



LOGIQ™ E10

Liver Shear Wave Elastography Guide

Simple guide for the set up, performance, system options and troubleshooting steps for a successful liver shear wave examination.

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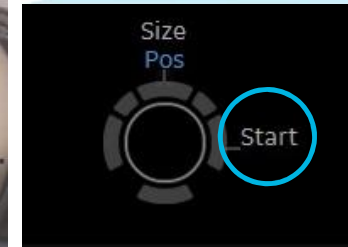
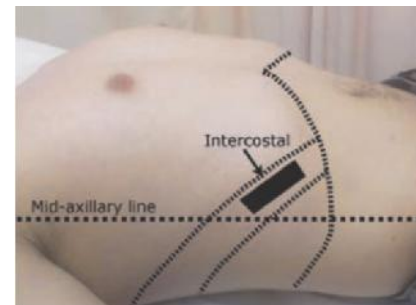
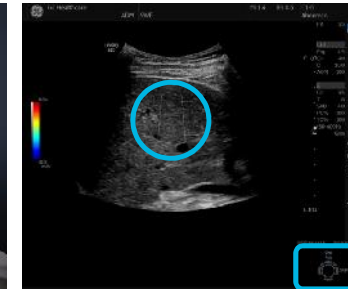
Starting the Shear Wave exam

Shear Wave Elastography is an imaging mode which quantifies tissue stiffness by measuring the speed of Shear Waves in tissue. Shear Wave provides a quantitative measurement for stiffness in the liver which can be used as a marker for Fibrosis. This is a noninvasive quantification technique for tissue stiffness and has the potential to be useful in diagnosis, staging and management of diseases associated with changes in tissue elasticity.

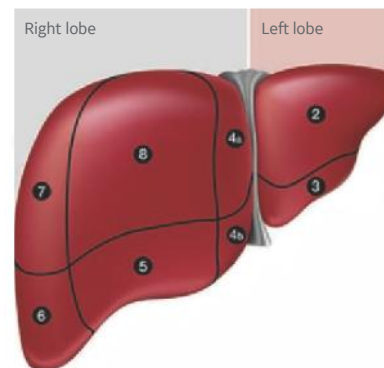
Scanning technique for best Shear Wave results

- Fasting 4-6 hours
- Utilize supine position (obtain slight left lateral decub as needed)
- Elevate right arm above head
- Scan intercostally with enough pressure to maintain stable contact
- Take measurements in segment 7 or 8 of the liver
- Place top of Shear Wave box 1-2 cm below liver capsule with middle of the Shear wave box between 3-6 cm for best results
- Avoid rib shadows
- Avoid vessels in the Shear Wave box
- Obtain measurement on suspended breath hold, not inspiration
- Acquire 10 measurements

Note: Shear Wave Elastography may be performed on patients with ascites.



Anterior surface



Note: Select right trackball key.

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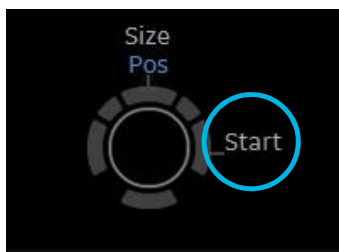
System use

Shear Wave workflow with Auto Measure “off”

Shear Wave is activated by using the Elasto hard key located on the keyboard. Shear Wave Elastography is available on the C1-6 and C1-6VN probes.



1. Select probe
2. Select Elasto hard key on the keyboard
3. Locate optimal intercostal window for Shear Wave Box placement
4. To start Shear Wave, select the right trackball key to start (Real-Time Shear Wave Elasto acquisition will begin)



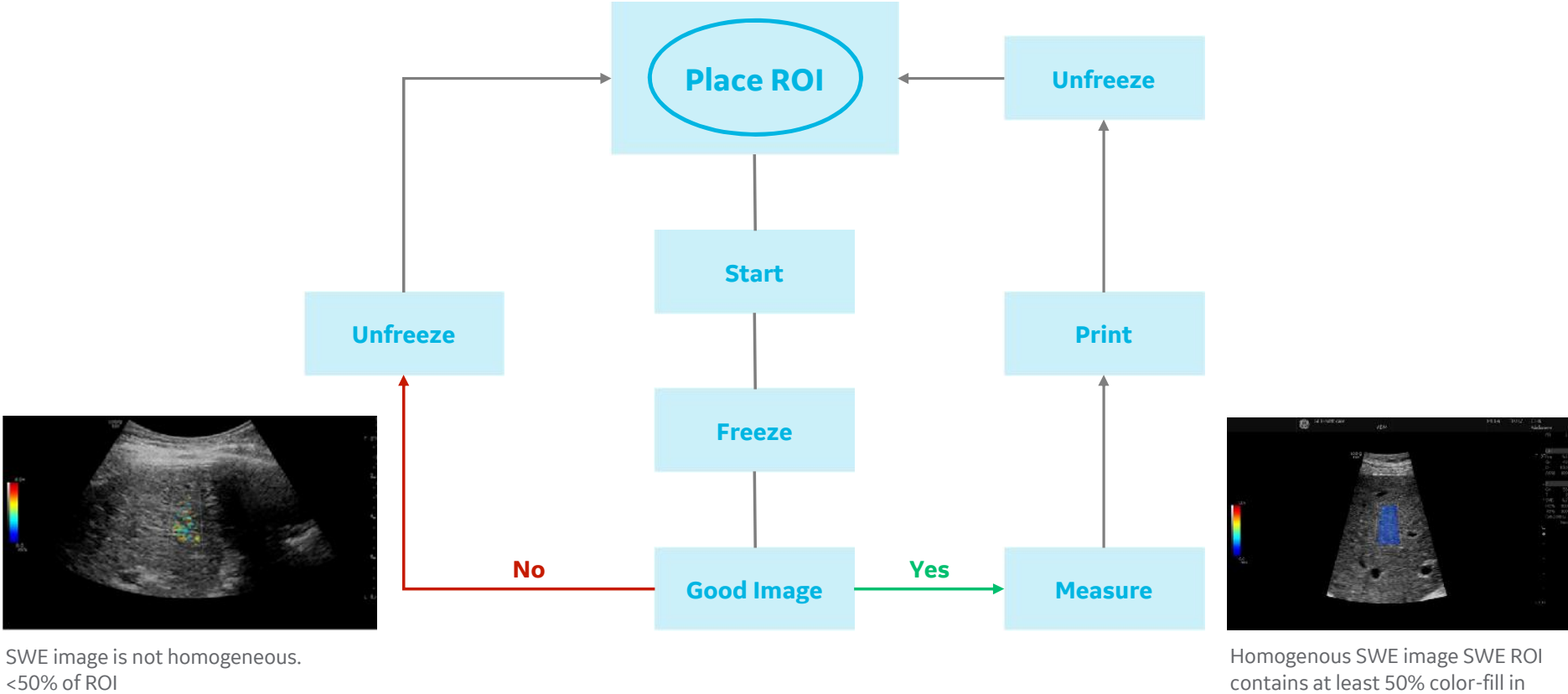
5. Select “Freeze” after the Shear Wave color image appears
6. Measurement caliper will display within the color-coded Shear Wave Box
7. Use Caliper and set keys adjacent to trackball to change placement or size of the measurement ROI, if desired
8. To save the measurement, select “Set” adjacent to trackball



9. Print image
10. Unfreeze
11. To continue Shear Wave acquisition, select the right trackball key re-start
12. Take additional measurements as needed

Note: If measurement ROI does not appear, select measure to activate. Measurements will be saved to the Abdominal Worksheet.

