikes an <u>*irregular*</u> or <u>rough</u> boundary and the <u>reflected sound radiates in more than one direction.</u>

Diffuse reflection allows imaging of structures that are not perfectly aligned with the ultrasound beam.

Example: Diffuse reflection due to rough walls allows imaging of the septal and lateral LV walls from the TG mid papillary short axis view.



Raleigh scattering is a special type of scattering that goes equally in all directions.

Raleigh scattering occurs when the objects dimensions are ***much smaller*** than the ***beam's wavelength***.

Raleigh scattering redirects the sound wave equally in all directions.

Higher frequency sound beams scatter more than lower frequency sound beams.

Scattering is directly related to frequency.

Rayleigh scattering increases dramatically with ***increases*** in **frequency**.

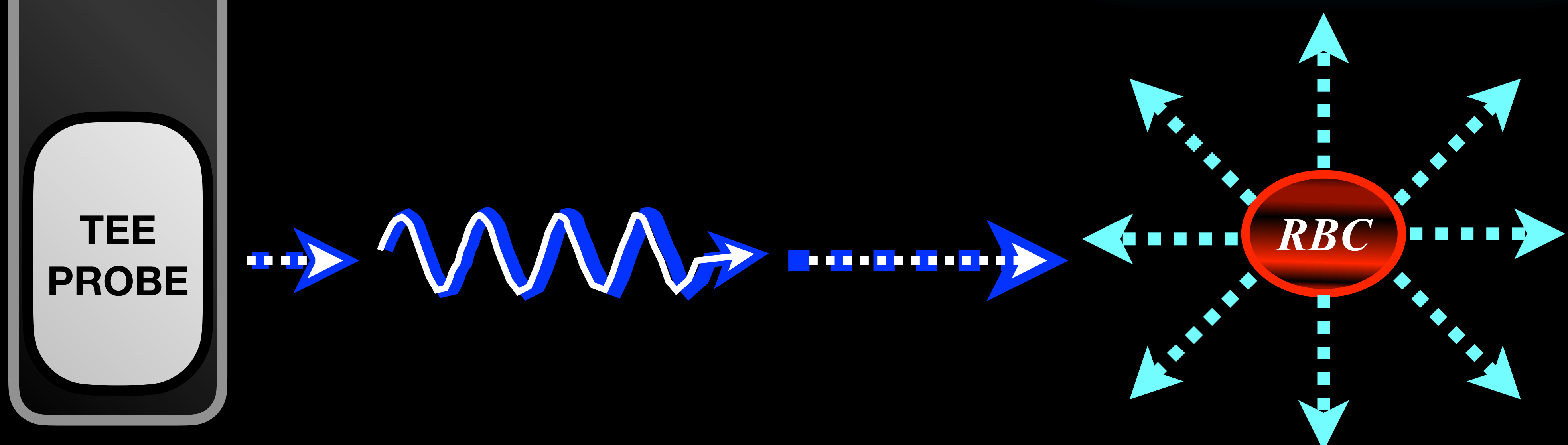
Rayleigh Scattering **is important for Doppler ultrasound, as red blood cells** are **much smaller** than the **beam's wavelength** causing **Raleigh scattering.**

References:

1. Mathew, JP et. al. Clinical Manual and Review of TEE, 3rd ed. McGraw-Hill 2019 page 12

2. Understanding Ultrasound Physics by Edelman, SK, 3rd ed. Pages 81

Raleigh Scattering



As sound is propagated through tissue, three processes contribute to attenuation: 1. Reflection, 2. Scattering, 3. Absorption.

As sound strikes a boundary between two media with different acoustic impedance, a portion of the sound wave's energy may be redirected or reflected back toward the transducer.

Reflection weakens the portion of sound that continues to be transmitted past the boundary and this contributes to attenuation.

Two forms of reflection occur: 1. Specular and 2. Diffuse.

They type of reflection that occurs at the boundary (specular or diffuse) depends on the nature of the interface that the sound wave strikes.

Smooth boundary = specular reflection.

Rough boundary = diffuse reflection.

Specular reflection occurs in only one direction in an organized manner after sound strikes a smooth boundary.

Specular reflection occurs when light waves strike a smooth mirror.

In order for specular reflection to return to the transducer the object must be aligned perfectly with the beam (90 degrees to the beam).

