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ULTRASOUND IN OPHTHALMOLOGY

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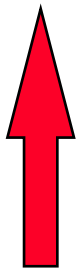
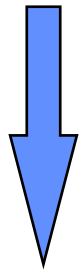
ULTRASOUND:

Sound waves above the audible hearing range.
Over 20 kHz or 20,000 cycles per second.

FREQUENCY: Number of cycles per second. The depth of penetration is inversely proportional to the frequency of the ultrasonic wave.



FREQUENCY



DEPTH OF PENETRATION

High frequency, shallow ophthalmic 8 to 20 MHz

Low frequency, deep body scanners 2.5 to 5 MHz

VELOCITY: The speed at which sound travels through a medium.

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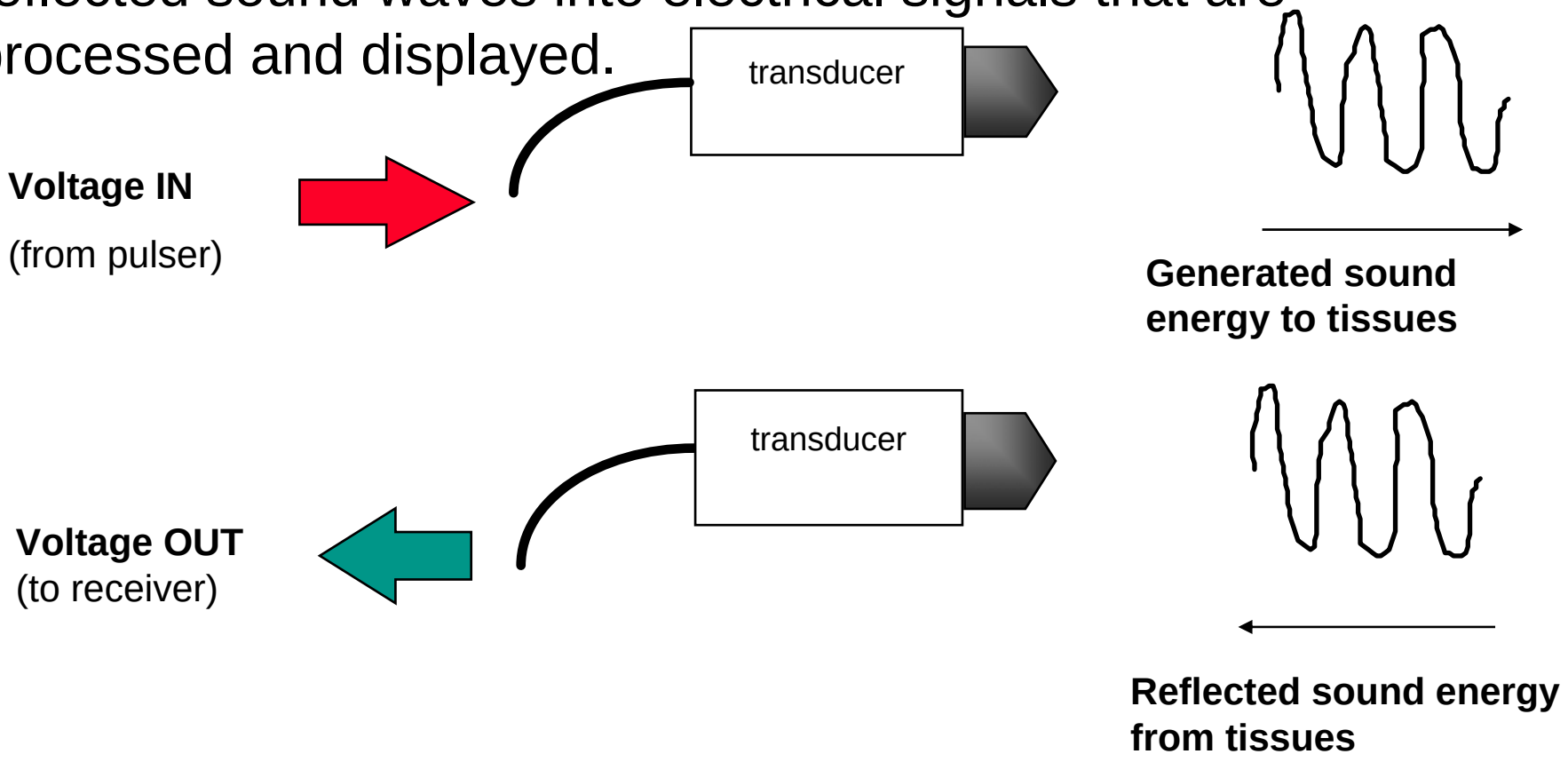
Water	1480 m/s
Air	330 m/s
Cornea	1550 m/s
Aqueous/Vitreous	1532 m/s
Clear lens	1640 m/s
Cataract lens	1590-1670 m/s
Soft tissue	1550 m/s

DISTANCE (millimeters)=TIME (second) x **VELOCITY (m/s)**

TRANSDUCER: A device that converts energy from one form to another. For ultrasound it converts electrical energy (voltage) into mechanical energy (ultrasonic waves).

Conversely the ultrasonic transducer also converts reflected sound waves into electrical signals that are processed and displayed.

