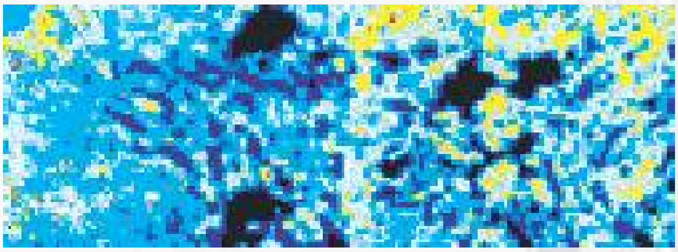
Ultrasonic Microscope

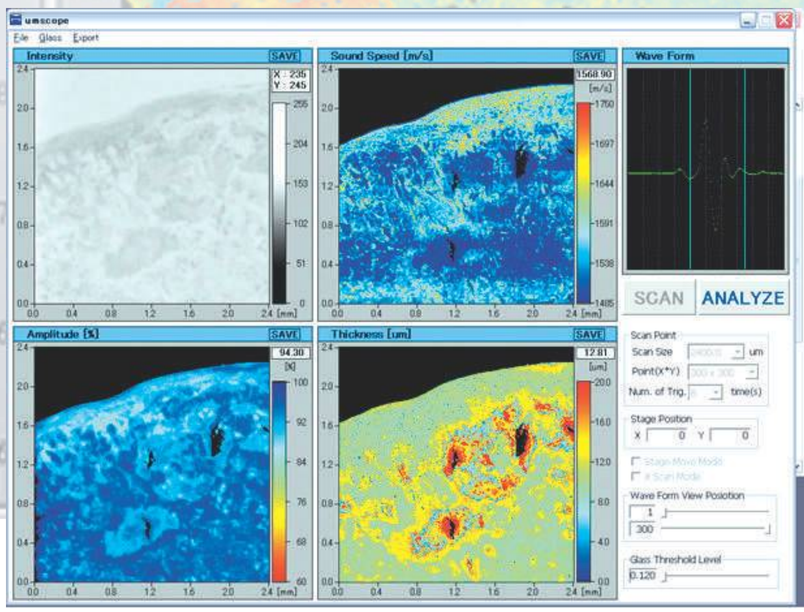


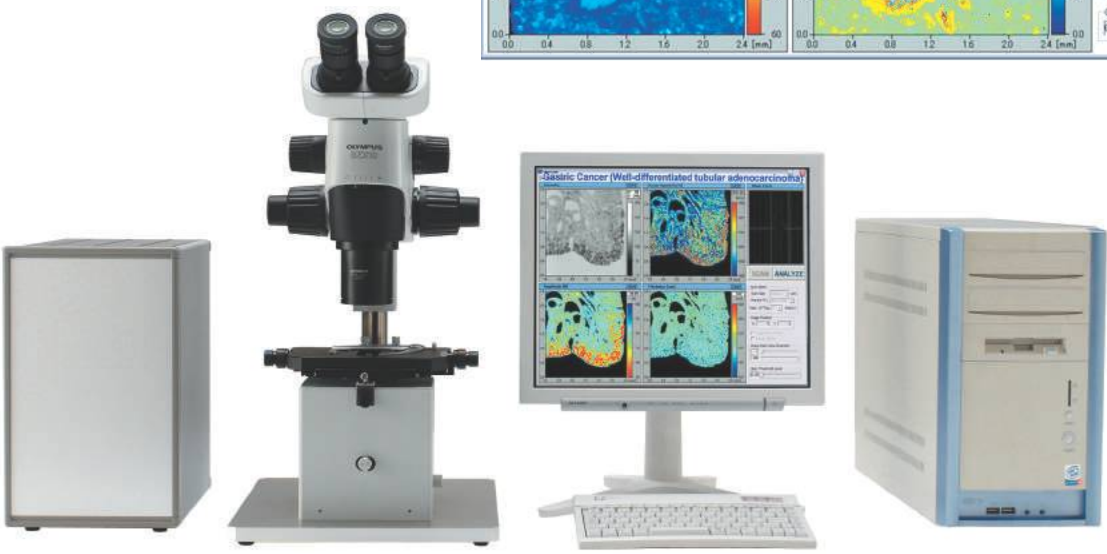
Bio Medical Ultrasonic Microscope

AMS-50SI

Opens the World of Ultrasonic Technology

Rapid tissue elasticity detection for medical





HONDA ELECTRONICS CO.,LTD.