Diffuse reflection (also called backscatter) occurs when sound strikes an irregular or rough boundary and radiates in more than one direction.

Most tissue interfaces are rough and thus allow diffuse reflection = backscatter to occur.

Diffuse reflections (backscatter) allow imaging of objects at suboptimal angles to the sound beam as the rough surface will produce reflections in many directions and some of these will return to the transducer.

The disadvantage of backscatter is that the signals reflected have a lower strength than specular reflections.

Scattering of ultrasound is the random redirection of sound in many directions.

Scattering of ultrasound occurs when the tissue interface is small; that is equal to or less than the wavelength of the beam.

Lung tissue scatters sound. Red cells cause a special type of scattering called Raleigh scattering.

Raleigh scattering occurs when the objects dimensions are ***much smaller*** than the ***beam's wavelength***.

Raleigh scattering redirects the sound wave equally in all directions. Scattering is directly related to *frequency*

Higher frequency sound beams scatter more than lower frequency sound beams.

Raleigh scattering is a special type of scattering that goes equally in all directions.

Raleigh scattering occurs when the objects dimensions are ***much smaller*** than the ***beam's wavelength***.

Raleigh scattering redirects the sound wave equally in all directions.

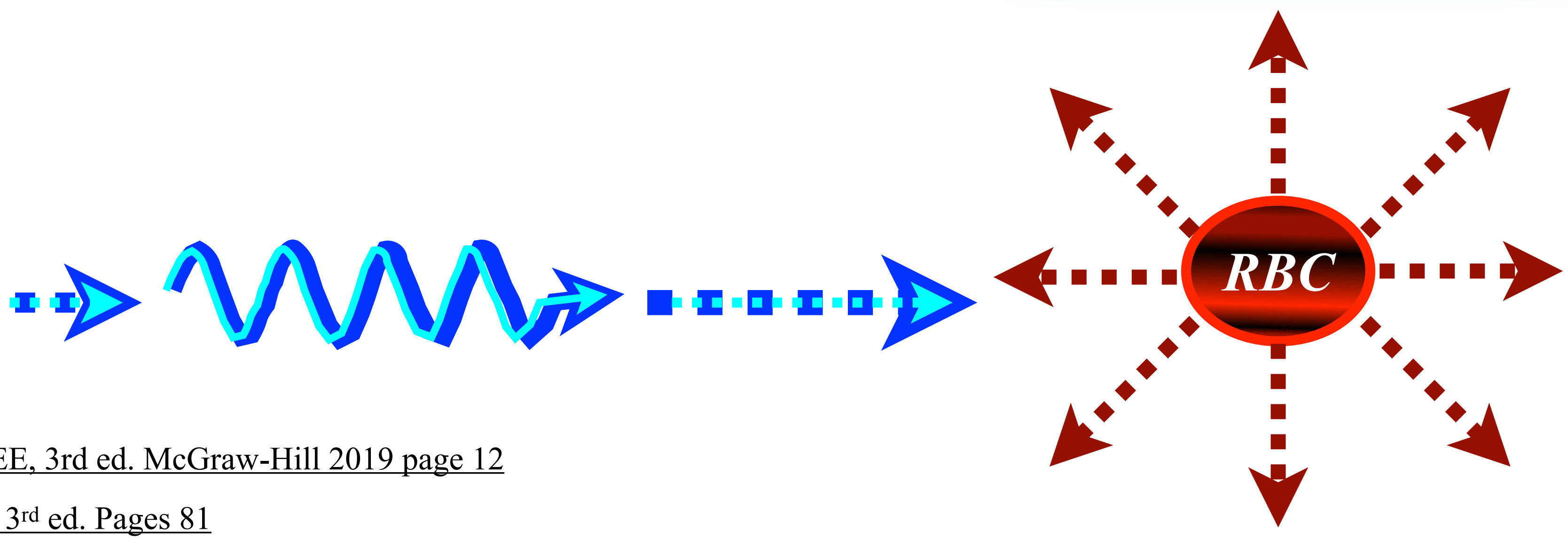
Higher frequency sound beams scatter more than lower frequency sound beams.

Scattering is directly related to frequency.

