



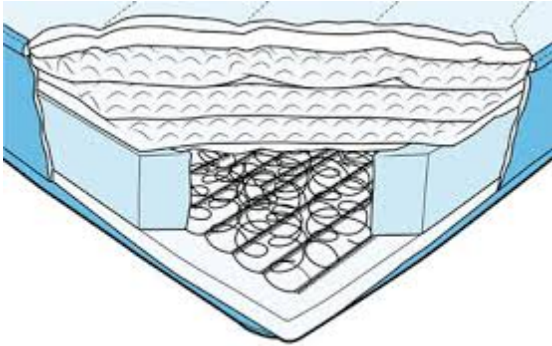
HITACHI
Inspire the Next

Princip RTE SHW

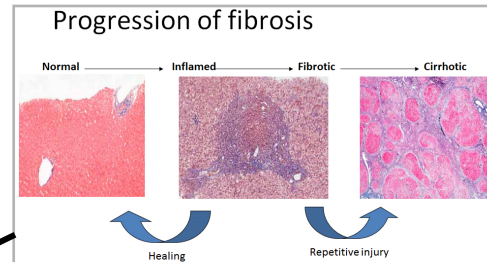
21/02/2019

Kazimierz Kukulski

Different methods of Elastography



RTE



SWM

*Fujimoto K. et al, Oncology 2013;84(suppl 1):3–12

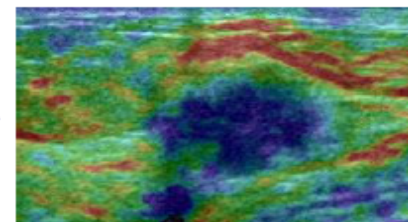
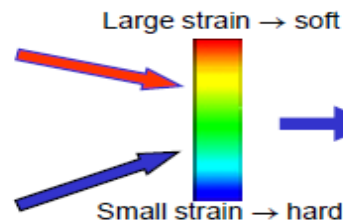
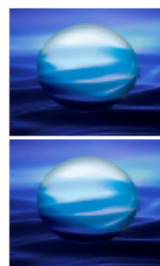
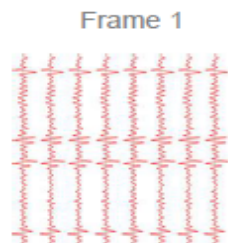
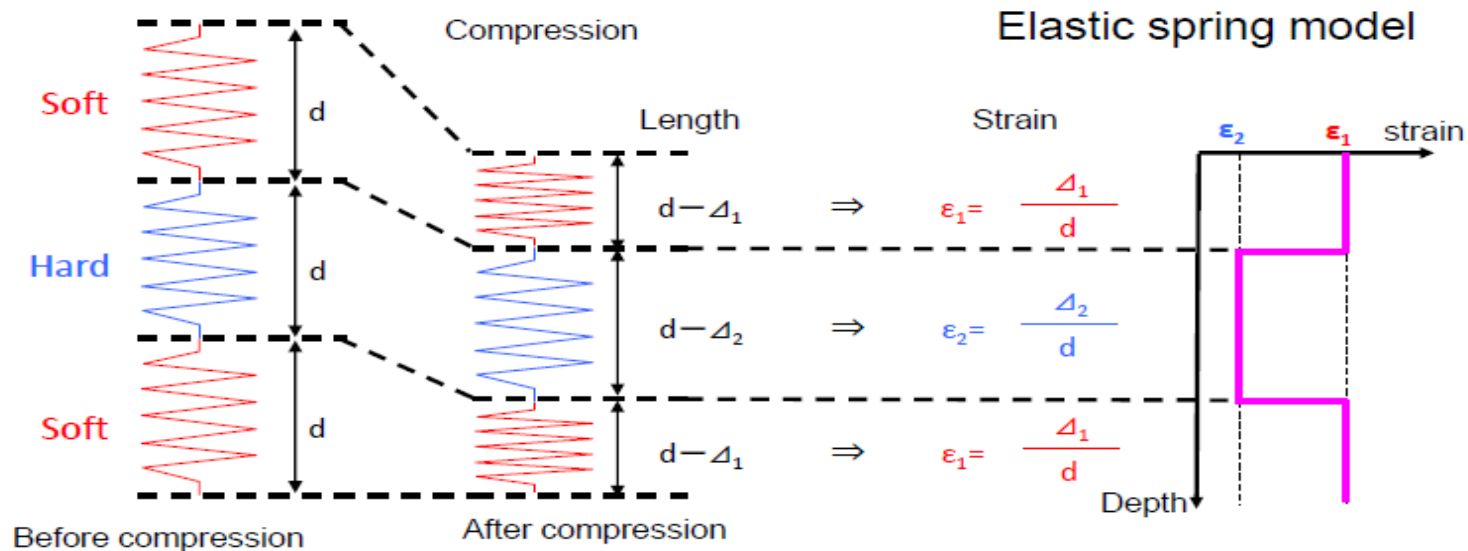
- Elasticity Modulus, E
 - The elasticity modulus is a measure of the stiffness of a given material
 - Defined as the rate of change of stress with strain:

