# Slides to support subcommittee focusing on the quantification and not imaging: analogy with Doppler

- Telco of June 8th: discussion of imaging versus quantification: we need to focus on Quantification

- This presentation aims at strengthening this point: focus on quantification (versus imaging using the analogy of Doppler) and discuss sources of system dependencies as follows:

- Differentiate ROI definition amongst systems:

    - zone for fibroscan

    - window for Siemens, Philips (others?)

    - ROI defined on an image

- Differentiate SWE methodologies based on the key steps of Elastography:

    - Constraint generation

    - Measurement of displacements and shear Wave velocities

   - Estimation of young's modulus (inverse problem)

Tradeoff for conventional ultrasound imaging: rate of acquisition versus imaging/acquisition area

- **Imaging using transmit and receive focusing: each transmit receive event is imaging one scan line**
- **The higher the number of lines the lower the framerate (zone-rate)**
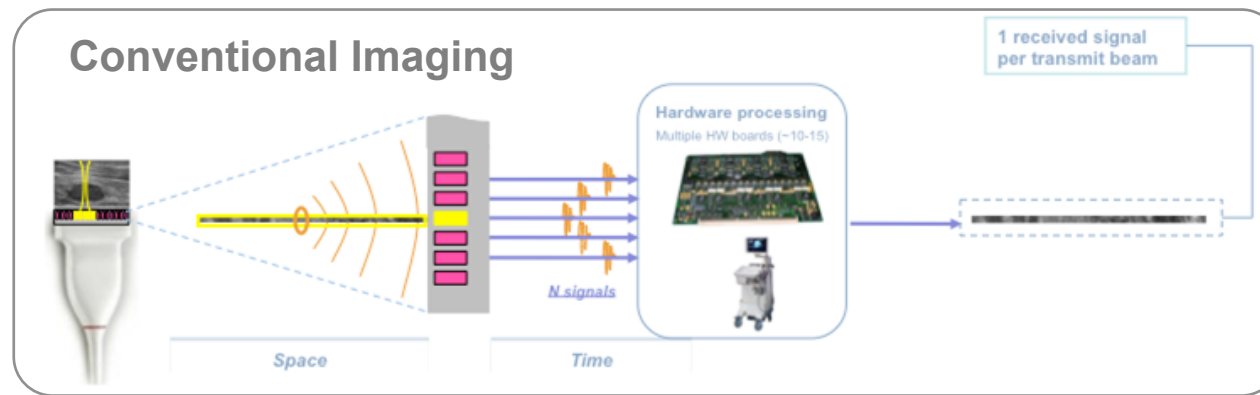
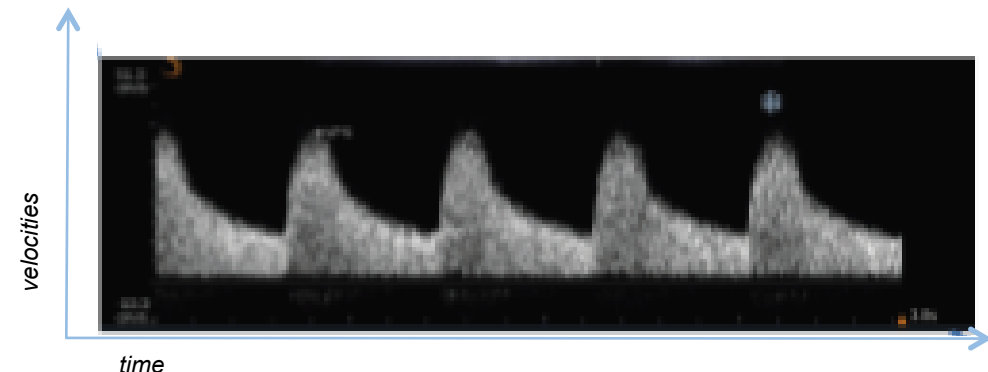*Loop over several (X) lines for Color Doppler at PRF/X (acquisition rate)*

Same scan line fired at PRF (acquisition rate)

