PHILIPS

Ultrasound

White paper

Achieving end-to-end efficiency in ultrasound workflow

EPIQ Elite and Affiniti ultrasound systems

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Overview

The dynamic healthcare environment requires that imaging exams be conducted as quickly and efficiently as possible while delivering high-quality results. Increased workload, staff shortages and the pressure to perform more scans within a shorter time frame have been identified as significant stressors for sonographers performing ultrasound exams.[1] This workflow study was conducted to determine how recent enhancements to the Philips EPIQ Elite and Affiniti ultrasound systems can help produce significant savings in time and effort needed to complete a successful ultrasound exam. The study was performed using EPIQ Elite. Affiniti and EPIQ Elite share a common user interface.

Background

EPIQ Elite and Affiniti ultrasound systems streamline workflow with end-to-end efficiency advances that help create enhanced experiences for users and patients alike. The objective of the study was to compare workflow efficiency measured during standardized ultrasound exam protocols completed using the next-generation release of the EPIQ Elite ultrasound system compared to the legacy EPIQ Elite ultrasound system.

Methods

A total of five sonographers and ten subjects participated in the study. Sonographers had varying levels of experience and all were familiar with the EPIQ Elite ultrasound system. Some also had experience with other ultrasound systems. All 10 subjects were scanned by each of the sonographers, resulting in a total number of approximately 100 exams*. There were no formal diagnostic or treatment endpoints for this preference study.

Workflow efficiency was measured using software on the systems that recorded scan time and the number of button pushes to complete the exam.

Study subjects were scanned twice: once using the next-generation release of EPIQ Elite and once using the legacy EPIQ Elite. Test subjects were scanned in random order, and the version of EPIQ Elite that was used first was randomized to eliminate bias.

Each sonographer was randomly assigned two applications and underwent an abdominal general exam and a vascular exam (either abdominal vascular or lower extremity vein), performed by the same sonographer on both study devices. The type of exams performed were the same for each subject.

All exams were performed per standard American Institute of Ultrasound in Medicine (AIUM) practice parameters for abdomen and vascular exams. Each subject had a complete exam, including scanning in all modes: B/C/D per AIUM practice parameters on each device.

Transducers used in the workflow study

Philips C5-1 abdominal transducer for general abdominal and abdominal vascular applications

Philips L12-3 linear vascular transducer for the lower extremity vein application

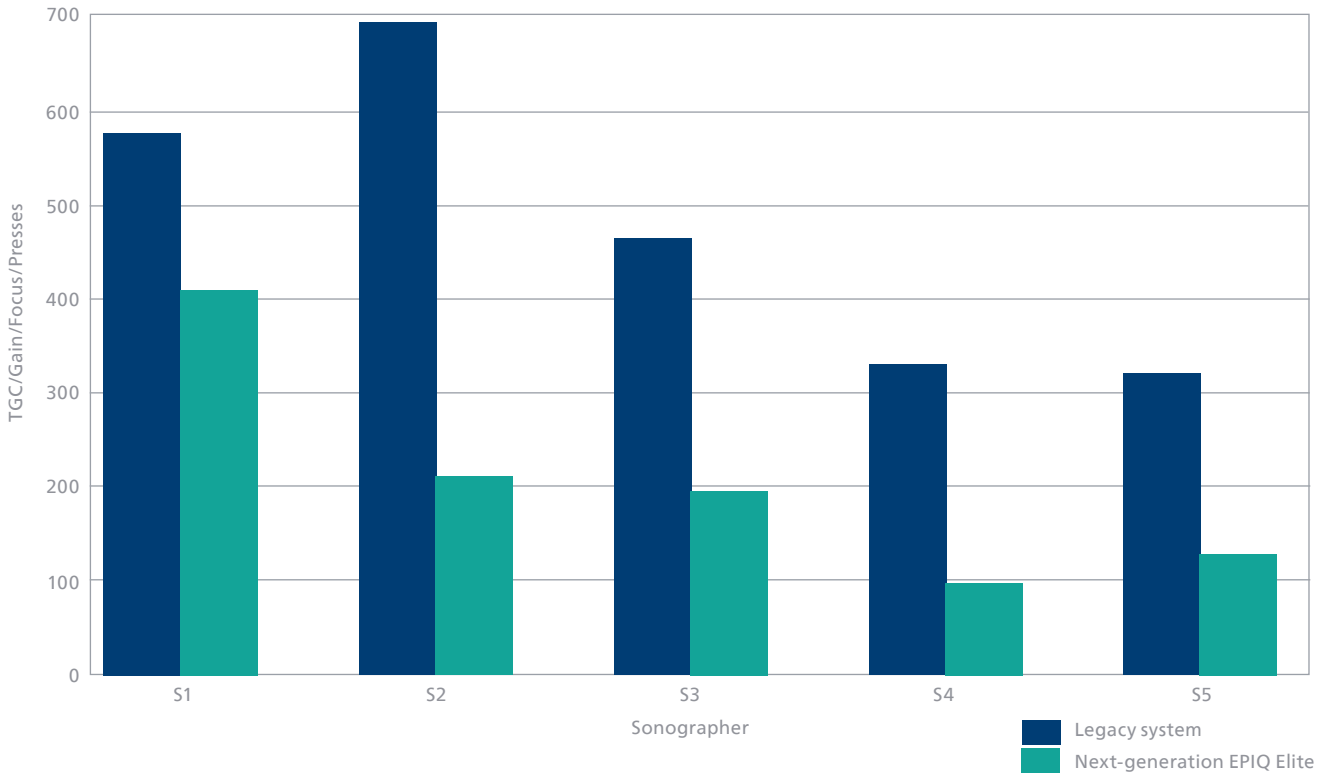
*Four lower extremity vascular exams were excluded from the analysis because of an error in data collection.