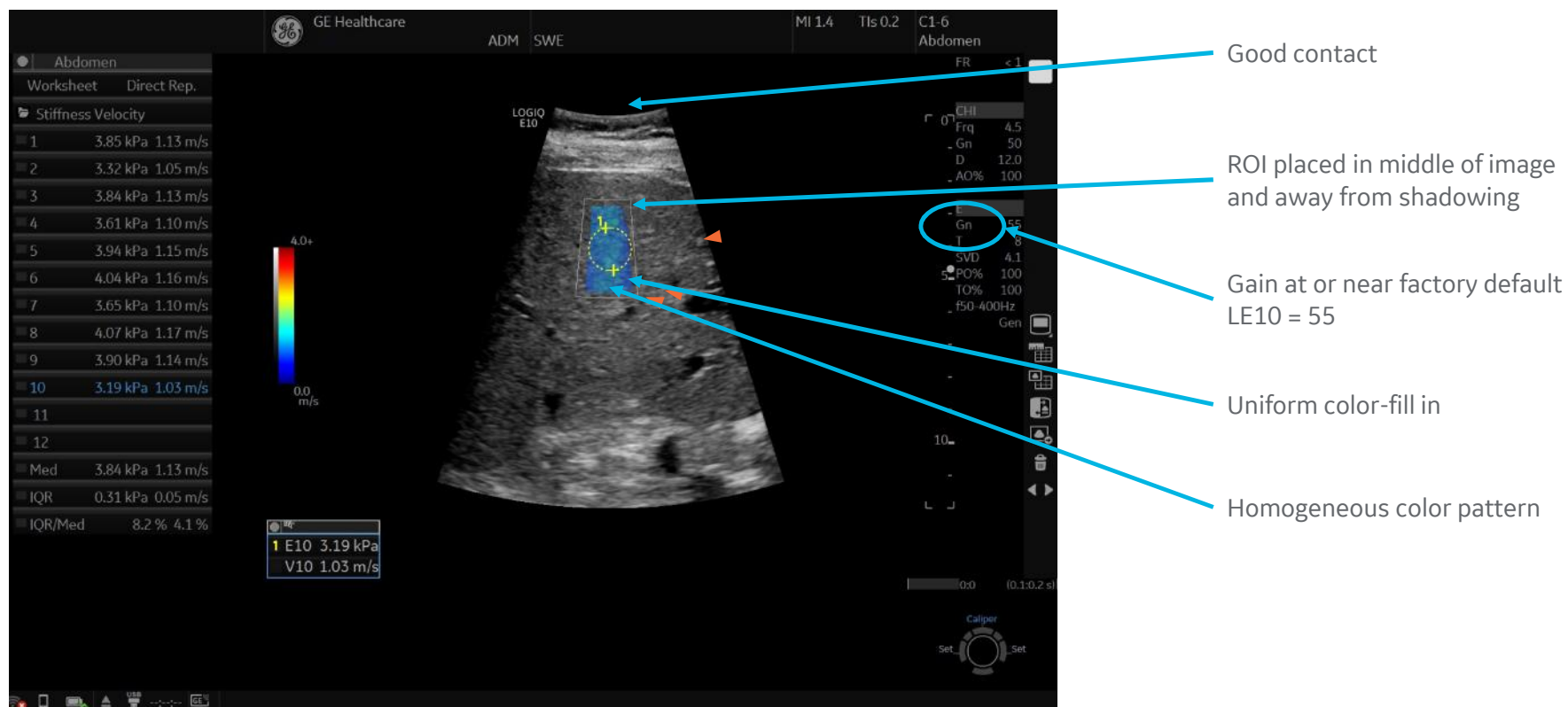
Shear Wave workflow



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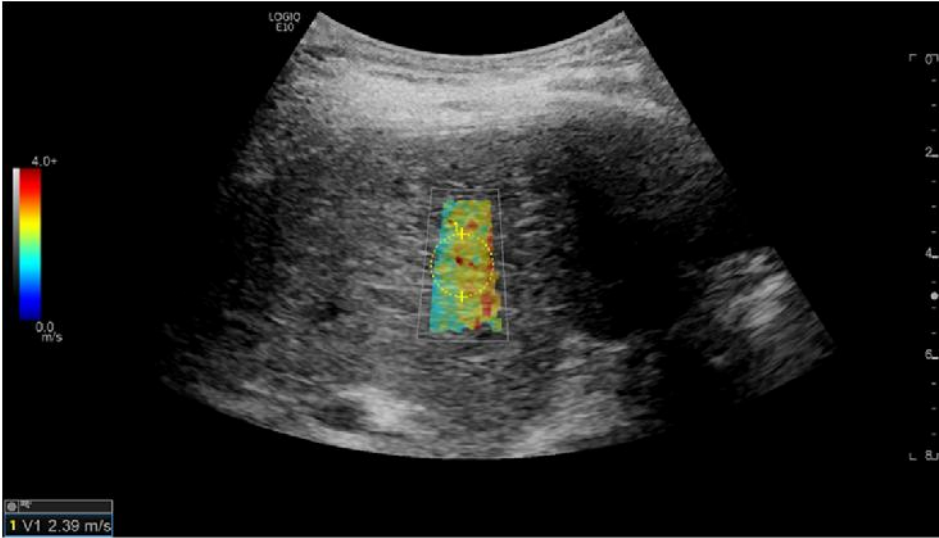
Placing Shear Wave Color Box