Imaging Color Doppler   **OR**   **Quantification of spectrum**
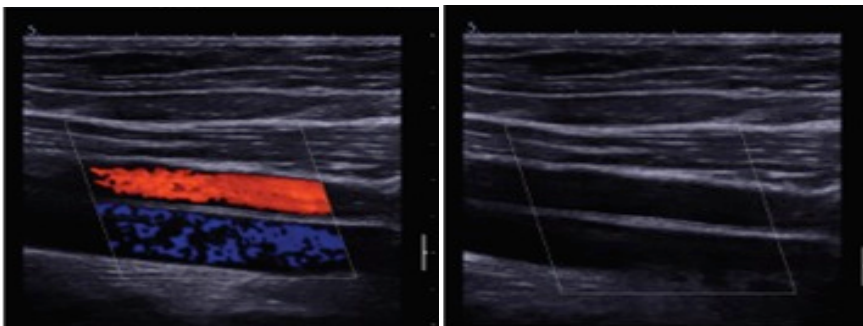
Mean velocity (central frequency) in a colour coded image representation

Quantification of velocity in 1 single location using spectrum analysis

Doppler acquisition requirements depend on velocity estimator

- Mean frequency for Color Doppler using Autocorrelation as an estimator

- Full spectrum for Spectral Doppler: FFT of highly sampled Doppler signal as an estimator

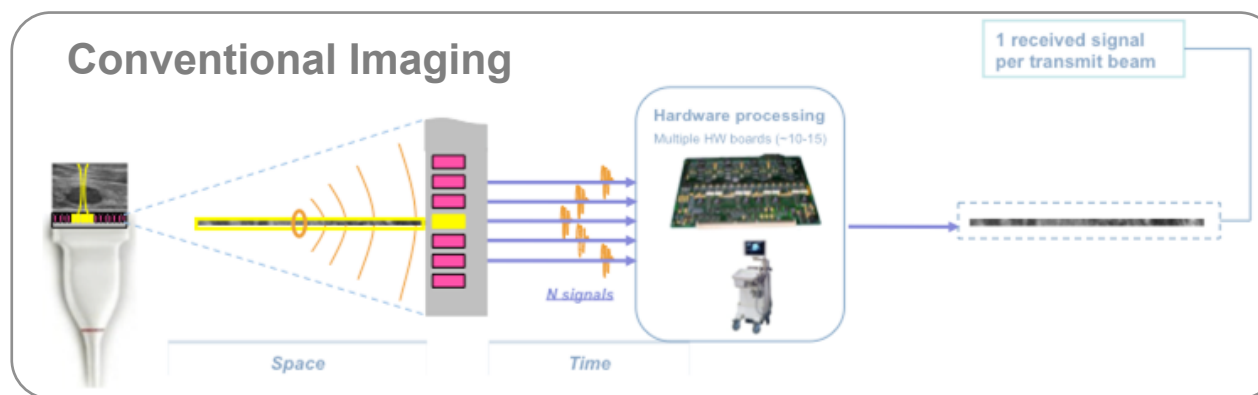- Each estimator requires its specific acquisition protocol

Elastography estimators for static and transient elastography

- Elastography is an indirect method: inverse problem: y = Hx y, observations; x young's modulus

- 2 physical phenomenon: deformation (**static**) under a constraint versus shearwave propagation (**transient**)

- Use of direct measurement y is used for both Static and SWE:

  - Deformation estimates stiffness in a qualitative manner for static Elastography (H is a full matrix)

  - ShearWave velocity estimates stiffness in a quantitative manner for transient Elastography (H is a diagonal)

As long as we measure velocity we donot need to consider inversion of H in the system dependencies.
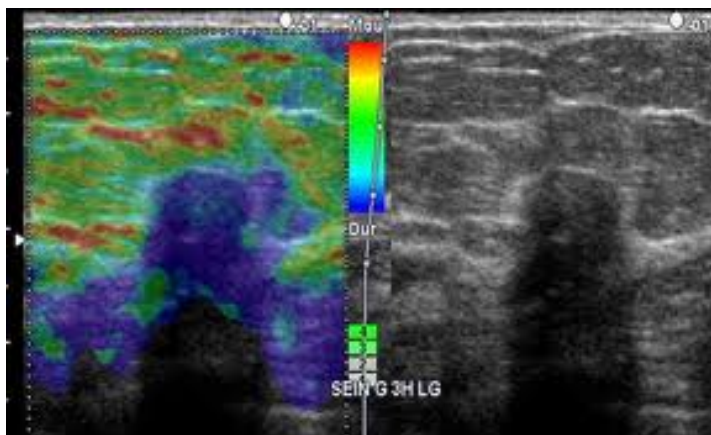
Strain imaging and SWE have different acquisition constraints