Bio Medical ultrasonic microscope

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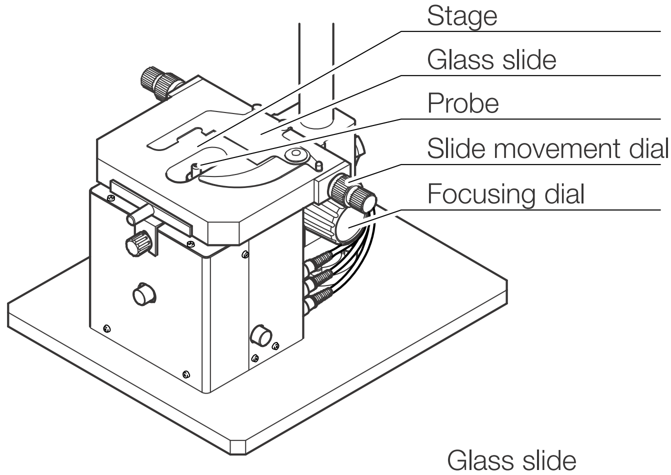
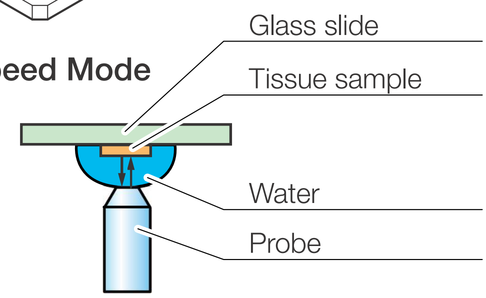
Ultrasonic microscope, AMS-50SI measures and visualizes microscopic image of sound speed or acoustic impedance of tissue sample.
By selecting optimum frequency and set the appropriate probe to the unit, then user can scan the tissue right away. Without hamble staining process that is necessary for optical microscope, tissue characteristic in elasticity region can be observed swiftly.



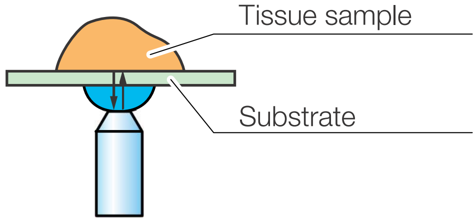
What is ultrasonic microscope

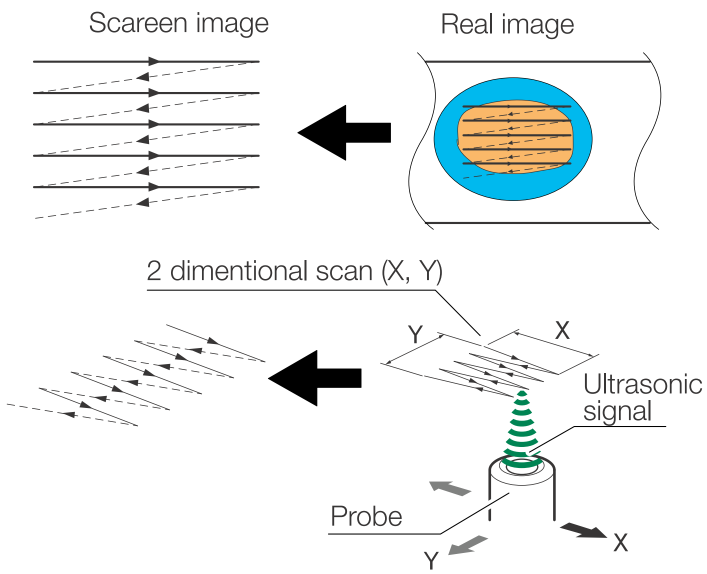
The elasticity of cells and tissues correlates with their sound speed. With the long time study of ultrasonic behaviour, HONDA ELECTRONICS has succeeded to develop a device that measures the sound speed rapidly with much less process of preparation for observation.
The newly developed acoustic impedance mode enables the observation without making sliced tissue sample.
The original sound speed mode for sliced sample is also available.