$$E = \frac{\sigma}{\epsilon}$$

σ = tensile stress

ϵ = tensile strain

- Elastography is a term referring to imaging techniques that aim to assess tissue elasticity.
- All methods introduced to date are based on the following three steps:
 - Mechanical force applied to tissue (external or internal force)
 - Measurements of tissue displacements
 - Estimation of tissue stiffness: Qualitative (strain mapping) or Quantitative (estimation of Youngs Modulus in kPa – some assumptions made)



Spatial correlation method

- Can calculate two-dimensional displacement
- Can be used to accurately measure large displacements
- Requires large amount of processing power



Phase domain processing

- Rapid and precise measurement of axial displacement
- Only small displacements ($\lambda/4$) can be detected unambiguously (problem of aliasing)
- High speed processing in real-time

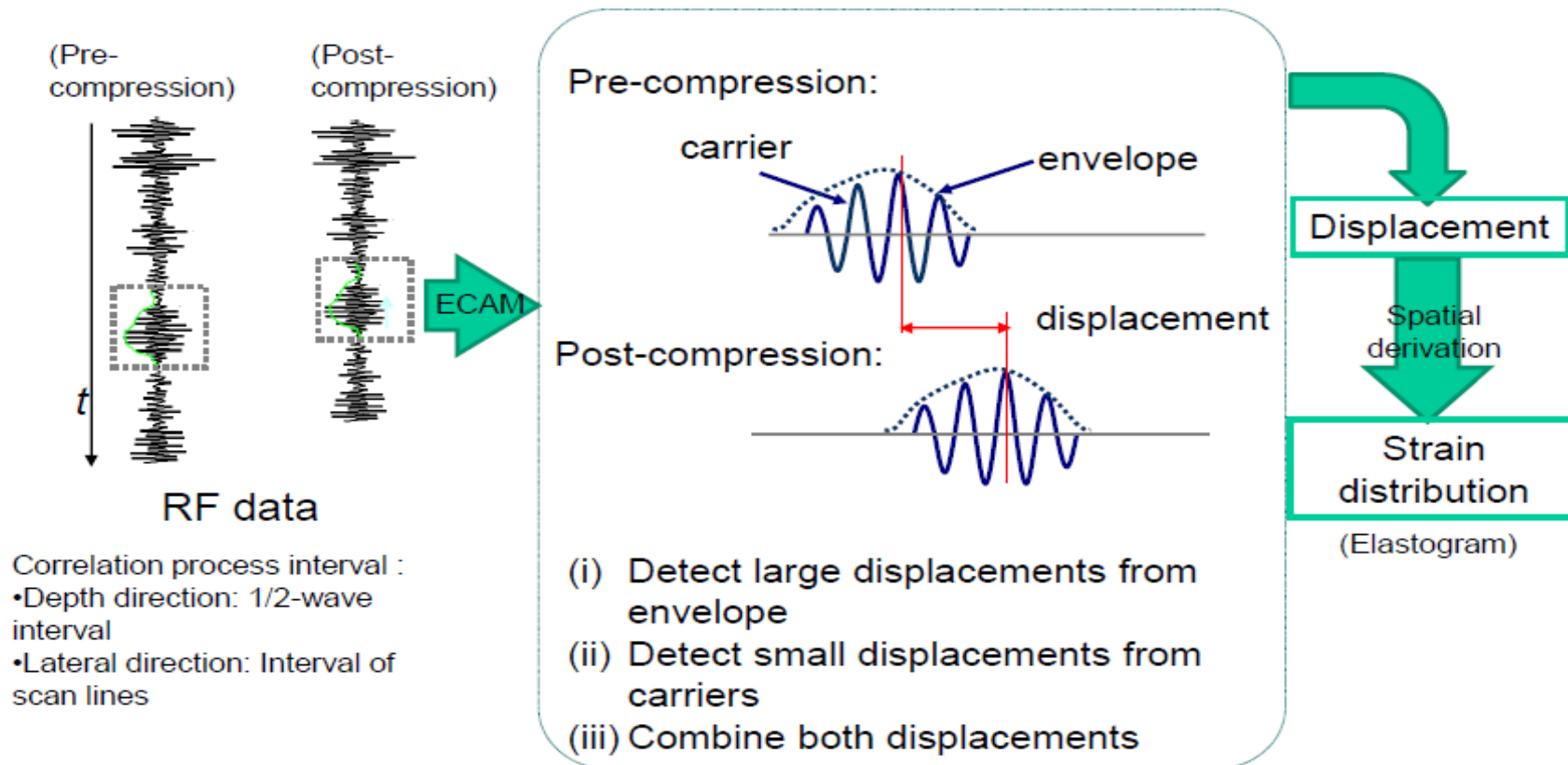


Extended Combined Autocorrelation Method Dr. Shiina, University of Kyoto, Japan

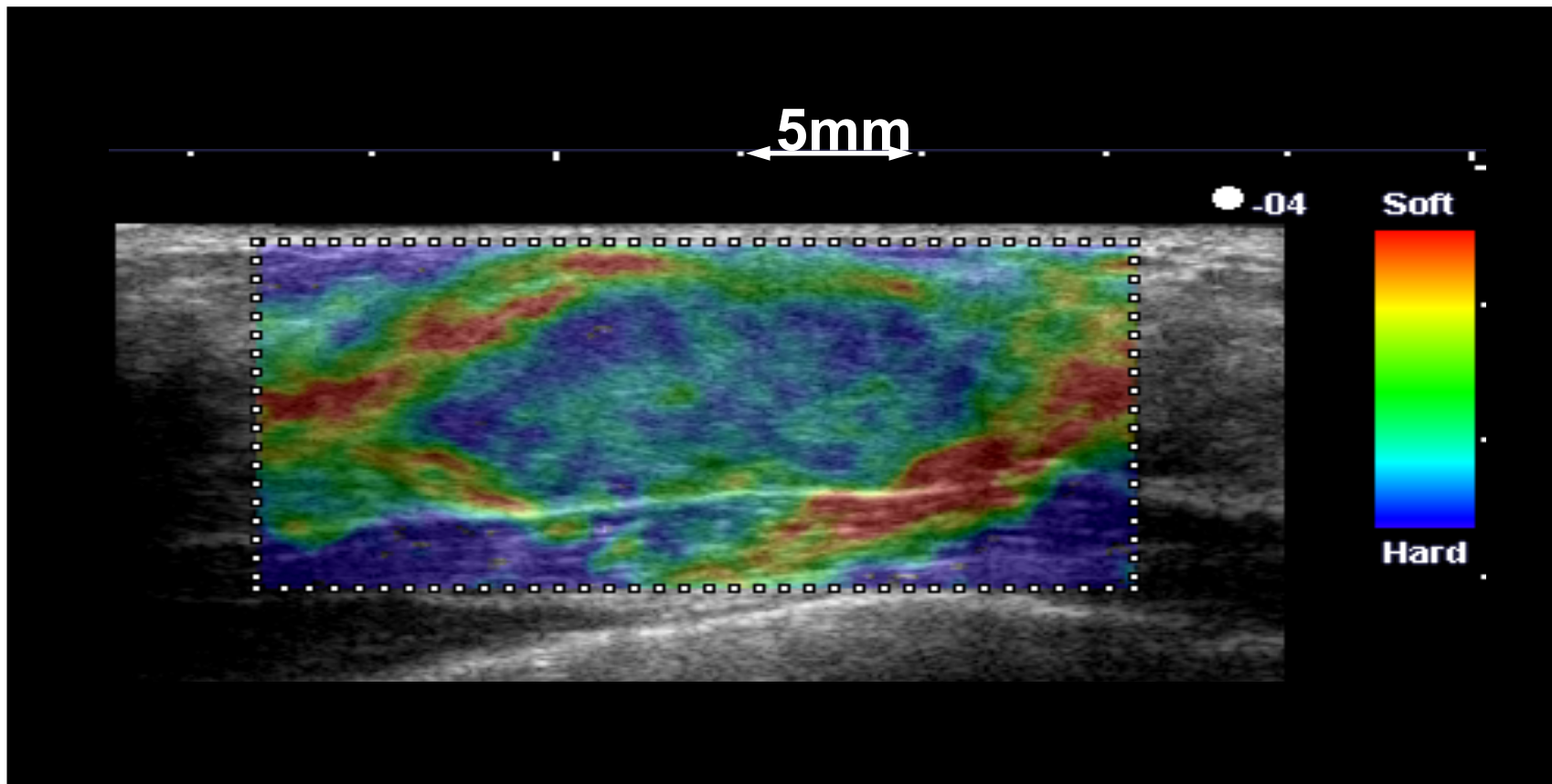
- Can accurately measure large range of displacements -> strain images with large dynamic range for robust measurement (robust to variations in speed or degree of compression)
- Can perform 2-D search in lateral directions using the 2-D correlation to overcome sideslip -> improves accuracy
- Decreases the amount of processing -> strain images in real-time (fast frame rates and large ROIs)