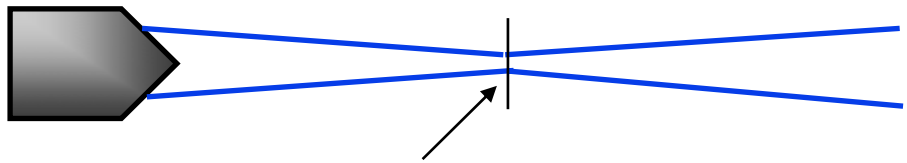


ULTRASONIC BEAM CHARACTERISTICS

Shape:

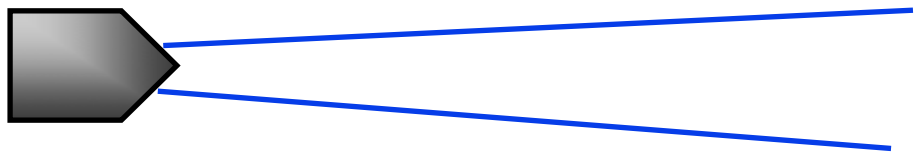
Focused

Accomplished by an Acoustic Lens



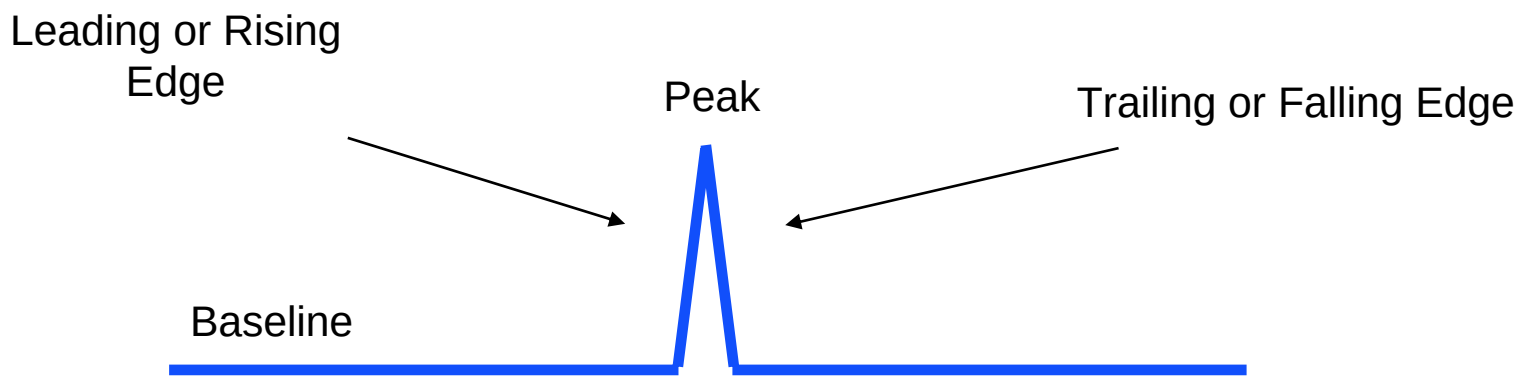
Best resolution around here

Unfocused



Parallel

ANATOMY OF AN ECHO:



FACTORS THAT AFFECT AMPLITUDE AND BRIGHTNESS:

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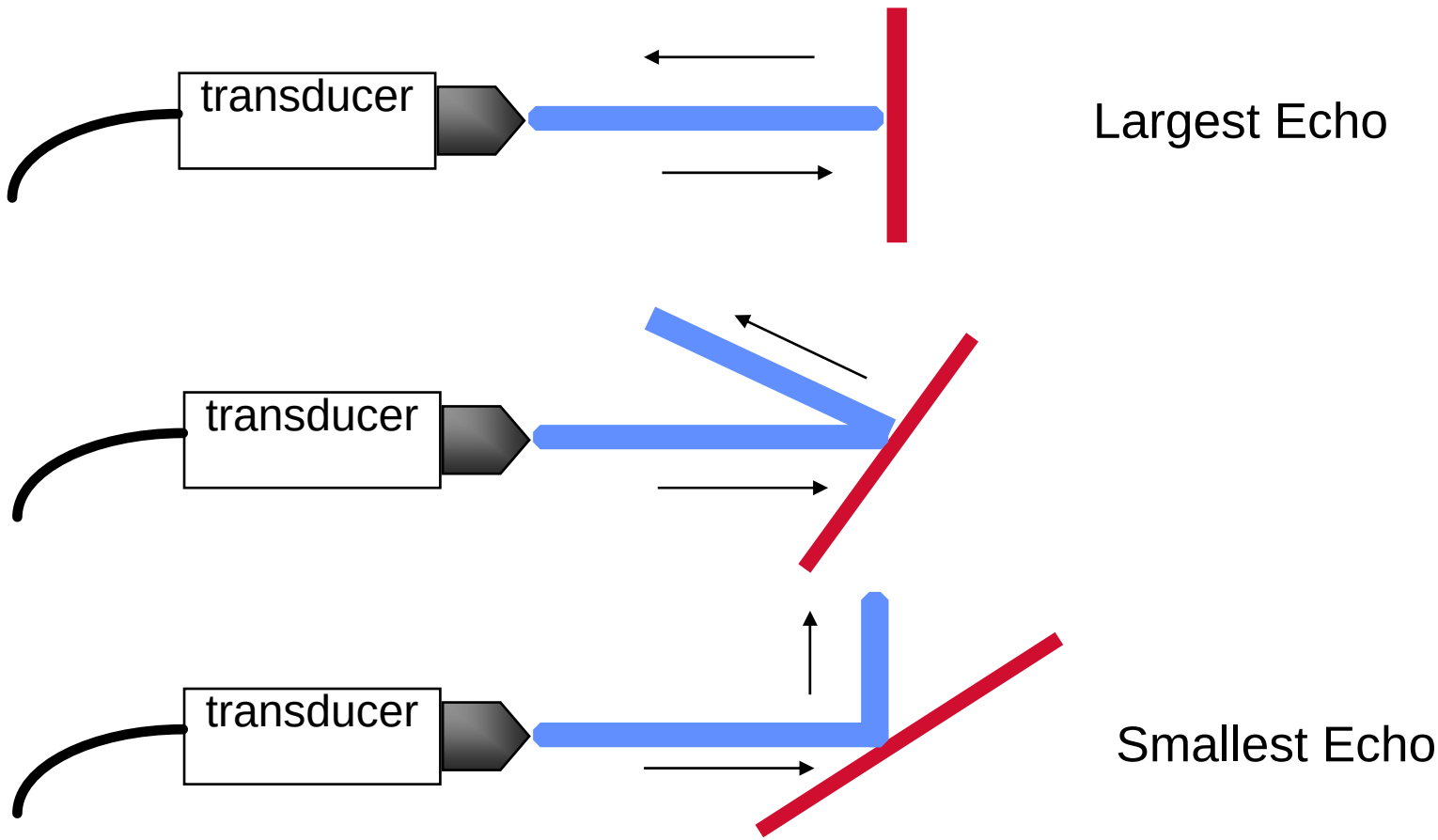
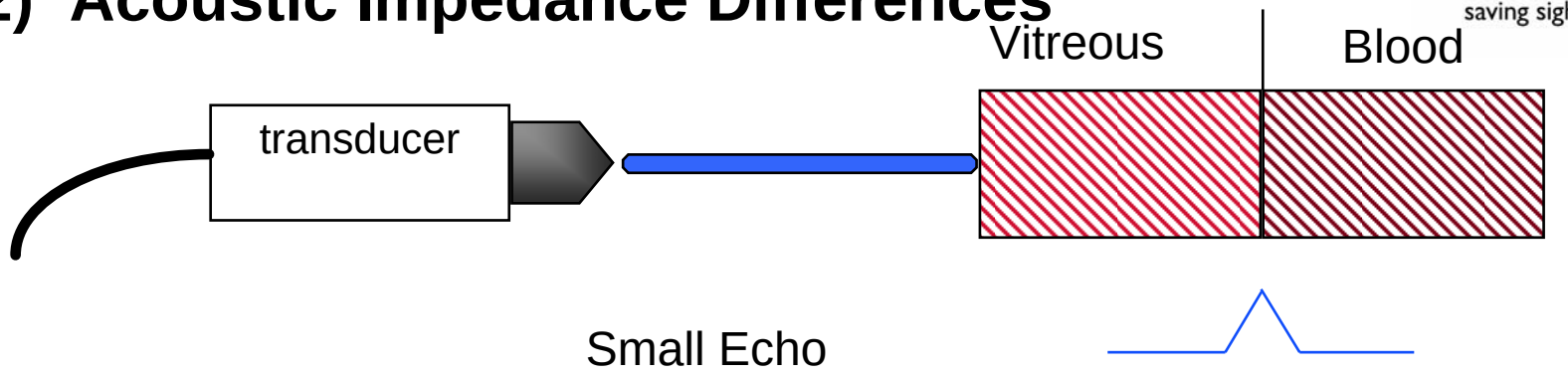
1) ANGLE OF INCIDENCE



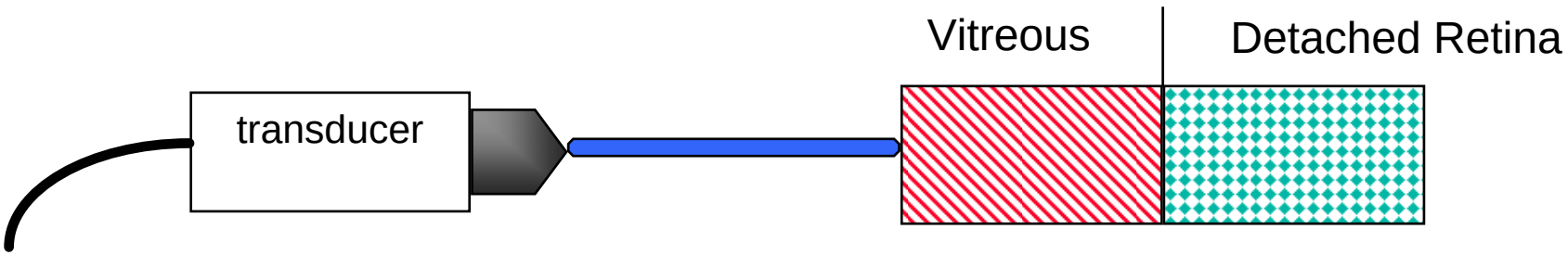
FACTORS THAT AFFECT AMPLITUDE AND BRIGHTNESS:

(Continued)

2) Acoustic Impedance Differences



Small Echo



Biggest Echo

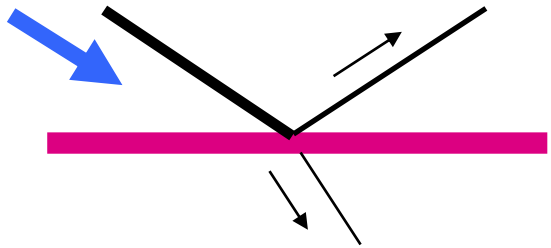
The larger the difference between the tissue types at an interface, the greater the reflected energy

FACTORS THAT AFFECT AMPLITUDE AND BRIGHTNESS:

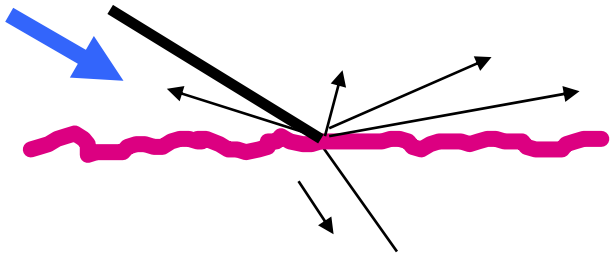
(Continued)

3) Texture and shape of surface

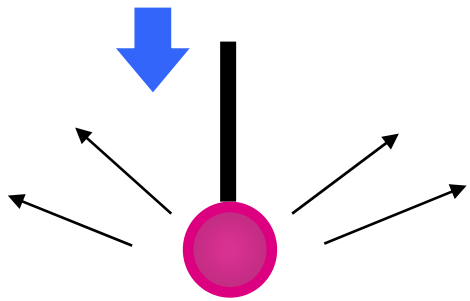
Smooth surface



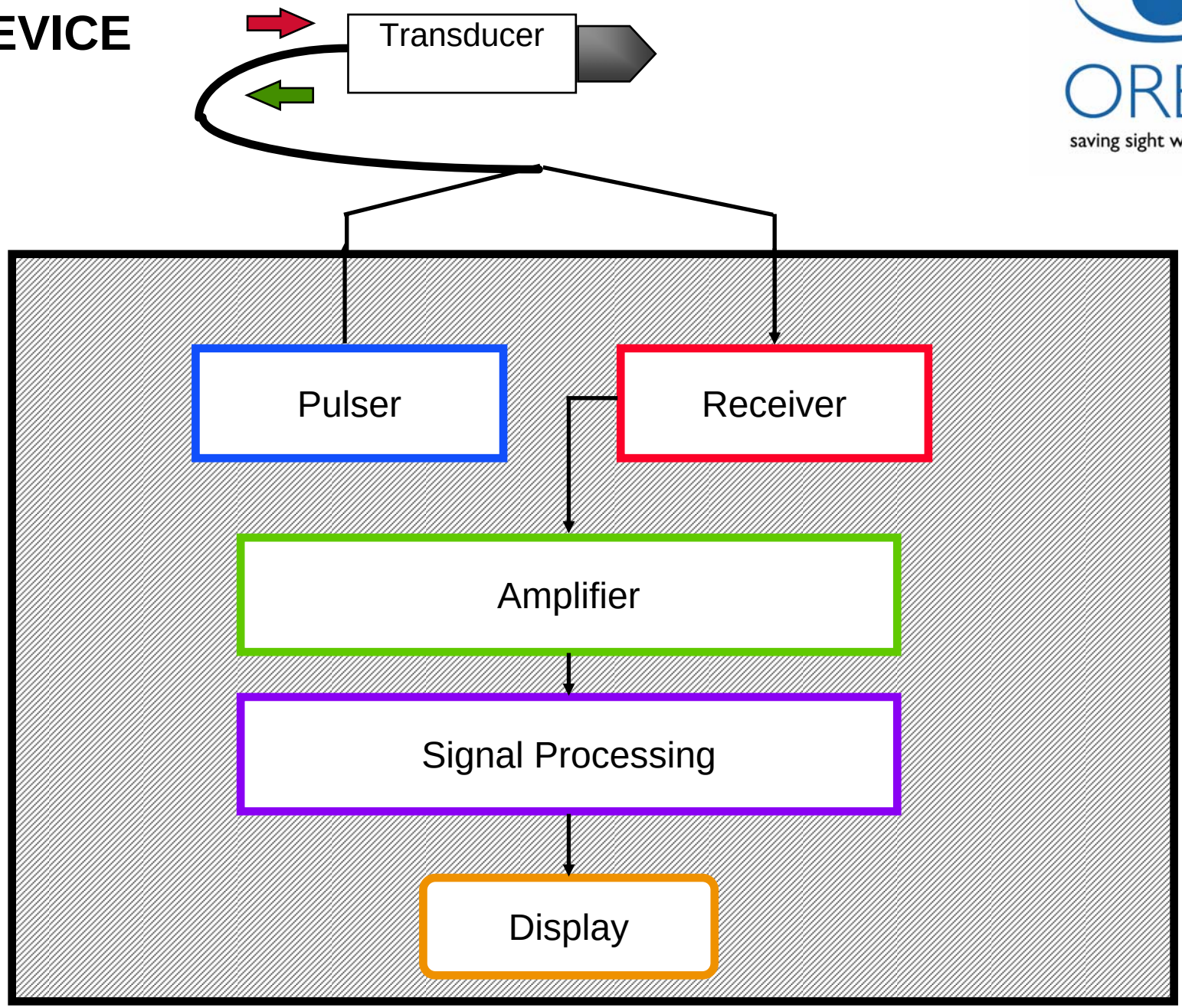
Coarse surface



Small Interface



BASIC COMPONENTS OF AN ULTRASOUND DEVICE



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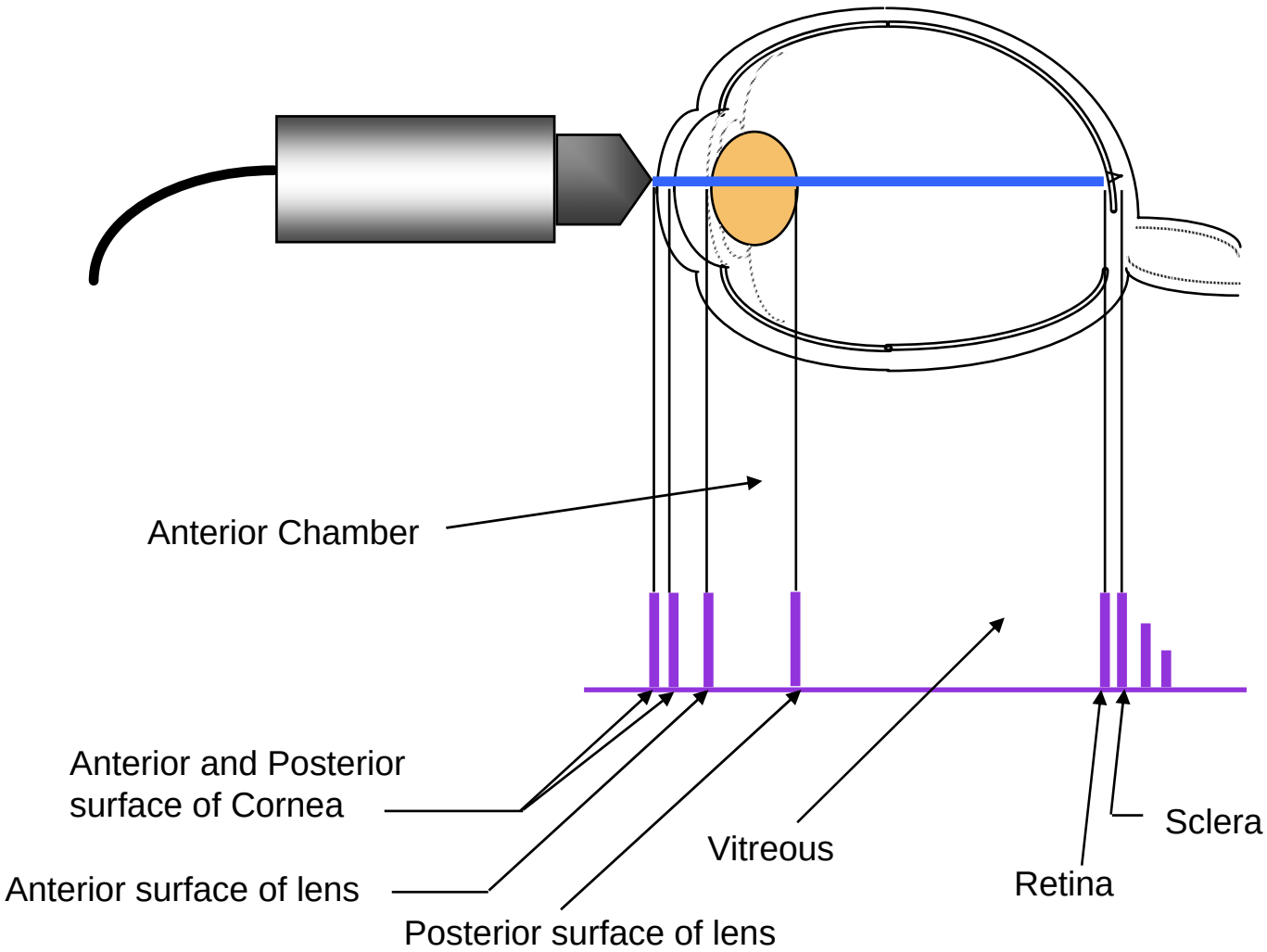
A-SCAN (amplitude mode)

• height of the echoes: determined by perpendicularity and acoustic impedance.

• distance between echoes: determined by the time it takes the sound to travel through the various structures in the eye.

A-SCAN


Anterior Chamber
Anterior and Posterior surface of Cornea
Anterior surface of lens
Posterior surface of lens