Sound Speed Mode



Acoustic Impedance Mode





Scanning image

Three measurement mode of observation for biomechanical property (elasticity) is available

Sound Speed mode and Acoustic Impedance mode shows quantitative observation

High-frequency ultrasonic process realized micron level resolution

Living cell observation is possible in Acoustic Impedance mode

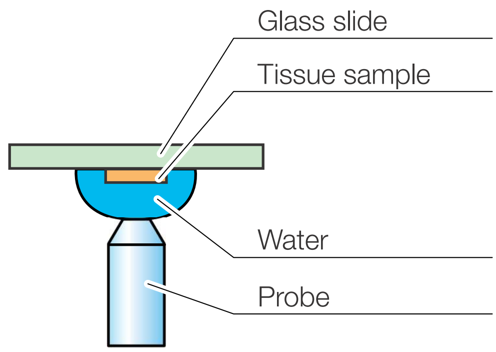
Correlation of elasticity vs density

$$C=\sqrt{\frac{K}{\rho}}$$

C : Speed of Sound
ρ : Density
K : Bulk Modulus

Sound Speed mode

Place a slide sections upside-down on the stage above the transducer, and apply distilled water between the transducer and the section as a coupling fluid.
Ultrasonic signal is applied upward to the slide via coupling water. The signal reflects on the front and back surface of the tissue sample.
The difference of the reflected signals are calculated for acoustic characteristic.



The speed of sound in tissues correlates with their elasticity as the faster, the harder and as the slower, the softer. Using blank surface as reference, quantitative measurement is realized.

The measurement is completed only from the own tissue characteristic, so no need of staining and quick observation is possible.

Theory of Sound speed mode

The ultrasonic signal from the probe reflects (A) on the front side and (B) on the back side as shown in fig. 1.
The actual signal is observed like fig. 2, A+B as interfered signal, because the two reflected signals are very close due to the small thickness of the tissue (10u).

Using the reference signal from the glass surface (C), the interfered signal can be distributed to (A) front side signal and (B) back side signal.

Then, the propagation time is calculated from (A) and (B) and sound speed of the tissue and tissue attenuation.