- **Rate of deformation can be measured while looping scan lines**
- **Shearwave propagation velocities requires high acquisition rate**

Conventional Imaging

1 received signal per transmit beam

Hardware processing
Multiple HW boards (~10-15)

N signals

Space | Time

Loop over several (X) lines for Static Elastography at PRF/X (acquisition rate)

Same line(s) fired at PRF (acquisition rate) or few lines (4x) scanned at PRF/4

Imaging static Elastography

OR

Quantification of Shear Wave velocity

Strain imaging using derivative of tissue Doppler

Claude COHEN-BACRIE, SuperSonic Imagine
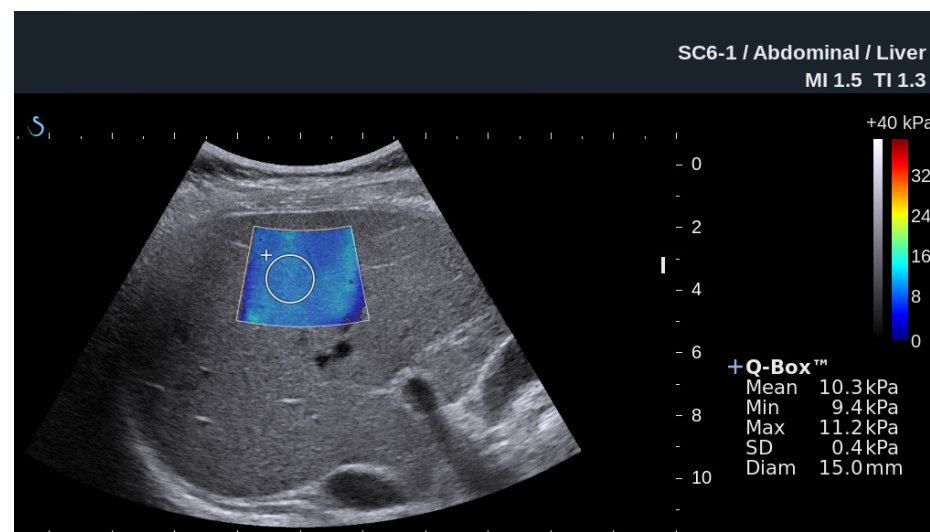
Quantification of velocity in 1 given location

SuperSonic SWE provides imaging AND Quantification
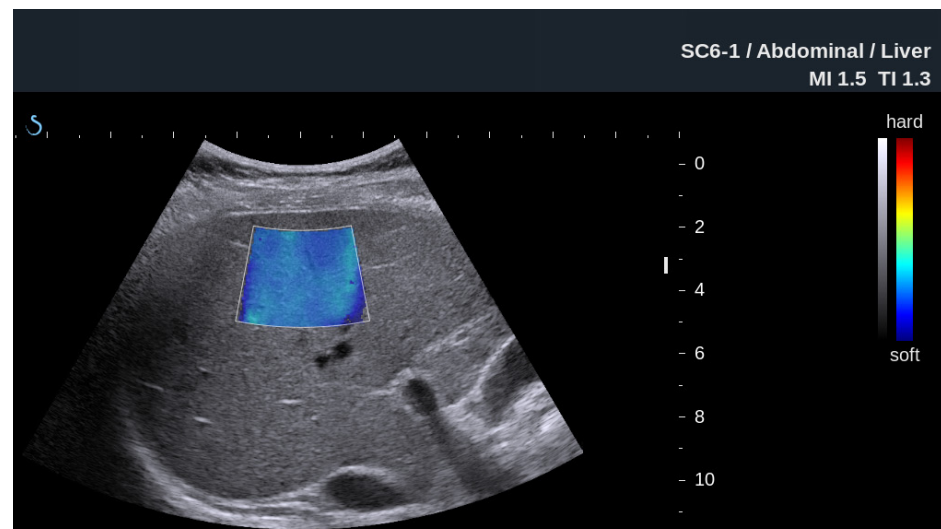
Imaging SWE