Vitreous
Retina
Sclera

- A-Scans are used to measure the axial length of the eye for determining the proper power of the intraocular lens to be implanted. Typical axial length measurements are from 21-26 mm.

To get the best A-Scan results:

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1) No air bubbles in probe
2) Perpendicularity
3) Do not indent cornea
4) Input eye type (phakic, aphakic, pseudophakic)
5) Corneal gate should be to the left of Corneal spike
6) Retinal spike should be well defined and perpendicular
6) Repeat results

SCAN EXAMPLES

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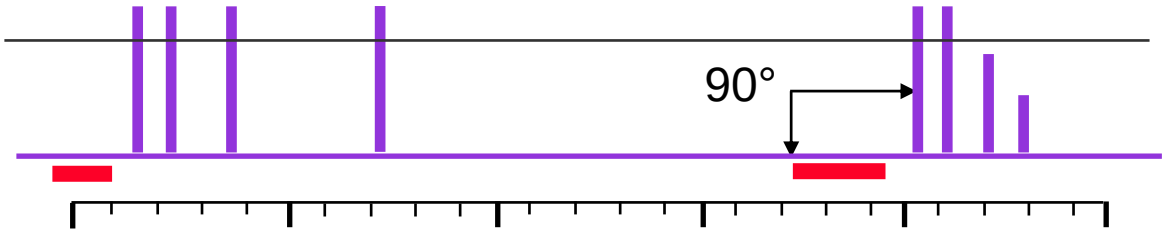
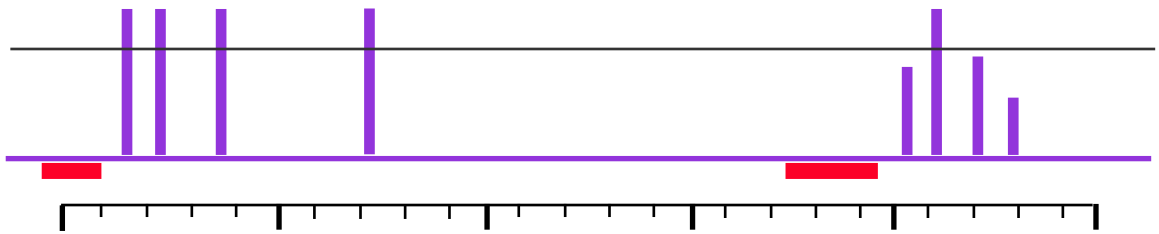
Normal Scan