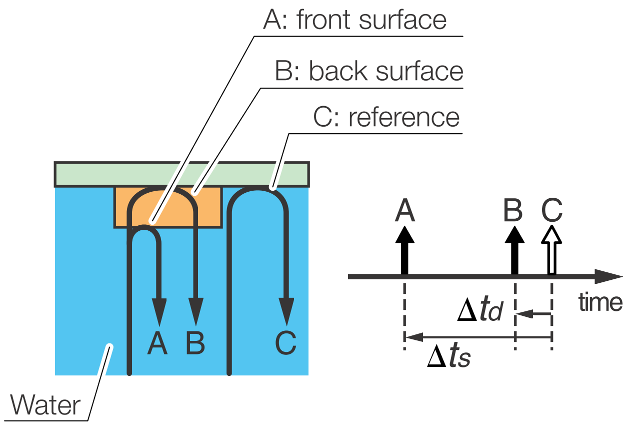


Fig 1. Reflected signal and the tissue

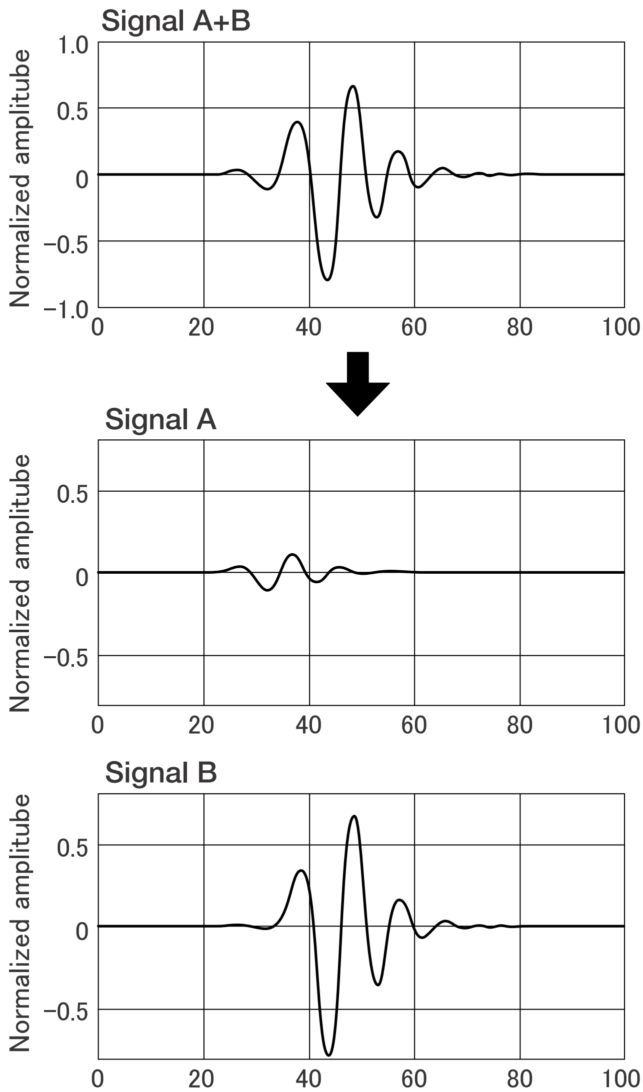


Fig 2. Reflected signal from tissue

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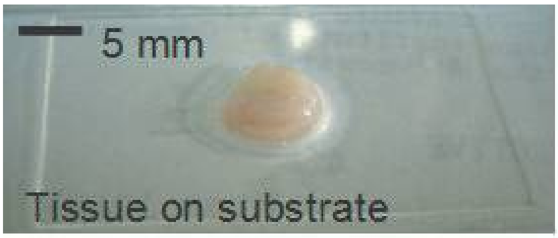
Acoustic Impedance Mode

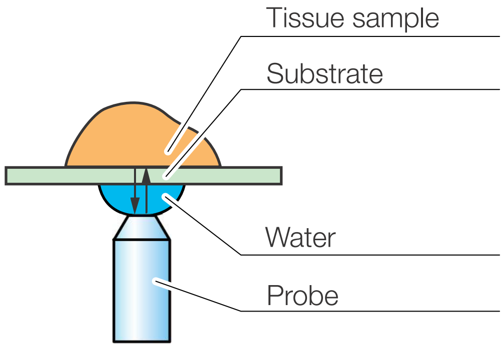
The reflected signal intensity correlate with how much the density is different at the boundary.
The ultrasonic signal applied from the bottom of the glass reflect at the boundry between tissue and the glass. The larger the density difference, the stronger reflected signal. When the density difference is small, there is less reflection and signal becomes weak.

Mice Cerebellum



$Z = \rho c$

- c : Speed of Sound
- ρ : Density
- Z : Acoustic Impedance



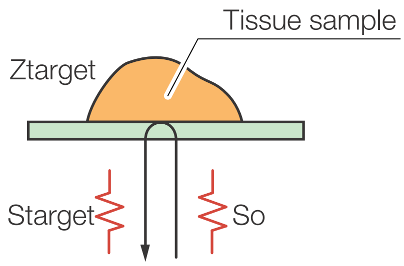
Acoustic impedance is described as "tissue density" x "tissue sound speed"

Tissue is not necessarily sliced, living tissue can be observed. Physical characteristics of the tissue at the boundary to the glass.

Theory of Acoustic Impedance mode

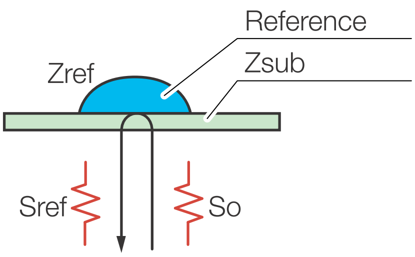
The difference of the acoustic impedance of the material attaching the substrate makes the difference of intensity of the reflected ultrasonic wave.

Having a reference value (i.e. purified water) measured, the acoustic impedance of the objective material by calculation.



$$S_{ref} = \frac{Z_{ref} - Z_{sub}}{Z_{ref} + Z_{sub}} S_o \qquad S_{target} = \frac{Z_{target} - Z_{sub}}{Z_{target} + Z_{sub}} S_o$$

$$Z_{target} = \frac{1 - \frac{S_{target}}{S_o}}{1 + \frac{S_{target}}{S_o}} Z_{sub} = \frac{1 - \frac{S_{target}}{S_{ref}} \times \frac{Z_{sub} - Z_{ref}}{Z_{sub} + Z_{ref}}}{1 + \frac{S_{target}}{S_{ref}} \times \frac{Z_{sub} - Z_{ref}}{Z_{sub} + Z_{ref}}} Z_{sub}$$



S_o : transmitted signal from probe
S_{target} : reflected signal from the tissue
S_{ref} : reflected signal by water
Z_{sub} : acoustic impedance of substrate
Z_{ref} : acoustic impedance of water
Z_{target} : acoustic impedance of the tissue

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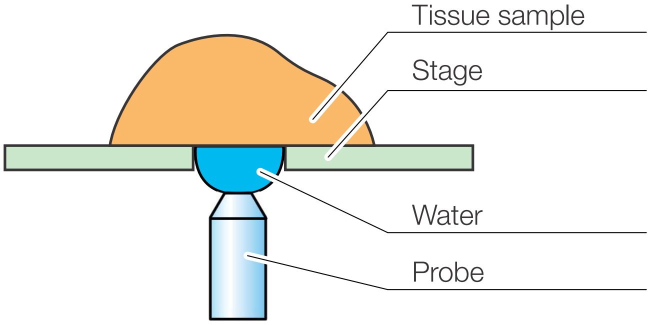
B Mode

B mode stands for "Brightness" mode. The image is reconstructed by collecting plural number of ultrasonic reflections.