AND

Quantification SWE

Q-Box™
Mean 10.3 kPa
Min 9.4 kPa
Max 11.2 kPa
SD 0.4 kPa
Diam 15.0 mm

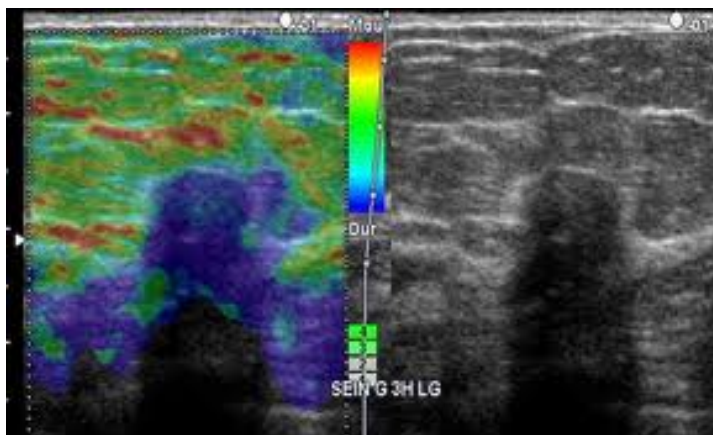*Loop over several (X) lines for Static Elastography at PRF/X (acquisition rate)*

Same line(s) fired at PRF (acquisition rate) or few lines (4x) scanned at PRF/4

Imaging static Elastography

OR

Quantification of Shear Wave velocity

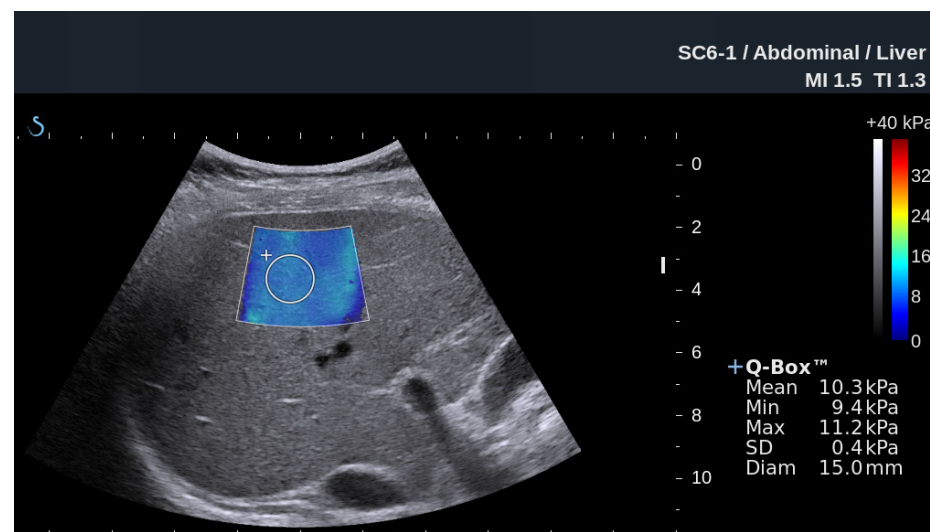*Strain imaging using derivative of tissue Doppler*

