White Paper

Simplifying Ultrasound with Automated Parameters

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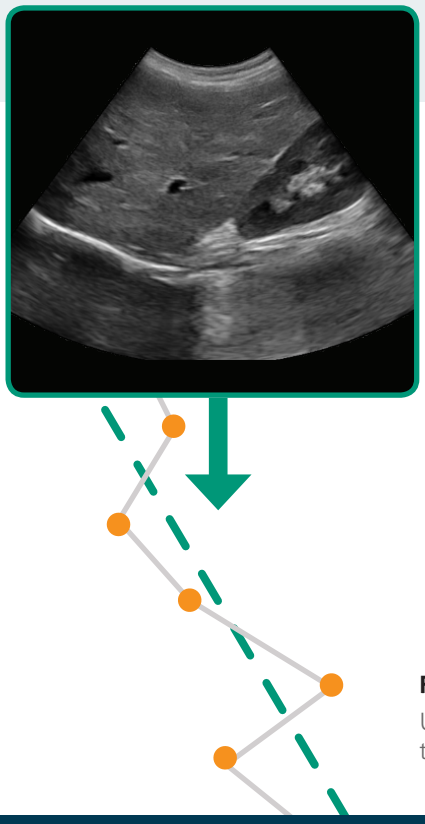
Introduction

Clarius wireless ultrasound scanners are designed for performance and simplicity. By using 192 transducer elements and high channel count electronics, Clarius always generates the highest resolution images that are at the same level of most well-established diagnostic ultrasound equipment on the market.

Whereas most traditional ultrasound systems have dozens of buttons and controls on the operator's console, Clarius uses a single control to automatically optimize a multitude of parameters. This reduces the training requirements for users and ensures the best images are always captured. This is made possible through three unique features:

- **Automated Imaging Gain**
- **Automated Depth-Based Parameter Adjustments**
- **Automated Focusing**



Automated Imaging Gain

Within the Clarius Scanner, ultrasound images are generated at a rate of 20 to 30 frames per second. While imaging, every ultrasound frame is analyzed using a complex method of region-based histogram analysis to determine if the image brightness requires an increase or decrease within a spatial resolution of 1mm to 1cm, depending on the workflow and depth selected. This negates the need for the user to control the overall gain or time-gain-compensation curve (TGC). An override method is provided for users who want to provide an additional adjustment to fine-tune the image so that it falls in line with their most optimal clinical interpretation.

Fig. 1
Uniform brightness controlled throughout entire image.

Automated Frequency Sliding

The Clarius scanner bandwidth is largely dictated by the piezoelectric material it uses. Clarius uses ultrawide band PZT substrates that allow us to adapt the actual frequency range to different applications. Depending on the application, need for penetration, and resolution, Clarius scanners have dependent sliding filters dependent on presets. The receive filters' sliding frequency changes dynamically as a function of depth, to emphasize the desired frequency.

Below are two examples of how the Clarius scanners optimize resolution with depth, based on the anatomy observed. The first case (Fig. 2) is the breast preset on the L7 scanner. In a near field configuration, the dynamic receive filters are set to receive at 14MHz center frequency. While the 14MHz frequency component is up to 30dB lower compared to the central frequency band, the filters significantly attenuate the central frequency so that the output is mostly the high frequency band of the piezoelectric elements—and dynamic range is usually set higher (>60dB) to ensure we get a broad range of low-level signals. In the near field, since signal attenuation is minimum, we can enhance and maintain dynamic range on the higher frequency signals. As we receive signals from deeper structures, since the high frequency signals are attenuated, the sliding receive filters' center frequency drops as well to the maximum resolution obtained from deeper structures.

In the second case (Fig. 3), the L7 DVT preset looks at deeper structures and needs to focus on penetration versus resolution, so the filters are optimized to receive lower frequencies.

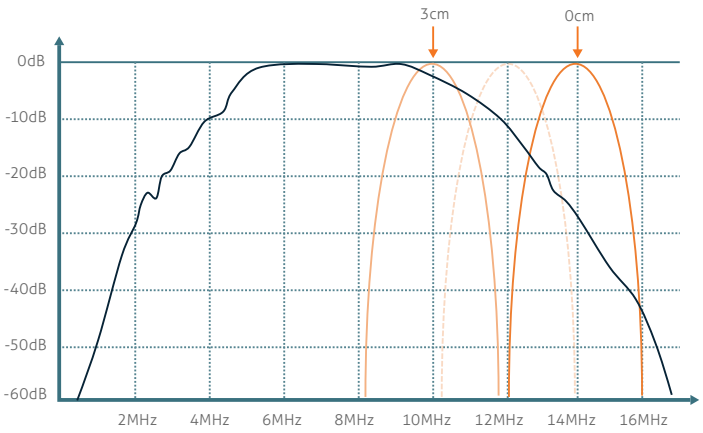


Fig. 2
Breast preset (L7 actual bandwidth)