It is similar to the ultrasonic diagnostic imaging system, "echo machine". User can obtain cross-sectional image having depth axis. Since ultrasonic microscope uses much higher frequency than standard echo machines, it visualize very high resolution image and It enables detailed observation of the tissues.

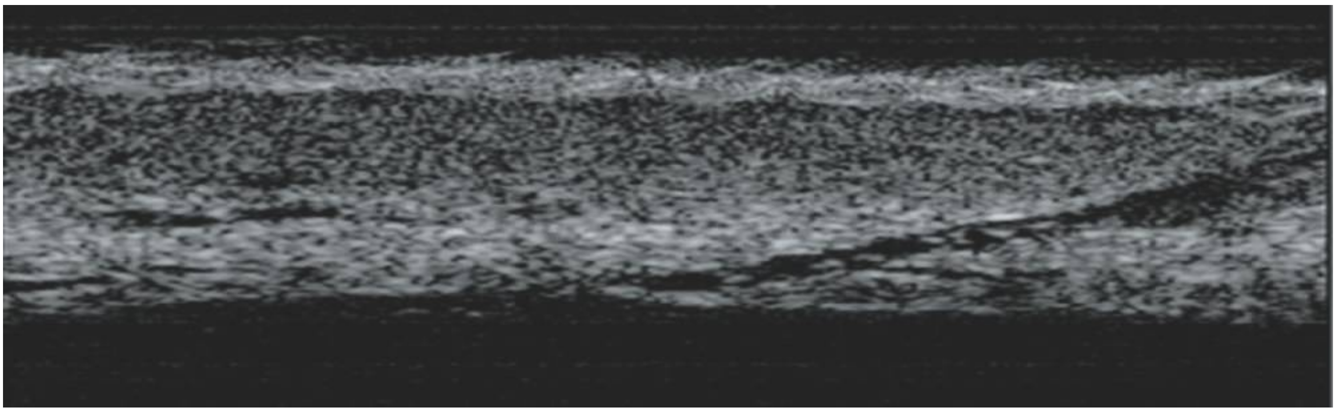
By the use of over 100 MHz ultrasonic signal, the resolution reaches approximately 15 micron meters.

B mode visualizes cross-sectional image in depth-wise and it enables the observation of micro tissue construction.



Continuous snapshots of B-mode (human skin)

2-dimentional continuous B-mode image (human skin)



provided by Dr. Saijo, Tohoku Univ.

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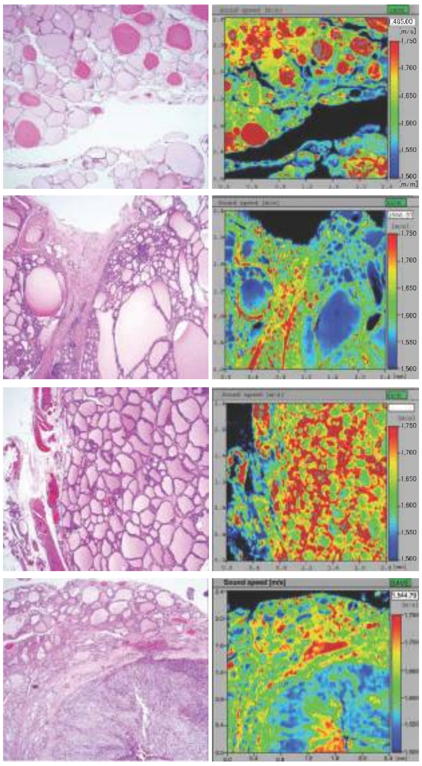
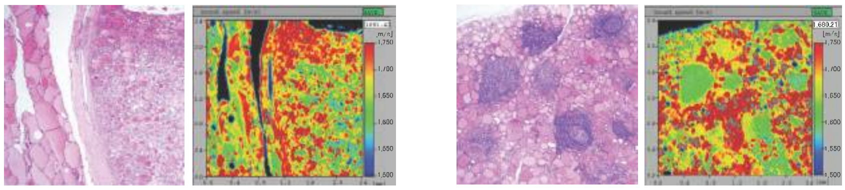
Image Samples (Sound Speed)