ECAM Strain Calculation Algorithm

Strain Estimation Using the Extended Combined Autocorrelation Method, Yamakawa& Shiina, Jpn.J.Appl. Phys.(2001);40:3872-3876

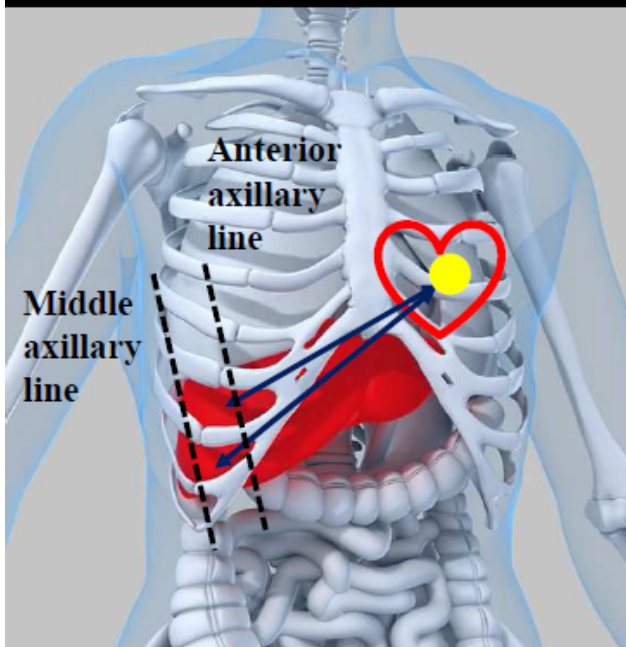


RTE; high: resolution, frame rate, dynamic

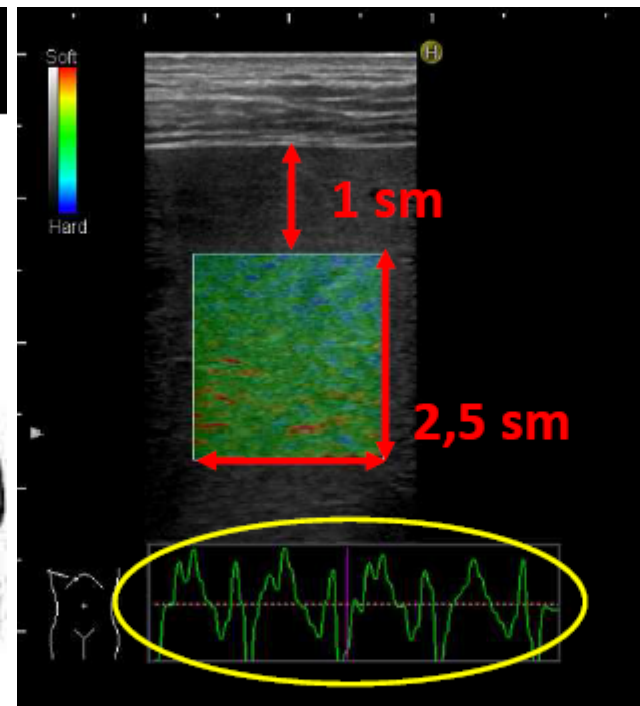
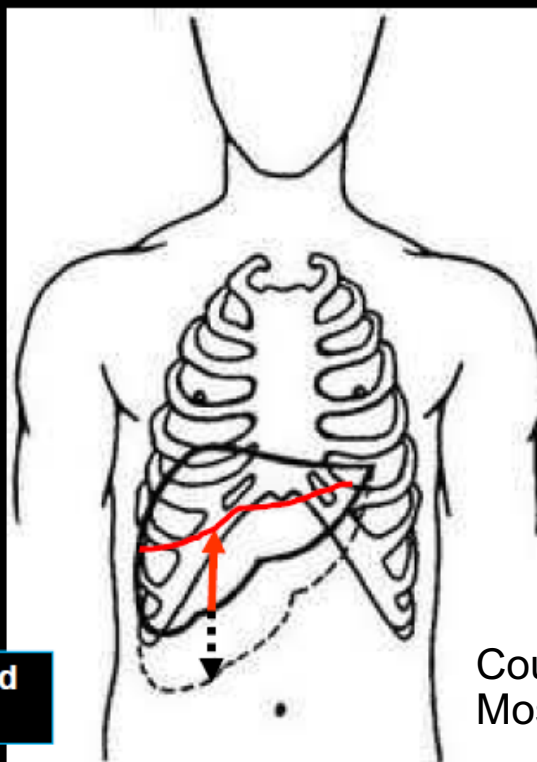