Rayleigh scattering increases dramatically with ***increases*** in **frequency.**

Rayleigh Scattering **is important for Doppler ultrasound, as red blood cells** are **much smaller** than the **beam's wavelength** causing **Raleigh scattering.**

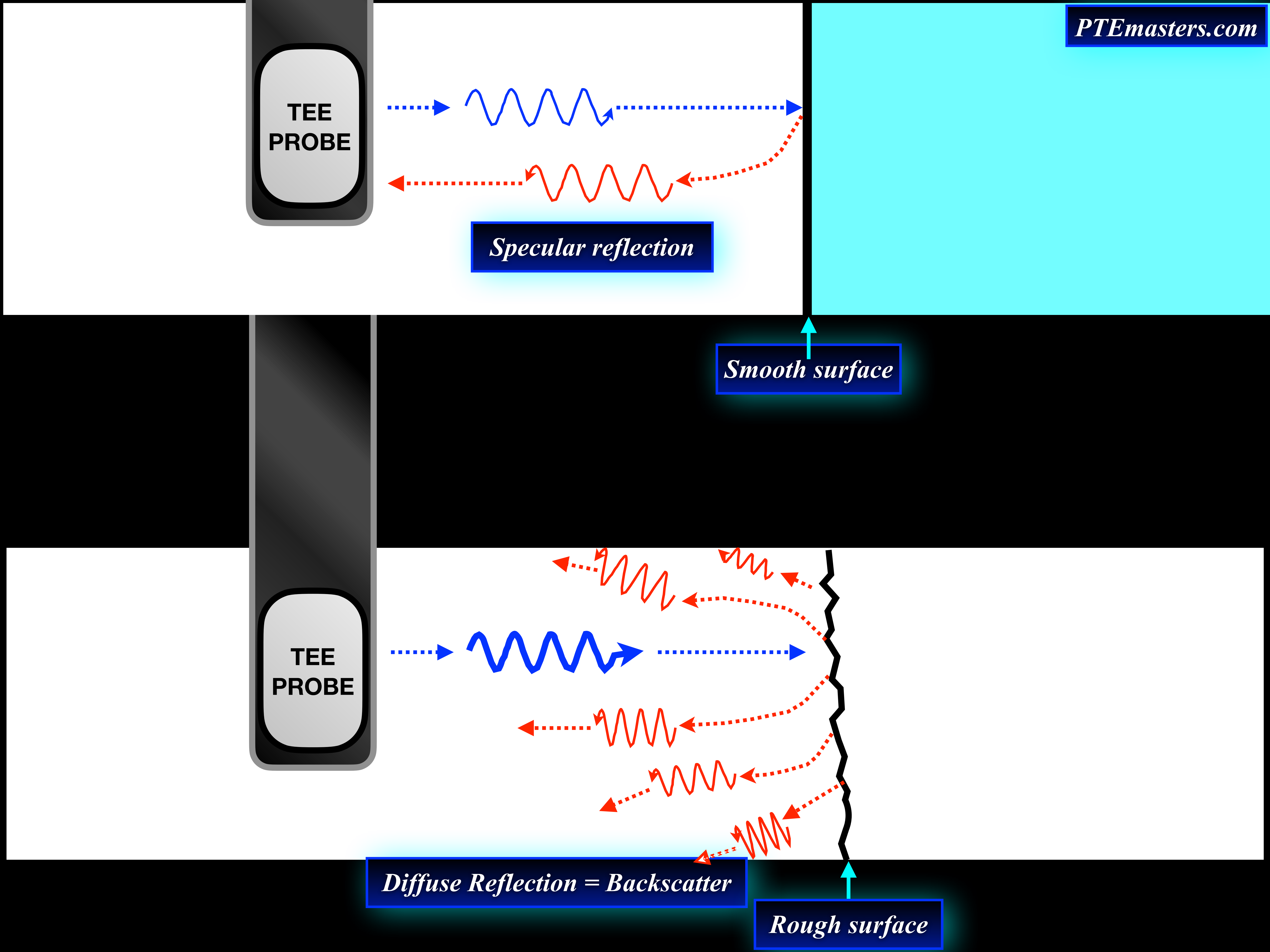
Raleigh Scattering



References:

1. Mathew, JP et. al. Clinical Manual and Review of TEE, 3rd ed. McGraw-Hill 2019 page 12

2. Understanding Ultrasound Physics by Edelman, SK, 3rd ed. Pages 81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