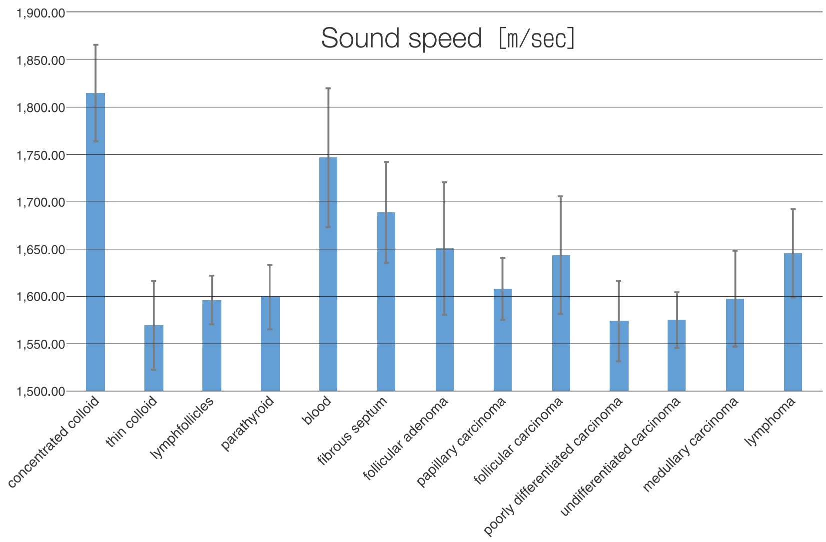
Thyroid observation (80MHz)

provided by Dr. Miura, Hamamatsu Univ. of Medicine



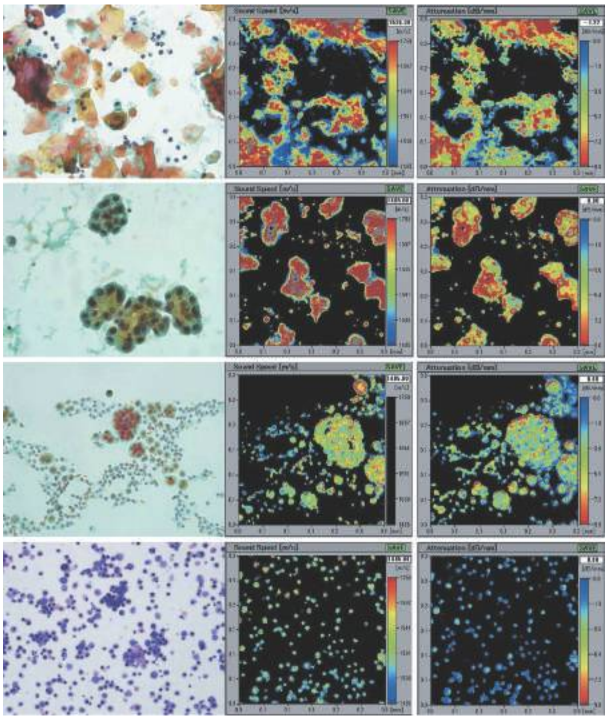
Optical microscope (HE stain) | Sound Speed [m/sec]



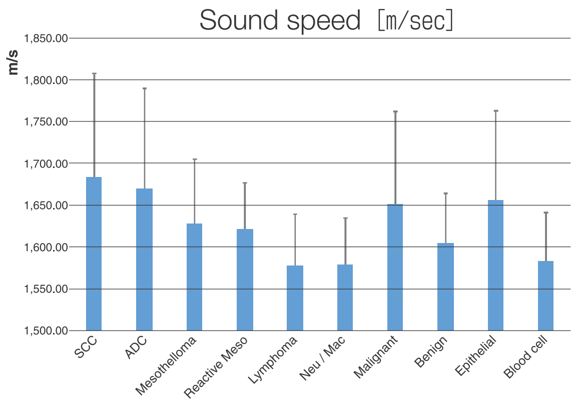


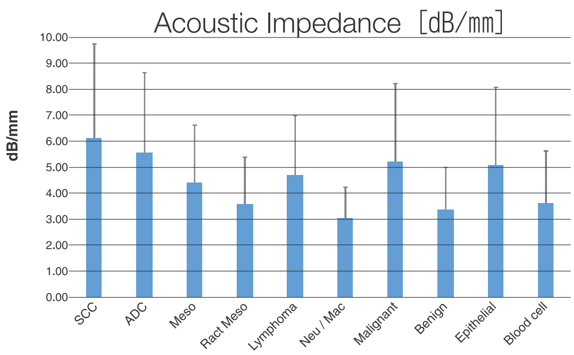
Cells observation (320MHz)

provided by Dr. Miura, Hamamatsu Univ. of Medicine



Optical microscope (Papanicolaou stain) | Sound Speed [m/sec] | Acoustic imp. [dB/mm]