Methodology of RTE in LF evaluation

SCAN TECHNIQUE (in non-atrophic Liver)

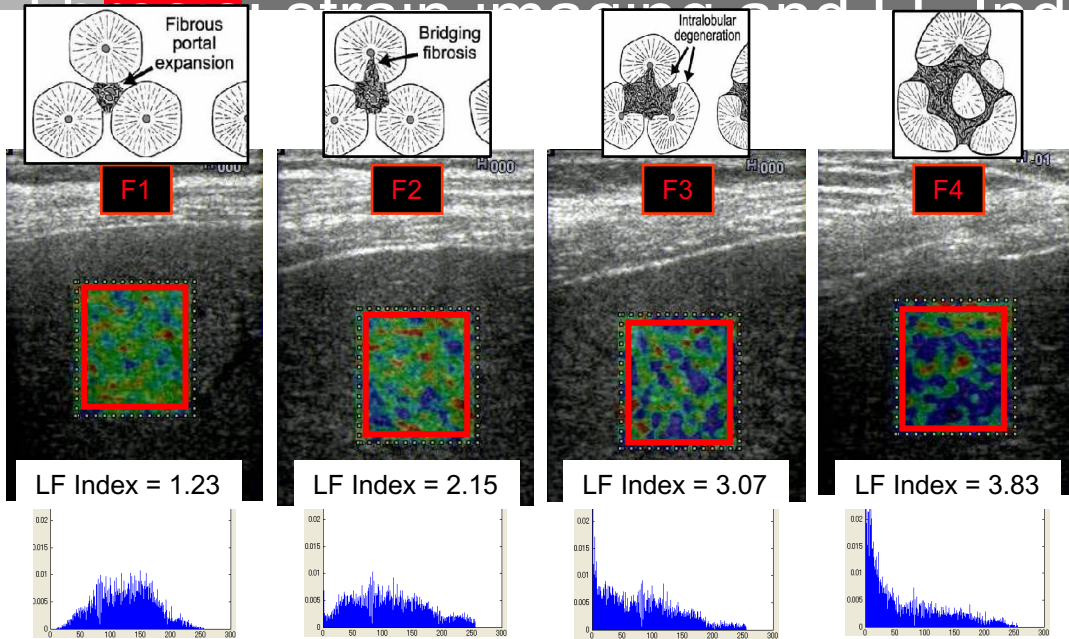


Intercostal space between anterior and middle axillary line (around S5/8)

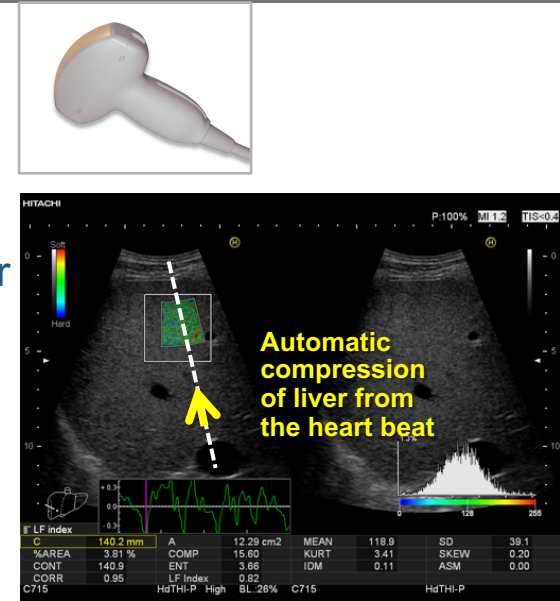


Courtesy: Dr.N.Postnova NVD Hospital Moscow

RTE (Real-time Tissue Elastography)