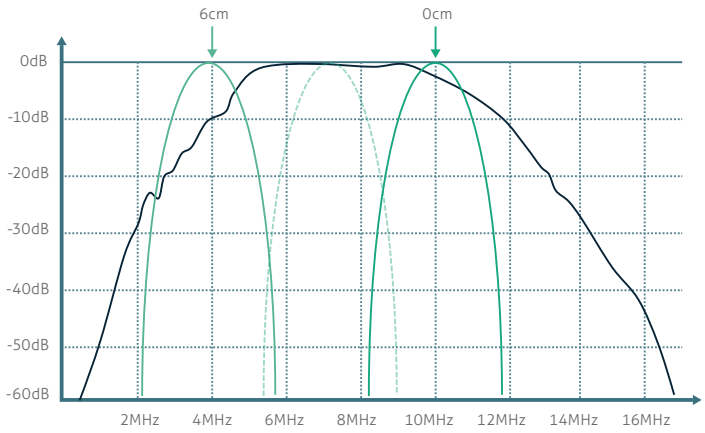


Fig. 3
DVT preset (L7 actual bandwidth)

Automated Depth-Based Parameter Adjustments

Other than gain, two of the most important controls on any ultrasound system are frequency and focal zones. These parameters help determine the resolution and depth of penetration, as well as place anatomy in a specified focal field for optimal viewing. The Clarius Scanner eliminates the need for users to adjust frequency and focal zones by making internal adjustments based on the depth selected by the user. By simply sliding up or down on the image, the imaging depth will change and automatically optimize the image for the selected view.

For example, using the L7 scanner at a depth selection of 1cm or below will output a frequency of 12 to 13MHz while placing one or more focal zones within the field of view. With a depth selection of 5cm or greater, a frequency of 6 to 8MHz will be used while spreading the focal zones across the depth field.

In conjunction with frequency and focal zones, a multitude of other parameters, such as dynamic range and reject thresholds, are also automatically tuned with the function of depth to ensure the best image quality possible. Clarius works with Registered Diagnostic Medical Sonographers and images dozens of real humans during the optimization process to ensure the best image is generated every time someone uses a Clarius Scanner.

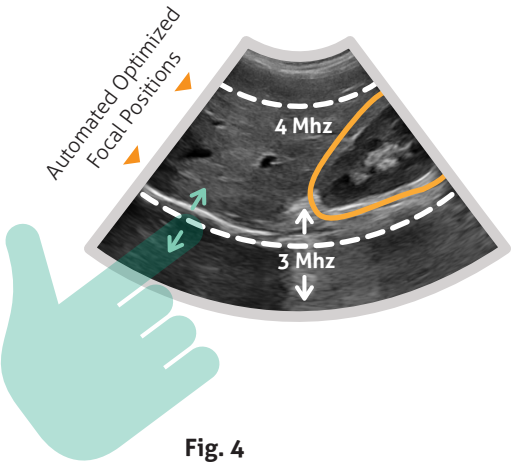


Fig. 4
Example of frequency transition boundaries.

Automated Focusing

Through Clarius' unique multi-beam architecture, the ultrasound is able to receive information from four beams at a time as well as cache beam data for further processing. By using subsequent data for up to 64 adjacent ultrasound beams, virtual transmit focusing can be accomplished to further leverage the delay-and-sum data that has been captured and processed. Instead of requiring many focal zones to improve resolution and reduce side-lobe artifacts, the virtual focusing method is employed to keep focal zones minimized to one or two depths, while the axial data below the last focal zone is brought into focus using these new computationally intensive algorithms.

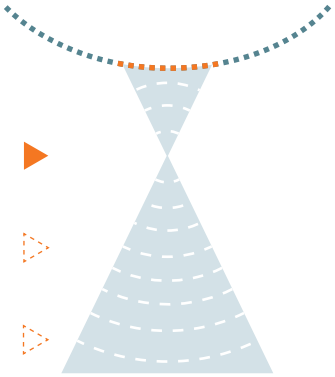


Fig. 5
Example of automated focusing