Example of a good Shear Wave Color image



Placing Shear Wave Color Box

Good sample



Homogenous color seen within the Shear Wave Color Coded Box

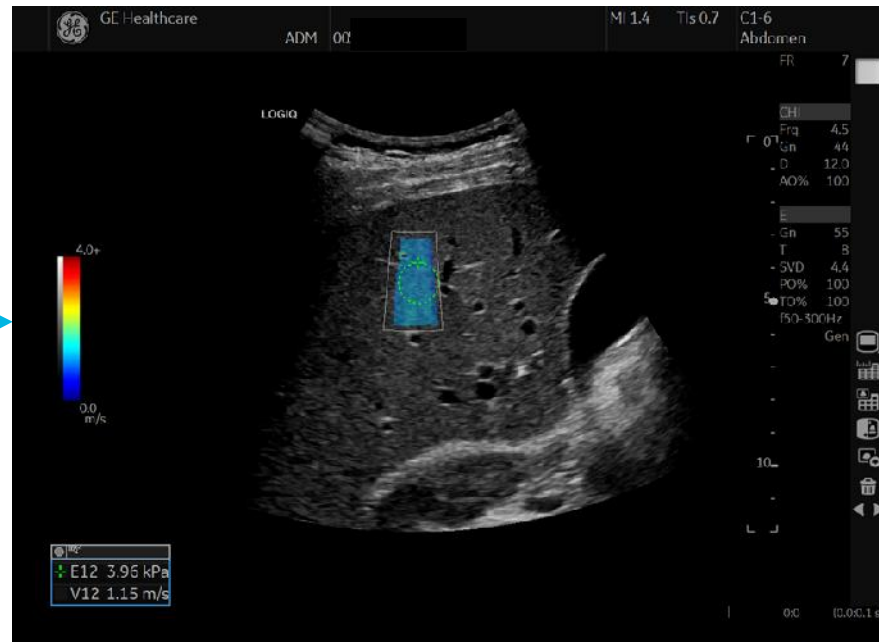
Bad sample



Color is pixelated and not homogenous. Inadequate contact. Measurements taken will be inaccurate in this example

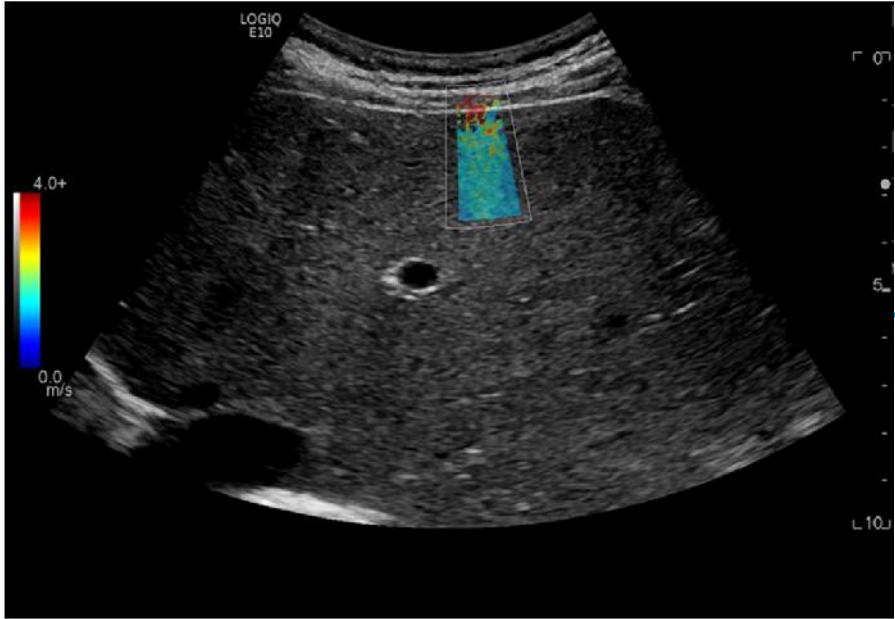
Placing Shear Wave Color Box

Avoiding vessels

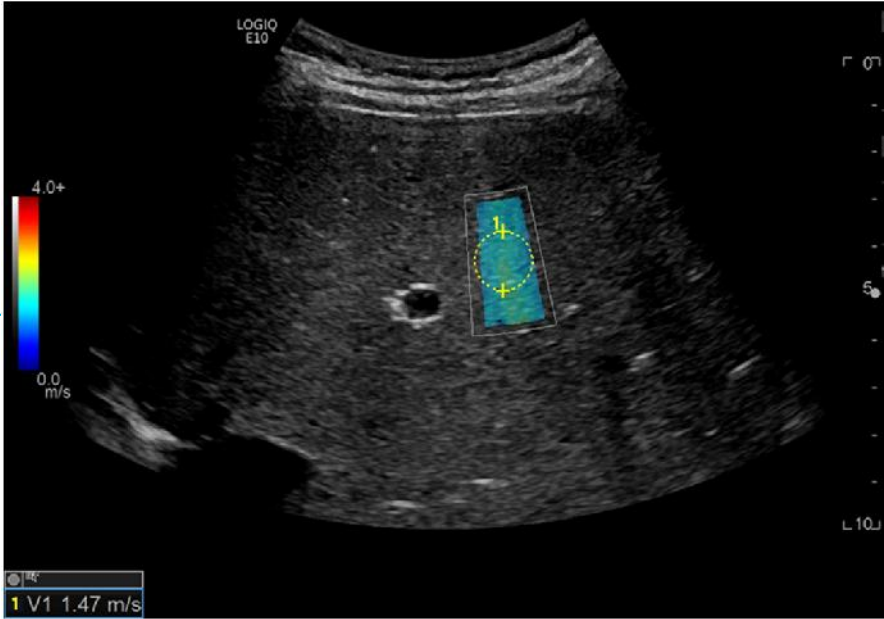


Placing Shear Wave Color Box

Distance from capsule



Stiff region over capsule



Adjust top of Shear Wave Color Box at least 1-2 cm below capsule

Placing Shear Wave Color Box

Effects of a higher BMI

Difficult-to-image patients (high BMI, stiff liver) are associated with increased risk of unreliable measurements. Do not attempt to increase color-fill by increasing the gain as this is likely to lead to inaccurate measurements.



Poor Shear Wave signal



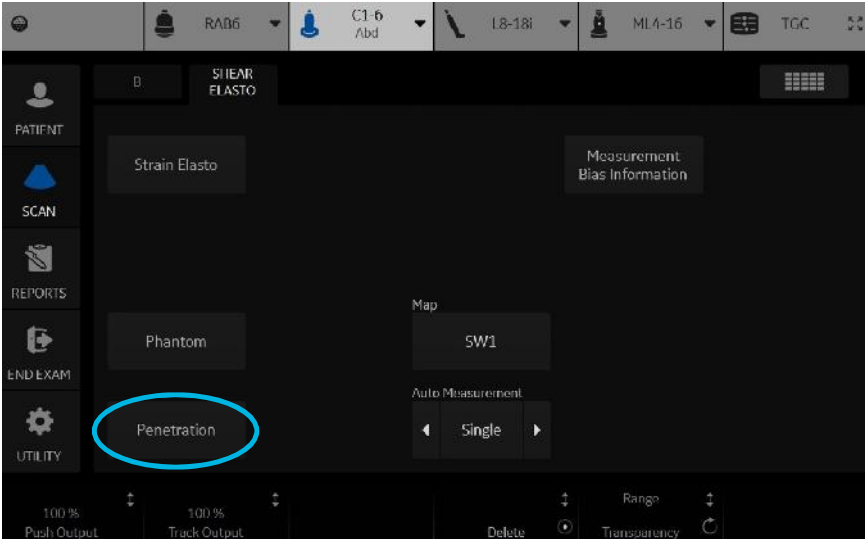
Do NOT increase color-fill

Note: Keep Color Gain at factory default. DO NOT INCREASE.