Quantification of velocity in 1 given location

Highly parallel imaging overcomes the limits of conventional imaging and tradeoff between imaging and quantification
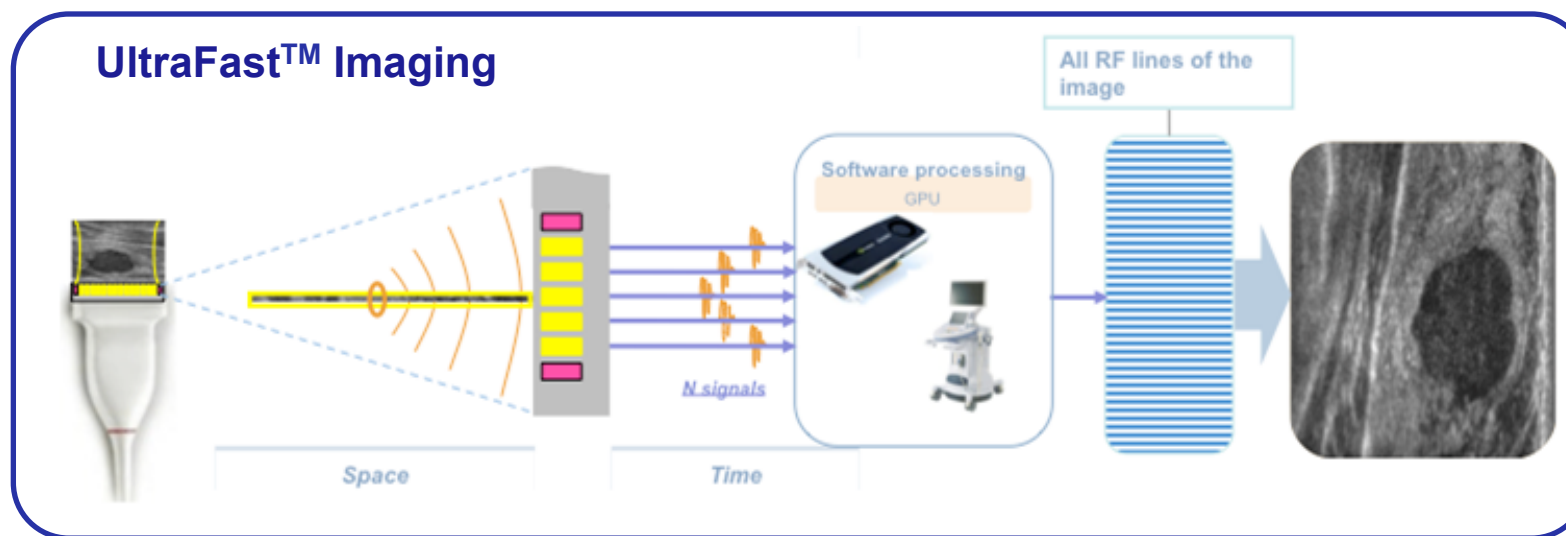

Imaging SWE

AND
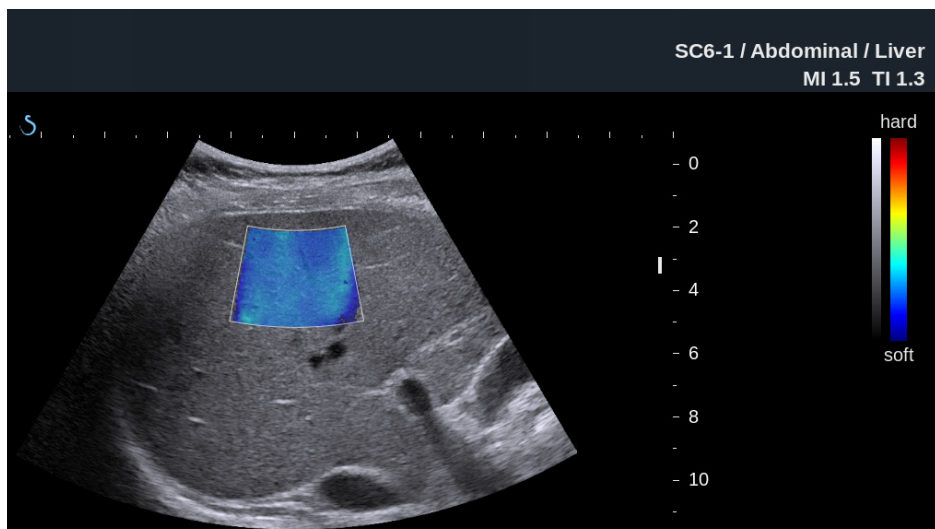
Quantification SWE

Debate and system dependancies should be focused on quantification NOT on Imaging

- Method of measurement depend on

  - Region of Interest definition

    - zone for fibroscan

    - window like spectral window

    - ROI defined on an image

  - SWE methodology

    - Constraint generation: pushgeneration; frequency content; source geometry; temporal length; impulsive; repeated, modulated; , Etc..

    - Measurement method

      - Scanning method: (scan lines (conventional imaging), zone acquisition (Fibroscan), multiline or ultrafast imaging); PRF, spacing of tracking beams, etc..;

      - Displacement measurement method (tissue Doppler methods)

      - Shear wave velocity estimation (correlation, etc..)

    - Estimation (if conversion in kPa) or not (ShearWave Velocity) which depends on Wave Physics model (assumptions on shear wave propagation)

- Recommendation to use these categories to list system dependencies in an exhaustive way