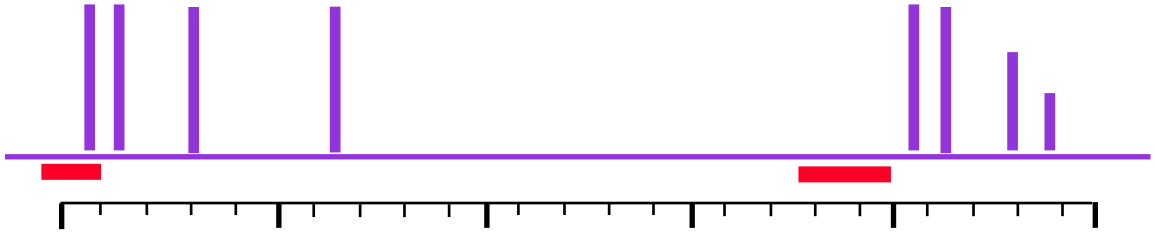


Inaccurate Scan (Measured > actual)



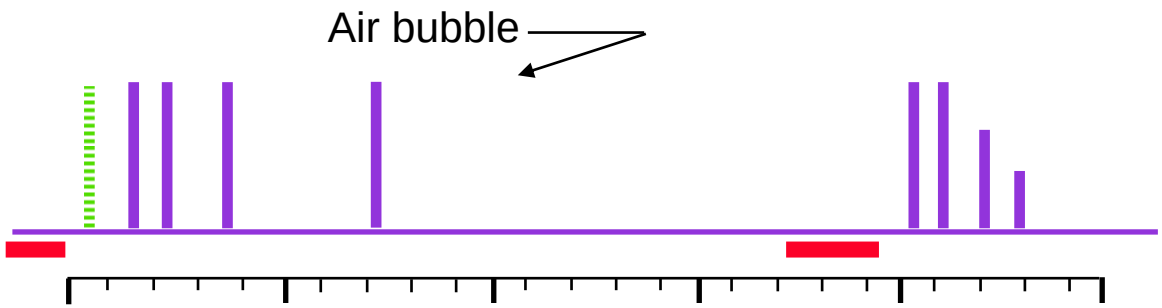
Retinal spike is not well identified

• Inaccurate Scan (< actual)



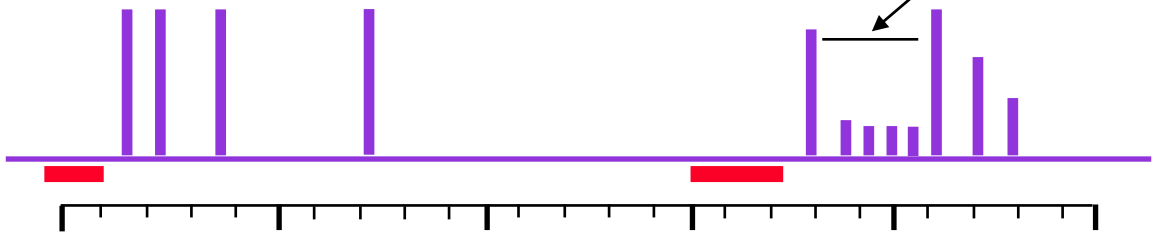
Corneal spike is placed outside the corresponding gate

• Inaccurate Scan (> actual)