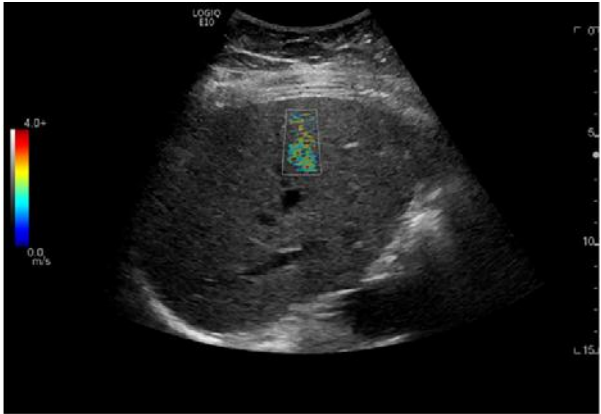
Placing Shear Wave Color Box

Effects of a higher BMI

Using the penetration setting, placing the ROI near the center of the image laterally, and placing the ROI shallow (approximately 4-5 cm deep) will help to increase color-fill. If you only get some color fill but it is homogenous, you can take a measurement in this area.

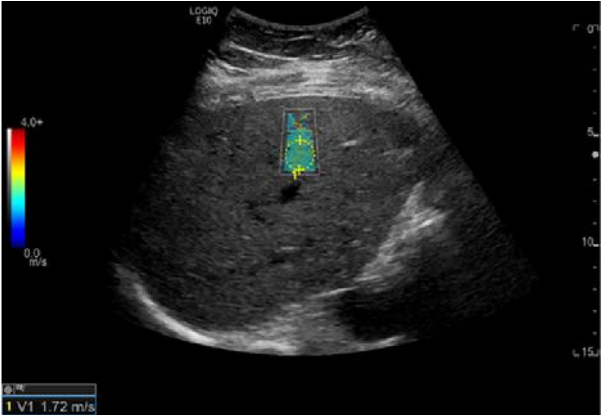


BMI = 46.6



Bad sample: Very pixelated color map/thick abdominal wall.

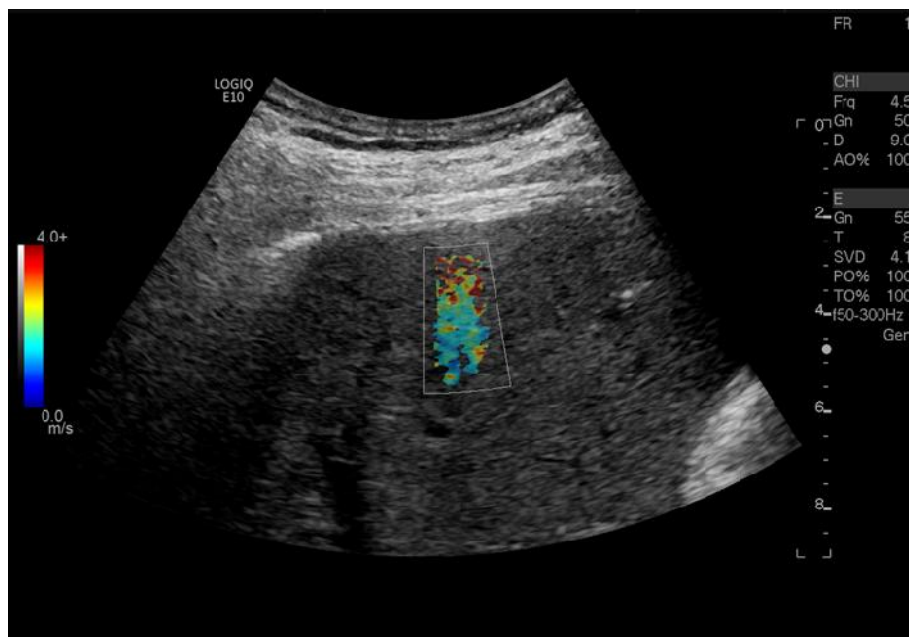
BMI = 46.6



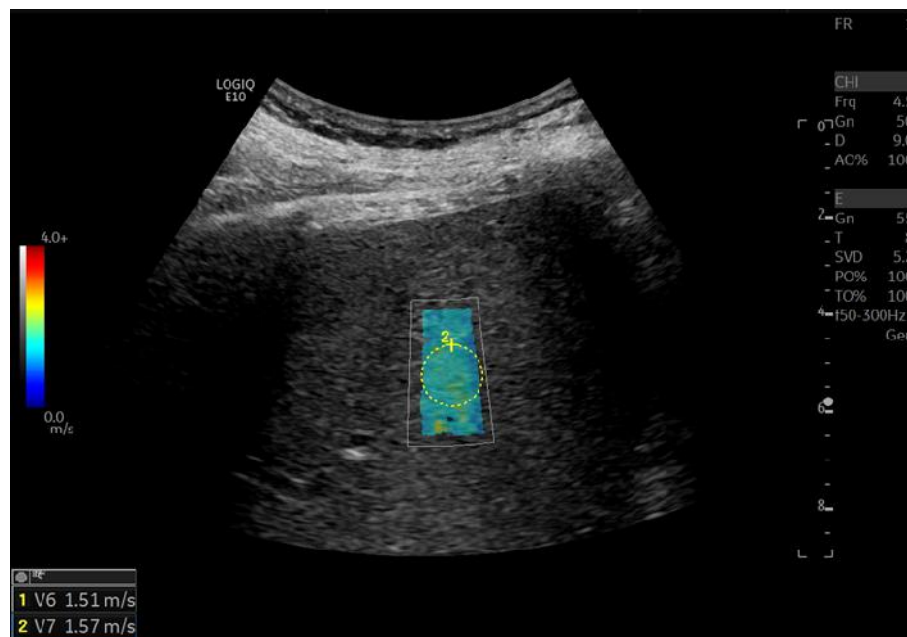
Good sample with penetration mode: Good homogenous color and color-fill in.