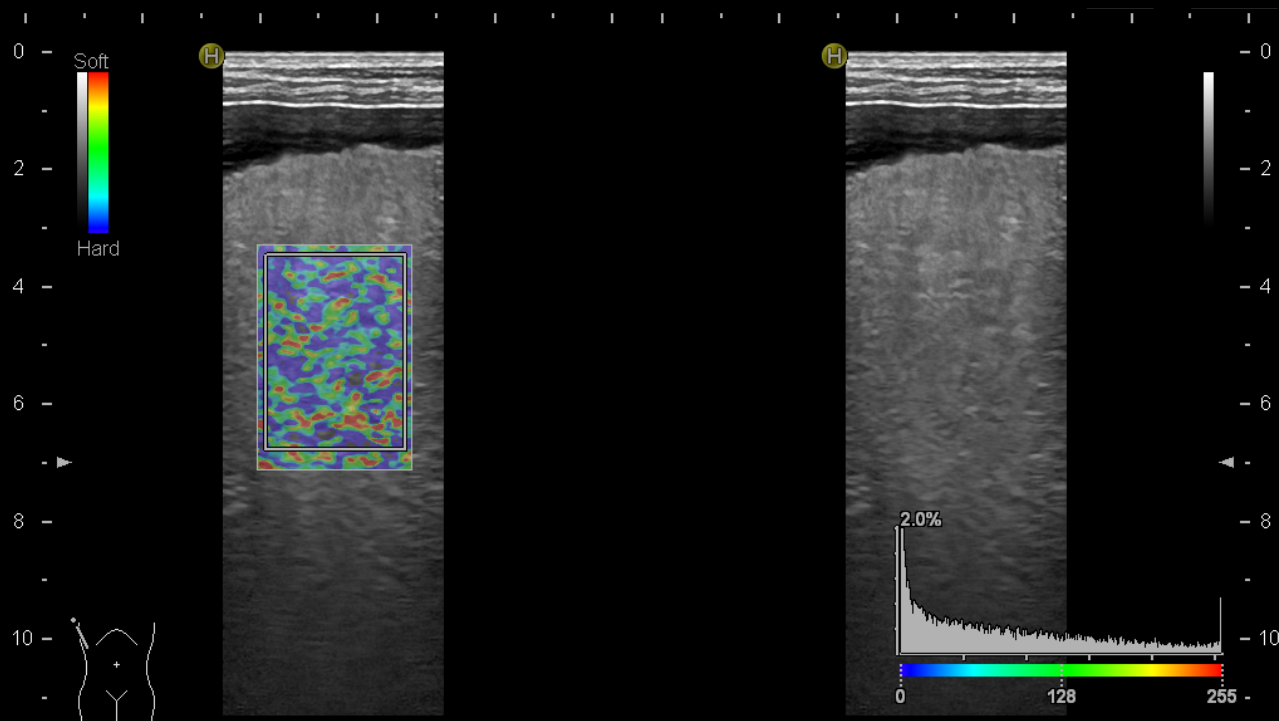
convex
transducer



- Use the same transducer as for B-mode imaging
- Wide FOV enables easy ROI position free from vessel artifacts and rib shadowing
- Good reproducibility
- Very good penetration for difficult-to-image patients

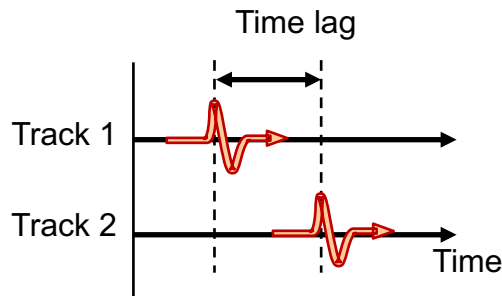
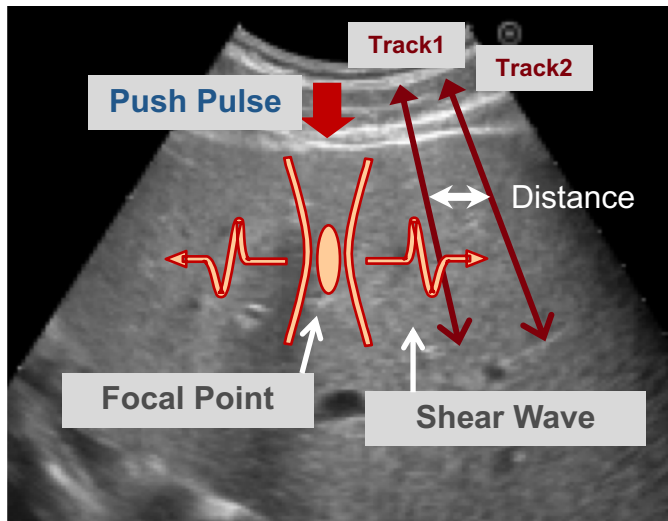
Fujimoto K. et al ; Kanzo 51(9) ; 539-541 (2010)