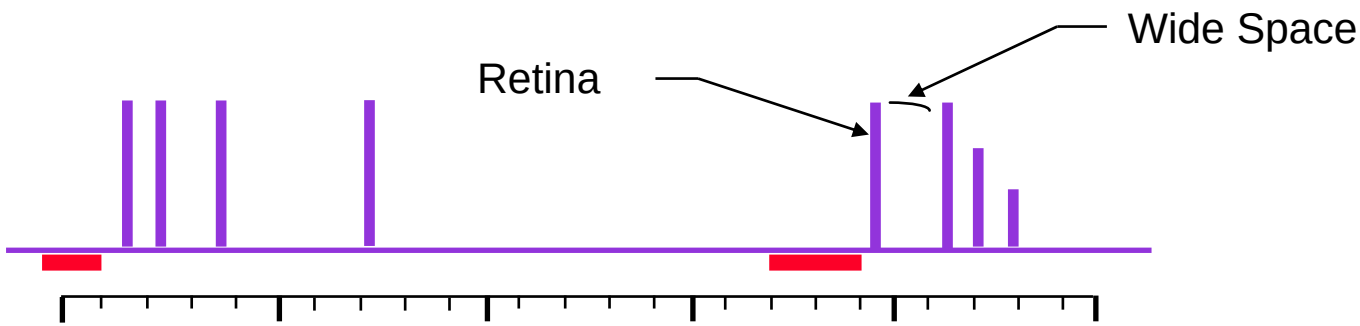


Air bubble present in probe

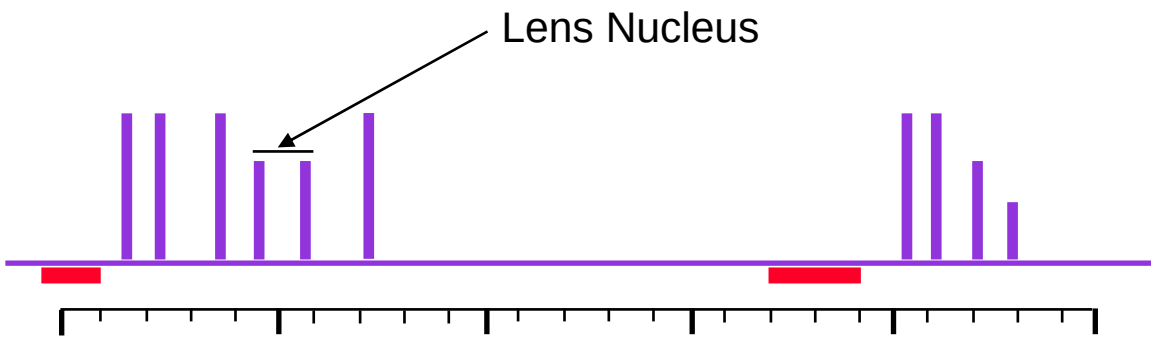
• Tumors



• Retinal Detachment



- Nuclear cataract



B-SCAN (brightness mode)

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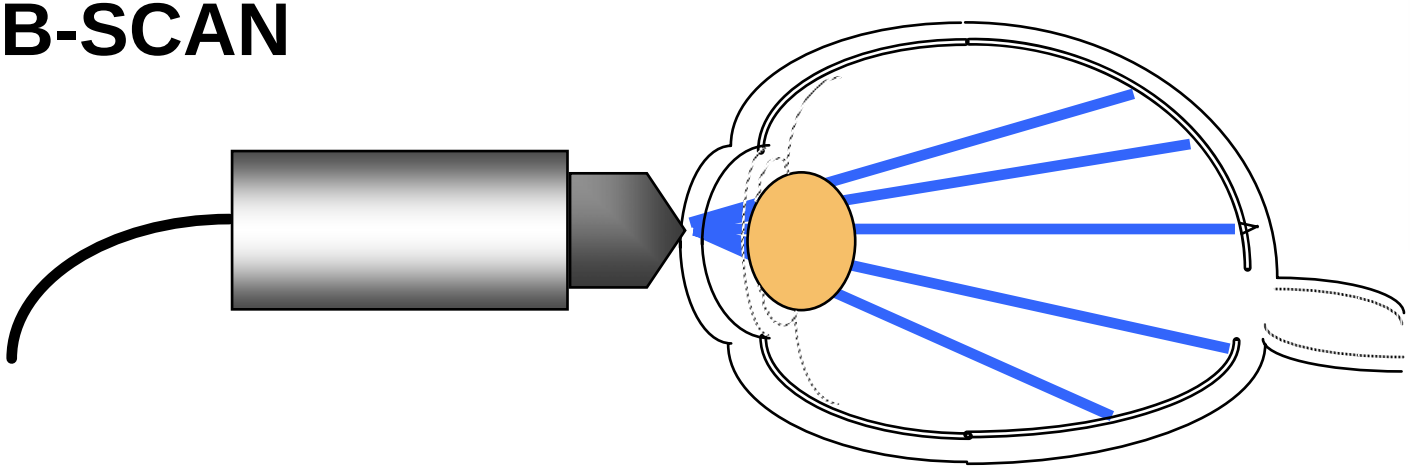
Two dimensional brightness evaluation.

- Each reflected wave is translated into a spot on the screen.
- Each spot corresponds positionally to the location of the point in the eye from which the wave is being reflected.
- The brightness of the spot is proportional to the amplitude of the reflected wave.

B-SCAN



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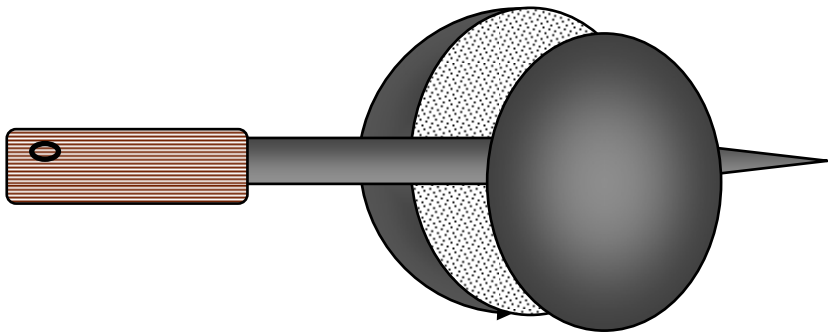
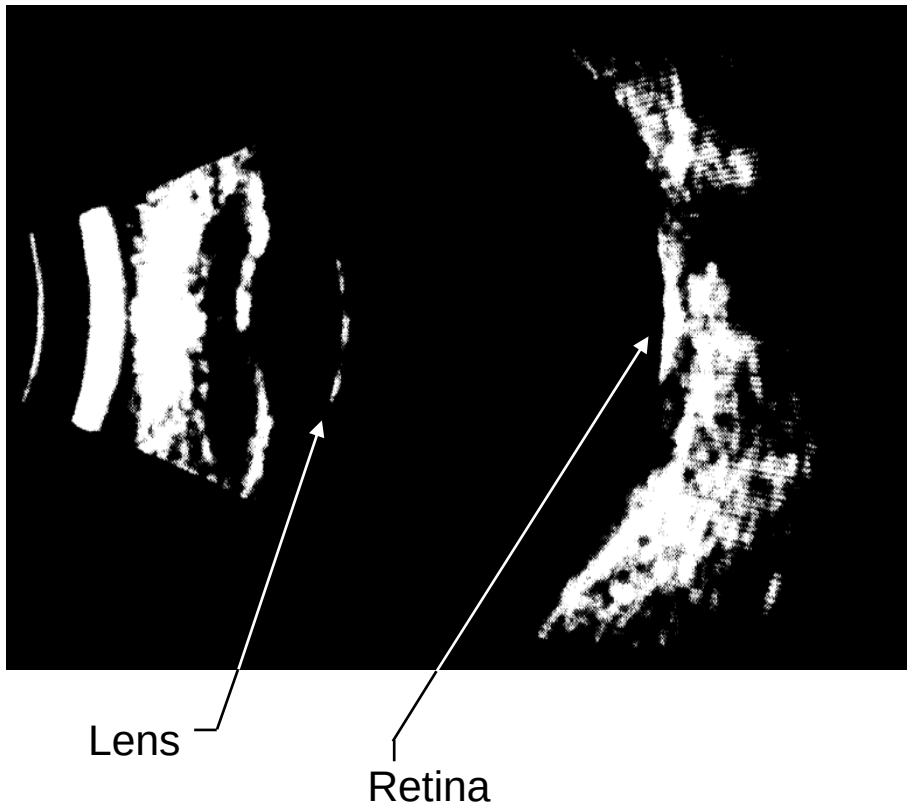
The transducer sweeps back and forth.