Placing Shear Wave Color Box

Low Shear Wave signal



The Color Box is not filling due to poor Shear Wave signal



Changing the sample window may improve the quality of the sample

Shear Wave Color Box tips

DOs

- ✓ Ensure good probe contact with patient and optimize imaging window to get best possible B-Mode image quality before starting SWE acquisition
- ✓ Place ROI in shadow-free region
- ✓ Place ROI near center of image (laterally) if possible
- ✓ Place ROI in region free of vessels and away from liver capsule

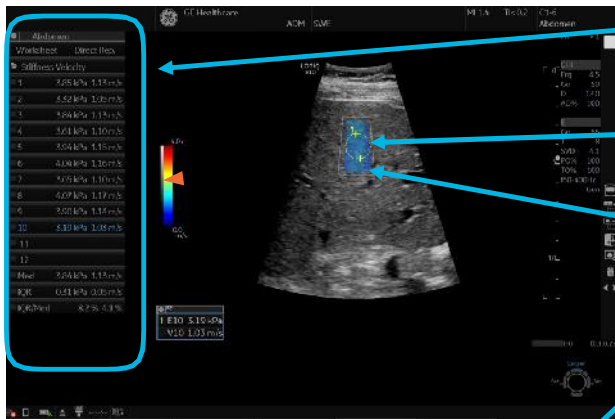
DON'Ts

- ✗ Place ROI near B-Mode shadow artifacts
- ✗ Place ROI near extreme left or right edge of image
- ✗ Change any image parameters during Shear Wave acquisition

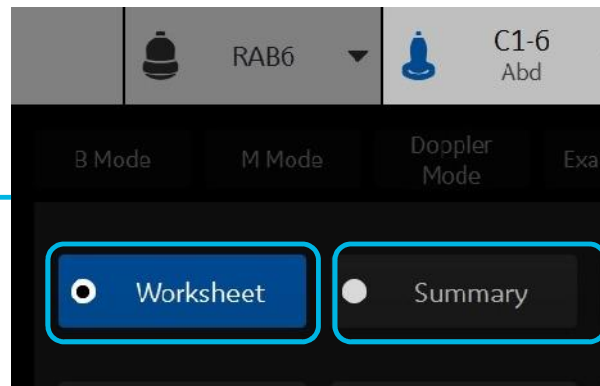
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Measurement technique

Example of good Shear Wave



Parameter	Value	m1	m2	m3	m4	m5	m6	Max/Min
RM Mode Measurements								
V (m/s)								
V1	1.13	1.24						List
V2	1.05	1.05						List
V3	1.14	1.13						List
V4	1.10	1.10						List
V5	1.15	1.35						List
V6	1.16	1.38						List
V7	1.10	1.10						List
V8	1.17	1.17						List
V9	1.14	1.14						List
V10	1.05	1.03						List
V Median	1.13							
V IQR	0.09							
V IQR/Median	1.1							



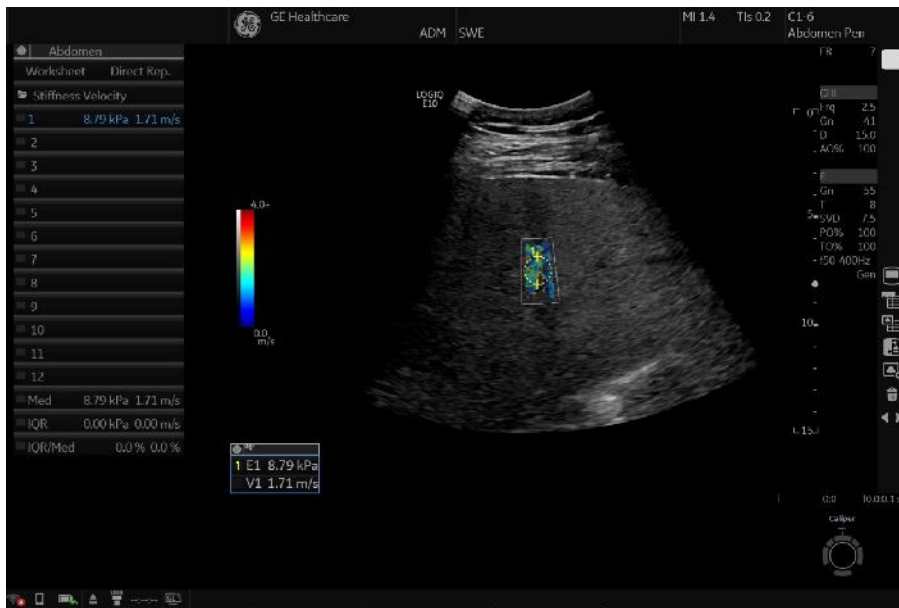
Note:

- In the case that more than one measurement is taken, as best practice, do not overlap measurements
- It is acceptable for the Measurement ROI to extend outside of the Color Box. This does not affect measurement

Shear Elastic	S.E	S.W
Med	3.81 kPa	1.13 m/s
IQR	0.33 kPa	0.05 m/s
IQR/Med	8.7%	4.4%
1	4.00 kPa	1.15 m/s
2	3.33 kPa	1.08 m/s
3	3.04 kPa	1.15 m/s
4	3.63 kPa	1.10 m/s
5	2.94 kPa	1.13 m/s
6	4.00 kPa	1.18 m/s
7	3.63 kPa	1.10 m/s
8	4.00 kPa	1.13 m/s
9	3.40 kPa	1.14 m/s
10	3.15 kPa	1.03 m/s
11		
12		