RTE



Str. Histo					
C	113.9 mm				
A	7.89 cm2	MEAN	74.1	SD	73.2
COMP	64.23	LF INDEX	4.93	%AREA	52.53 %
L52		HdTHI-P Low	BL.:28%	L52	HdTHI-P

SWM (point sheare wave measurement)

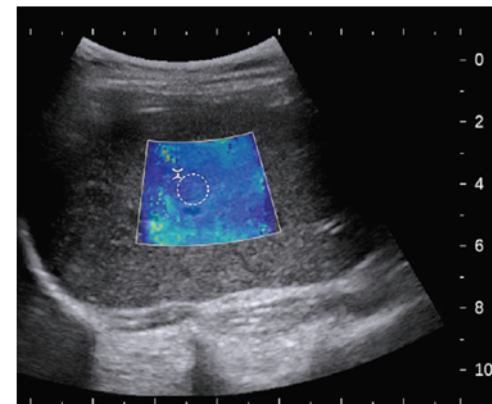
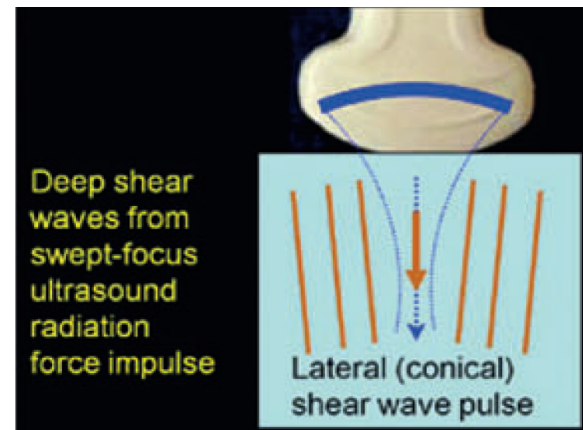
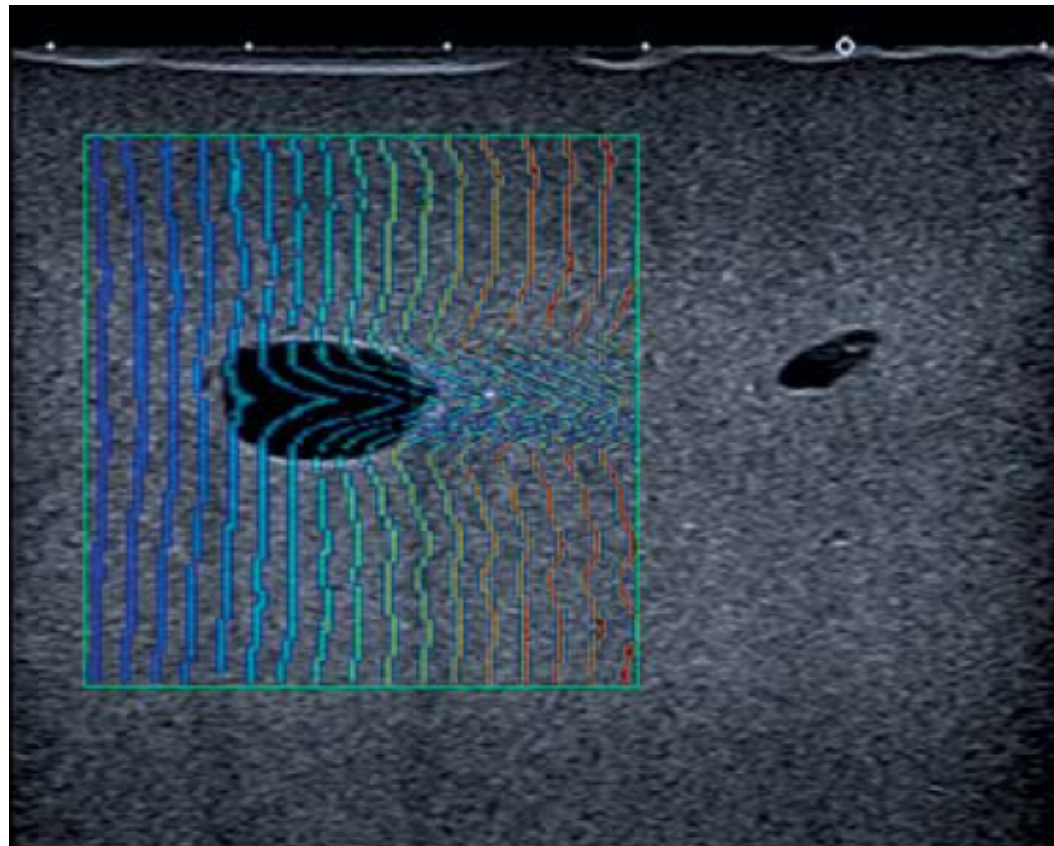