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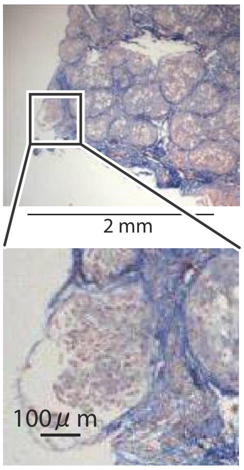
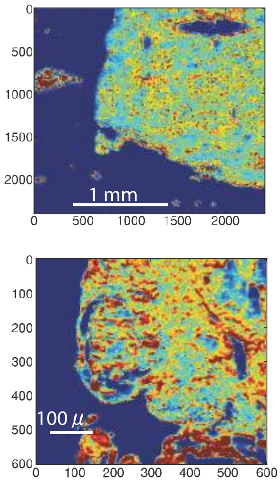
Images by different frequencies

Rat NASH

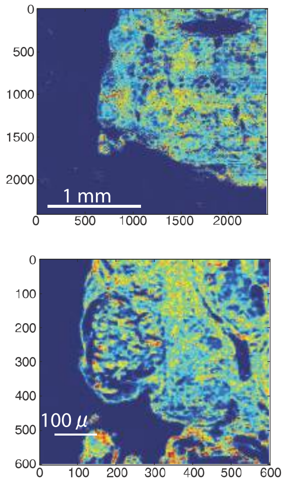
provided by Dr. Yamaguchi, Chiba Univ.



Optical microscope
(Azan stain)



Sound speed
[m/sec]

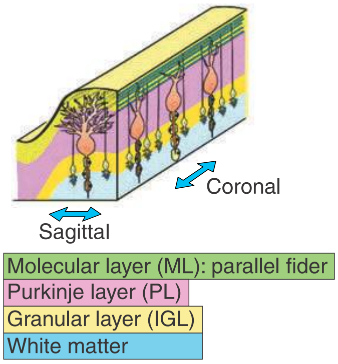


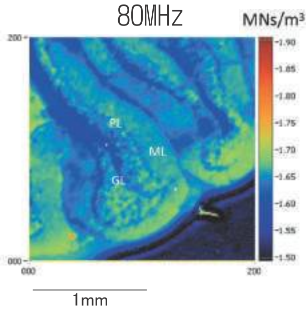
Acoustic impedance
[dB/mm]

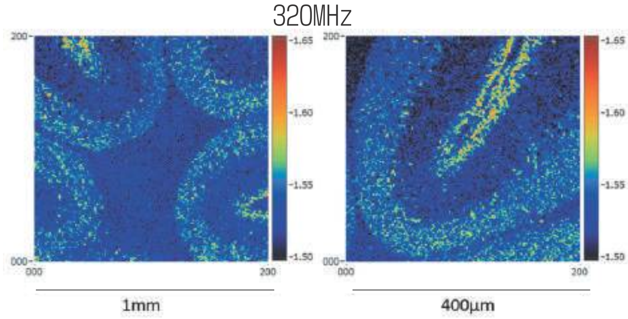
Image Samples (Acoustic Impedance)