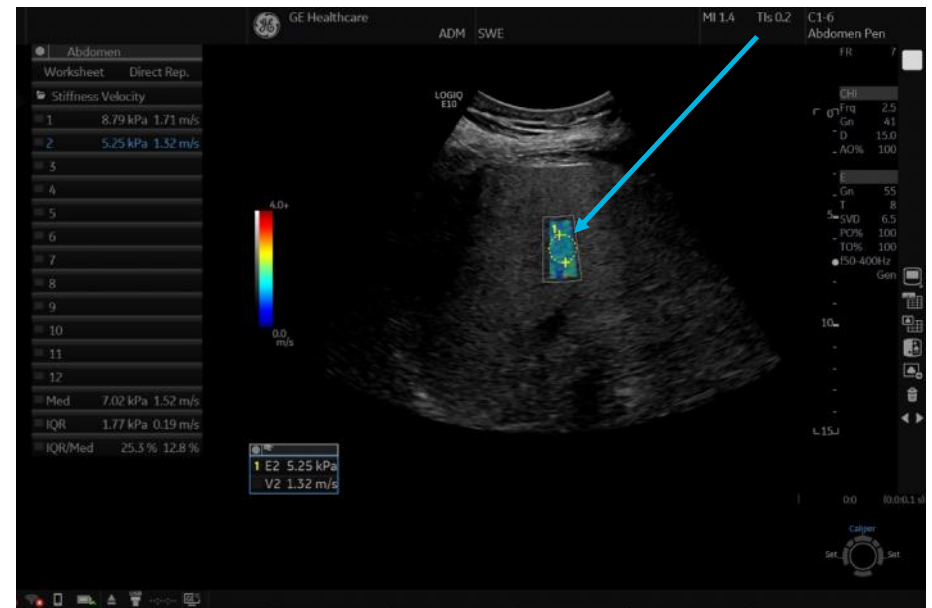
Placing measurements ROI

Don't measure



Very pixelated area without uniform color. Note the very thick abdominal wall

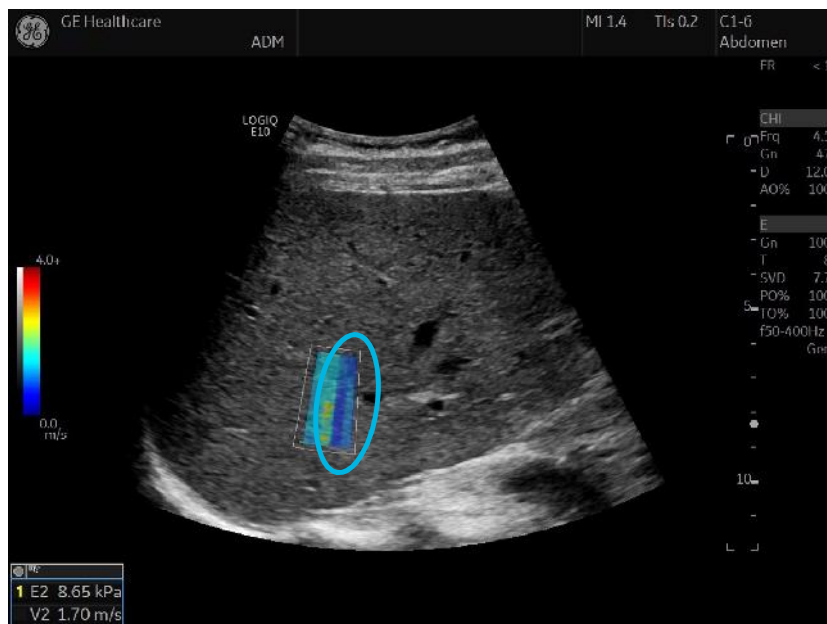
Measure



Changing the window may improve Shear Wave signal. If artifact is present in the image, measure around artifact. In this case, there is good uniformity in the lower half of the Shear Wave Color Box

Placing measurements ROI

Effects of motion



Vertical lines



Adjust measurement ROI when vertical lines are present

Note: Motion may be due to patient or user motion.

Placing measurement ROI tips

DOs

- ✓ Take measurement when >50% of ROI has color-fill with default gain (55)
- ✓ Take measurement on region with uniform color-fill

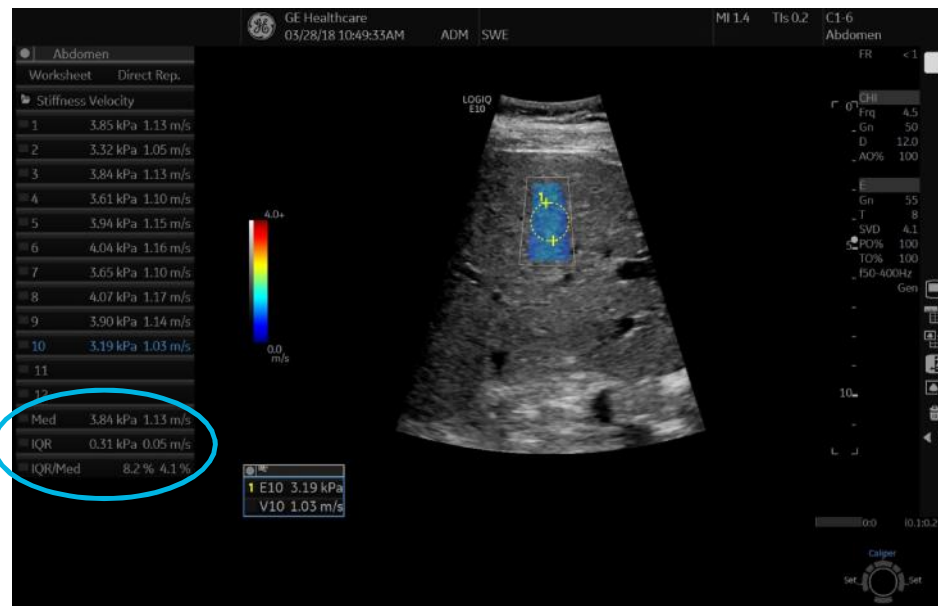
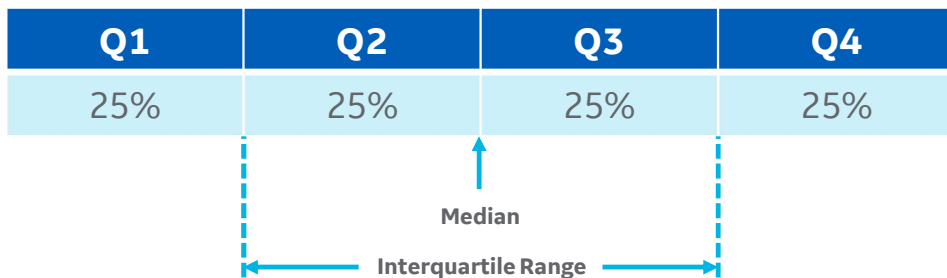
DON'Ts

- ✗ Take measurement when <50% of ROI has color-fill with default gain
- ✗ Increase the SWE gain to force color-fill if there is inadequate fill-in
- ✗ Take measurement on region with speckled non-uniform color

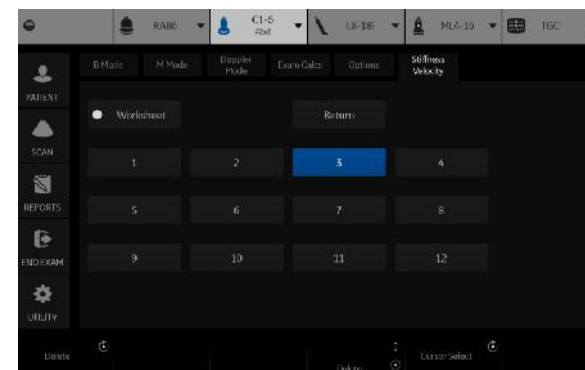
Calculation options

Effects of motion

- **Mean:** Average value of all the measurements
- **Standard Deviation:** Amount of variation in the measurements
- **Median:** Measurements are put in order from smallest to largest, then the middle one is taken for the median indicating the typical value of all measurements taken
- **Interquartile Range (IQR):** This discards the lowest 25% and highest 25% of measurements. The variability is then given based on the remaining values (similar to standard deviation)



Note: Mean and standard deviation are available as part of display options.