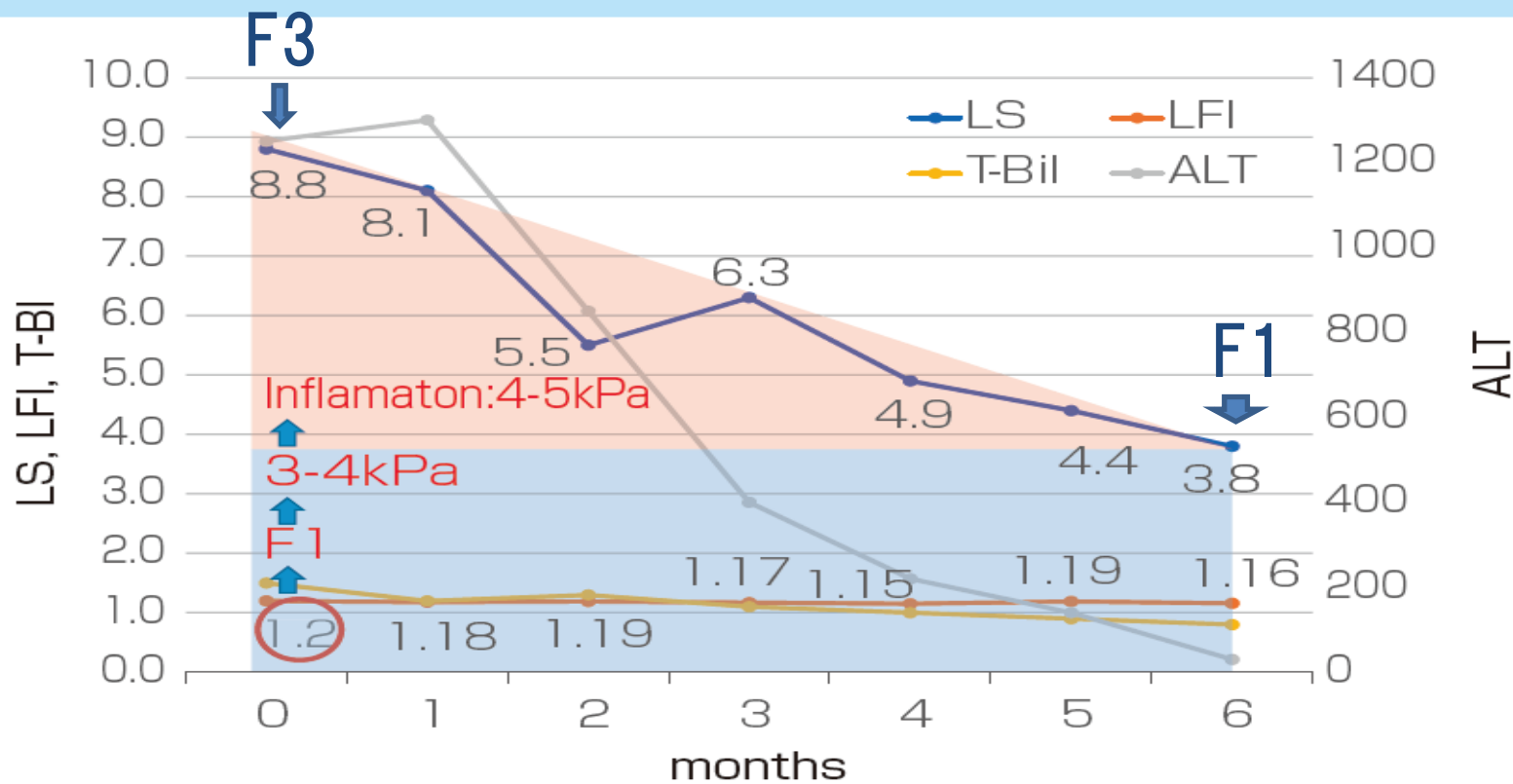
$$V_s = \text{Distance} / \text{Arrival time lag}$$

- Calculate Propagation Speed:
 - Tx. Rx. “**Track Pulse (T1,T2)**” continuously
 - Detect arrival time at each position

V_s (1-10m/s in the tissue) - speed of shear wave is used to estimate Young's Modulus in kPa ($\text{Pa} = \text{N/m}^2$), using the formula $E = 3\rho V_s^2$
(ρ = tissue density, assumed to equal 1g/cm^3 or 1kg/m^3)

Shear Wave Elastography (2D SWE)





HITACHI
Inspire the Next 