Acoustic observation of developing rat cerebellar cortex

provided by Dr. Hozumi, Dr. Yoshida, Toyohashi Univ.of Technology

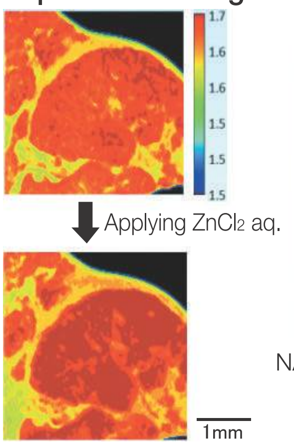


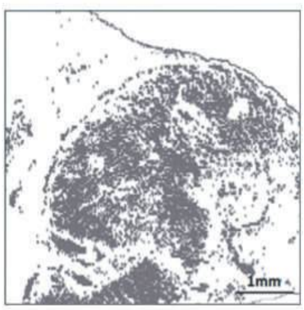




Showcases of the drug-dependent impedance changes

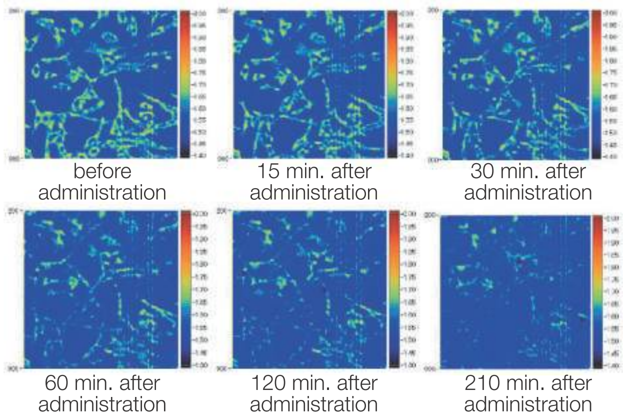
provided by Dr. Hozumi, Dr. Yoshida, Toyohashi Univ.of Technology





NASH-delivered mice hepatocyte

The increased impedance of hepatocyte (liver cancer) due to Zn^{2+} absordance



The impedance of rat C6 glioma (brain tumor cell) was decreased with cytochalasin B application, due to inhibition of F-actin deploymerization.

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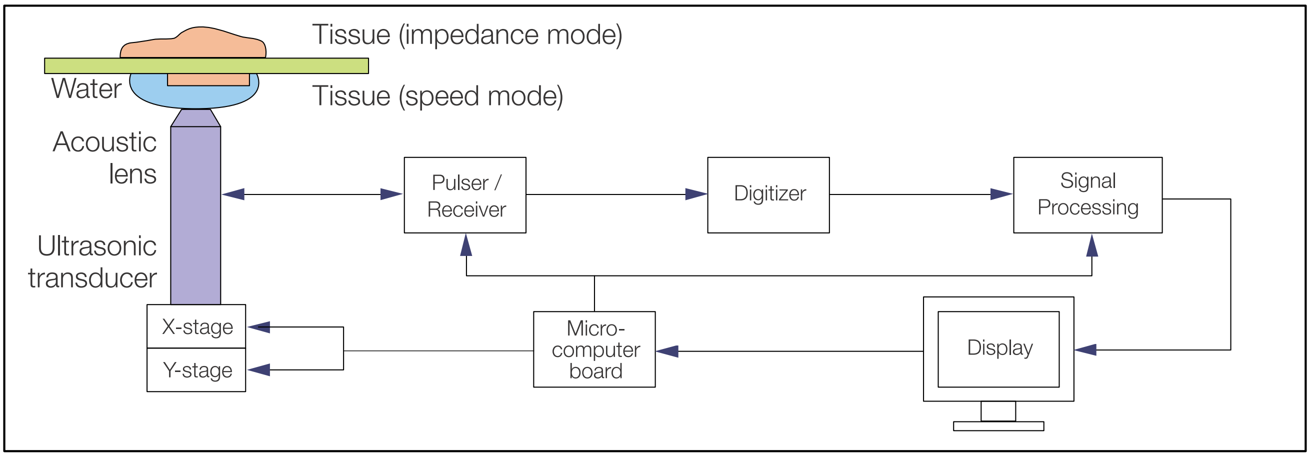
Features

- Three measurement mode of observation for biomechanical property (elasticity) is available
- Sound Speed mode and Acoustic Impedance mode shows quantitative observation
- Living cell observation is possible in Acoustic Impedance mode
- Rapid measurement (about 1 minute after setting 2.4 mm square tissue) with easy operation

Block diagram



Specifications

Scanning Method	Mechanical scan (X, Y: Auto, Z: Manual operation)
Frequency	50～500MHz
Transducer	※80MHz
Sound Speed	1,495～1850m/sec
Acoustic impedance	1.45～1.80：1.45～1.80 ×10^6N·s/m^3
Image Area	4.8×4.8mm、2.4×2.4mm、1.2×1.2mm、0.6×0.6mm (Sampling：300×300 points)
Dimension (mm)	Stage：320(W)×460(D)×480(H)mm、Controller box：170(W)×250(D)×300(H)mm PC：180(W)×400(D)×370(H)mm、LCD display：380(W)×250(D)×420(H)mm
Weight	24kg approx. (Stage and Controller box)
Power	100VAC, 50/60Hz, 180VA

※Please contact HONDA ELECTRONICS for the further details

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