Tips to remember

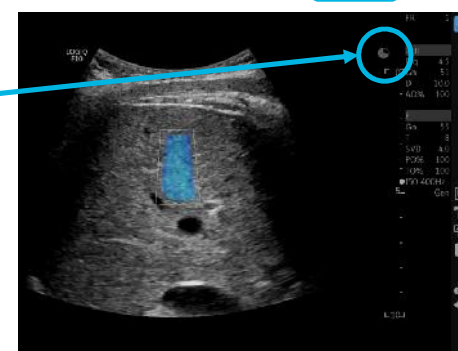
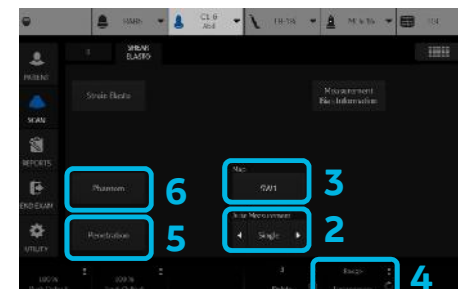
- Lack of color-fill indicates that poor shear wave signal was generated
- Do not attempt to increase color-fill by increasing the gain as this is likely to lead to inaccurate measurements
- Patients with high BMI and/or stiff liver are associated with increased risk of unreliable measurements. SWE measurements may not be possible in difficult patients
- Using the penetration setting, placing the ROI near the center of the image, and placing the ROI shallow (around 4-5 cm deep) will help to increase color fill
- Do not underestimate the effect of good patient positioning to increase intercostal access and perpendicular firm positioning of the probe has on successful results

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System parameters

Tool	Definition	Clinical Use
Overall Gain (1)	Changes the overall amount of color seen in the color-coded ROI area	Reducing gain will prevent lower quality velocity measurements from being displayed
Auto Measure (2)	Automated single and multiple acquisition workflow enhancement	Enhances efficiency and accuracy of exam acquisition and results display, supporting productivity in busy lab environment
Shear Wave Map (3)	Defines the relationship between Shear Wave Elasto color and tissue stiffness	Adjust the Shear Wave Elasto Map to provide different levels of color contrast within Shear Wave Elasto Color-Coded Map. Use E-gray for a gray scale map
Range (4)	Range pertains to the color assigned to each velocity tissue stiffness within the Shear Wave Elasto Color-Coded Map	Changing the range will change the color assigned to each velocity. Increasing range will show more blue. Decreasing will show more red
Transparency (4)	Defines the transparency of the Shear Wave Elasto Color-Coded Map	Adjust the transparency to change the appearance of the Shear Wave Elasto Map. Decrease transparency in order to see more vivid color within the Shear Wave Elasto Map. Increasing will show more of the B-Mode image within the SWE ROI
Penetration (5)	Shear Wave Elasto shortcut for more penetration (only available on LE9)	Penetration Shortcut on Shear Wave Elasto touch panel can be used for harder to image patients. Using this setting will decrease frame rate
Phantom (6)	Settings are optimized specifically for phantom testing	Use Phantom button setting only for imaging phantoms

Display	Definition
SVD (Sample Volume Depth)	Change the SVD via trackball
PO % (Push Pulse Output)	Related to the power that generates the Shear Wave
TO % (Track Output)	Related to the Power used to track the Shear Wave



Countdown clock icon for Shear Wave frames

Note: The countdown clock informs you as to when the next frame of Shear Wave Elastography is acquiring. The countdown clock is seen on the screen when the frame rate is <1 per second.

Additional system set-up

Adjusting Shear Wave display

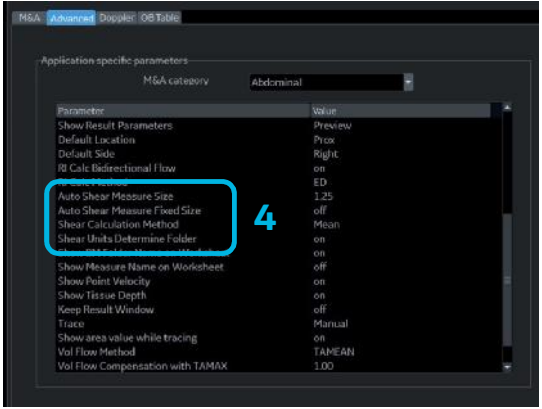
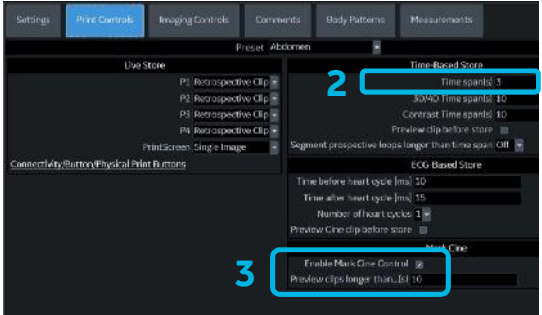
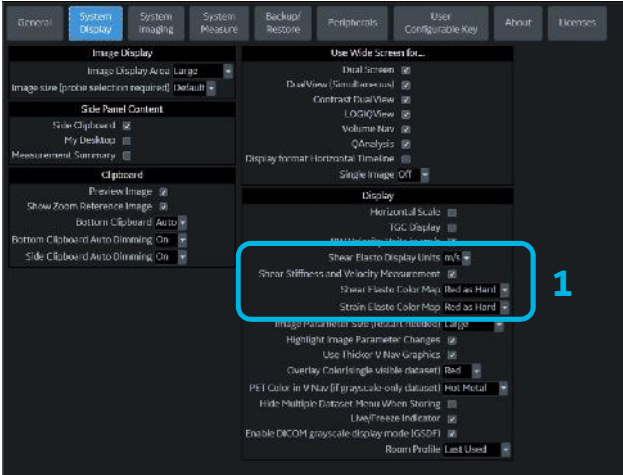
- The color map associated with tissue stiffness may be changed in the utility pages. Utility > System > System display (1)
- Shear Wave Elasto Display Units (kPa or m/s) may be changed in the Utility pages. There is also the option to display both Stiffness and Velocity Utility > System > System display (1)

Using Clip Storage

- Each Shear Wave Elasto frame takes about 2-3 seconds to acquire. If setting up print controls for taking clips, make sure to set time to at least 6 seconds to acquire multiple frames of Shear Wave Elasto. Utility > Application > Print Controls > Under Time Based-Store (2)
- To store multiple frames, user may setup Mark Cine control. Mark Cine may be initialized within the Utility Pages: Utility > Application > Print Controls > Enable Mark Cine Control (3)

Measurement ROI selections

- Shear Wave Value can be shown without setting measurement: Utility > Measure > Advanced > Show Shear Measure Value without Set (4)
- The size of the measurement ROI can be fixed if desired: Utility > Measure > Advanced > AutoShearMeasure Fixed Size (On) (4)
- If desired, user can display the Mean, Median, IQR or Standard deviation. These can be changed by going into Utility > Measure > Advanced