The ultrasonic beam is equivalent to a knife blade, exposing a cross section of the cut object.

B-SCAN EXAMPLE



PHACOEMULSIFICATION

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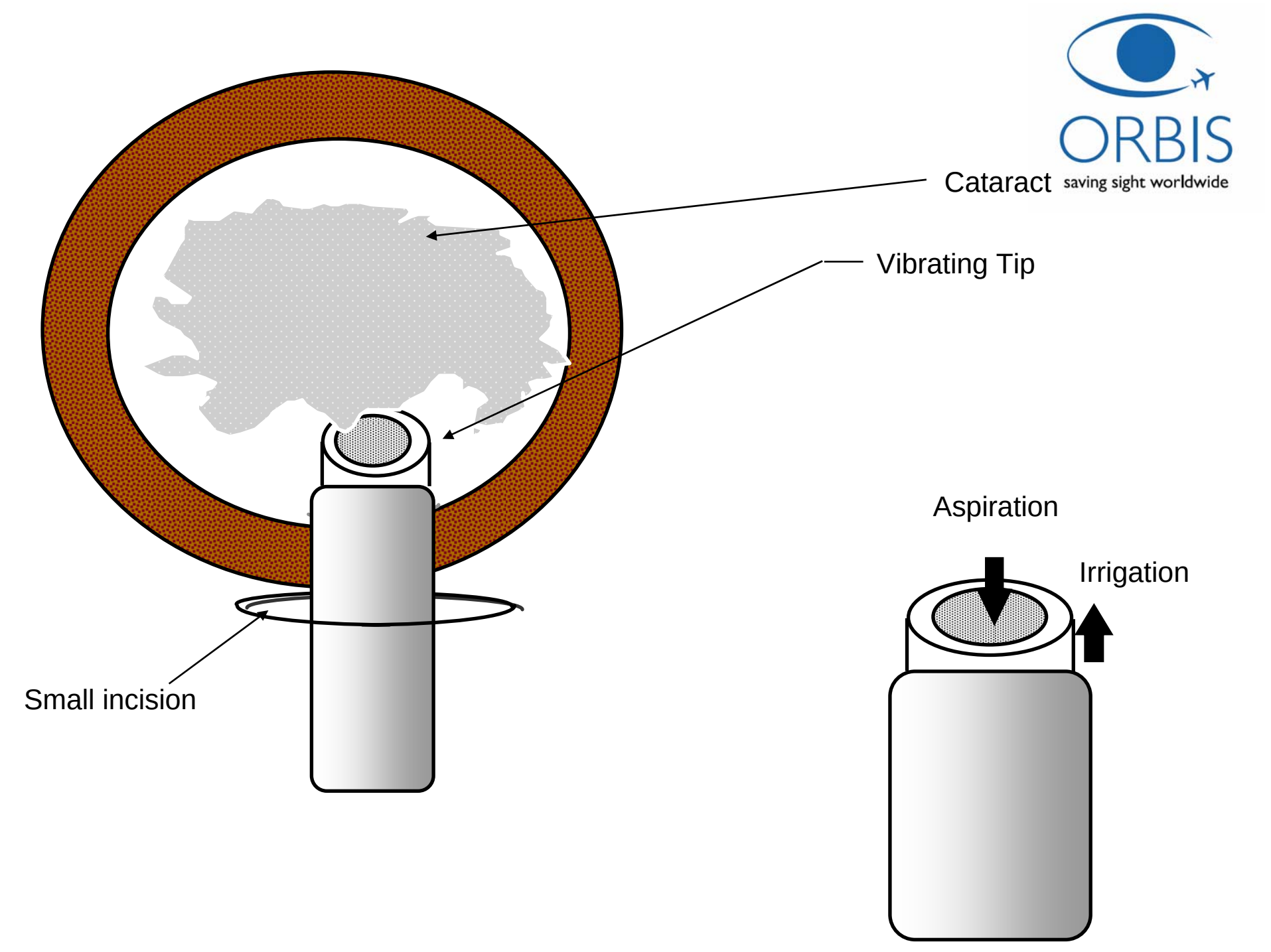
- Used to remove cataracteous lenses from the eye.
- A probe is vibrated at the ultrasonic frequency of about 40 KHz breaking up the lens into small particles.
- The small particles are drawn out of the eye by a suction system through the probe's hollow center, aided by an irrigation solution.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Cataract
Vibrating Tip
Small incision
Aspiration
Irrigation