Auto measurement options

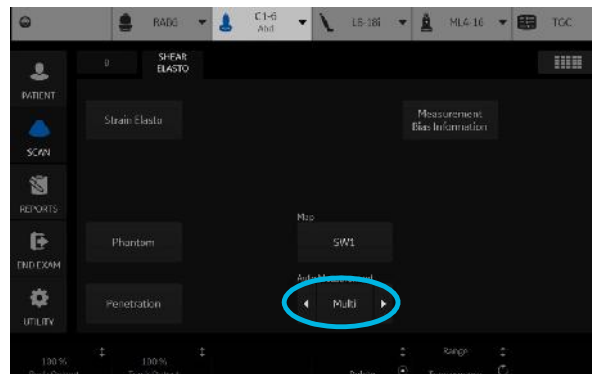
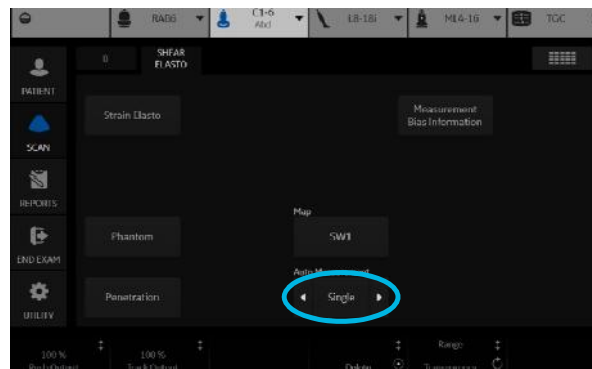
- Selections for the auto measurement are located on the touch panel in the Abdomen model: Off, Single and Multi

Single Auto Measure Workflow:

- Activate Elasto in Abdomen model
- Select “Start” using paddle to the right of the trackball
- One frame of shear wave is acquired, the system will automatically freeze and a repositionable measure
- ROI appears on the elastogram. The measurement ROI can be repositioned and maintain size if fixed size is selected “on” in Utility > Measurement > Advance Tab
- The user can accept the Shear Wave value by printing or can unfreeze to reacquire another Shear Wave elastogram if value is not acceptable
- After storing, the system will automatically unfreeze and be ready for acquisition of next elastogram

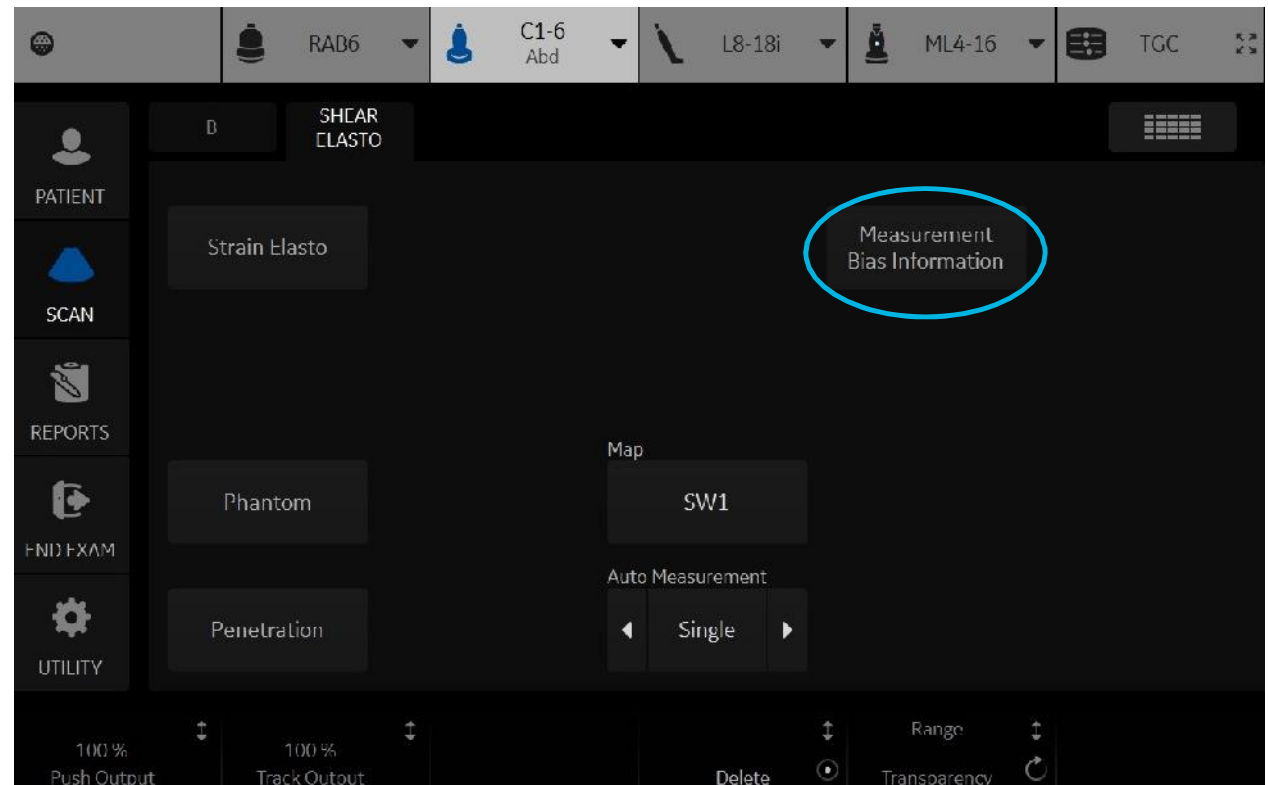
Multi Auto Measure Workflow:

- Activate Elasto in Abdomen model
- Select “Start” using paddle to the right of trackball
- Acquire multiple frames/cycles of Shear Wave Freeze. The measurement ROI automatically comes up on first frame/cycle of the acquisition
- To select this value, operator prints image and the system will move measurement ROI on to the next frame/cycle. If the operator does not want any value a “Skip Frame” function is available on the lower tab below trackball. The system will automatically cycle through all the frames acquired



Bias table

These tables show differences in stiffness measurement made by Shear Wave and the phantom manufacturer on the CIRS 049A phantom. The results shown in the bias table are valid only for the CIRS 049A phantom. Any change in target size, shape, stiffness, or background stiffness will affect the measurements.



References:

Ferraioli, G., et al. WFUMB Guidelines and Recommendations for Clinical Use of Ultrasound Elastography: PART 3: LIVER. Ultrasound in Medicine & Biology 2015; Vol. 41, No. 5: pp. 1161–1179.

Barr, R., et al. Elastography Assessment of Liver Fibrosis: Society of Radiologists in Ultrasound Consensus Conference Statement. radiology.rsna.org. Radiology: 2015 Volume 276: Number 3.

Cosgrove, D., et al. (2013) EFSUMB Guidelines and Recommendations on the Clinical Use of Ultrasound Elastography. Part 2: Clinical Applications. Ultraschall in Med 2013; 34: 238–253.



Imagination at work

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