Results

Per-subject analysis of the button pushes demonstrated higher efficiency with the next-generation EPIQ Elite system, resulting a significant reduction of imaging button pushes of -53.95% [-60.65%, -47.24%] compared to the legacy system ($p<0.0001$). Fewer button pushes were needed during the entire exam in 84% of the exams.* A consistently high satisfaction score, averaging 4.6 out of 5.0, was achieved for overall image quality, including image uniformity during changes of image depth and image quality of the vessel lumen.

54% reduction in button pushes with next-generation EPIQ Elite*

Departmental efficiency by sonographer: button presses needed to complete a successful exam (improvements seen in 84% of exams)



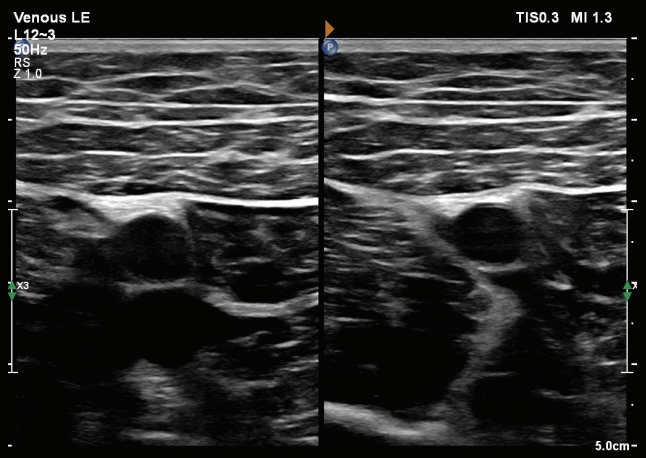
Fewer button pushes were needed during the entire exam in **84%** of the exams.*

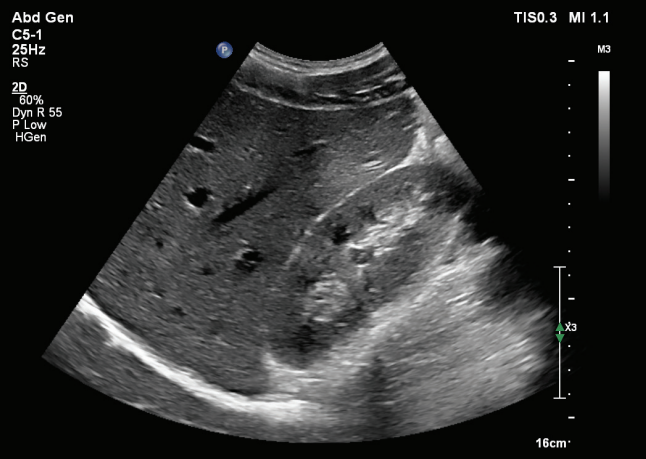
The remaining 16% of exams demonstrated the same level of efficiency between the next-generation and legacy systems.

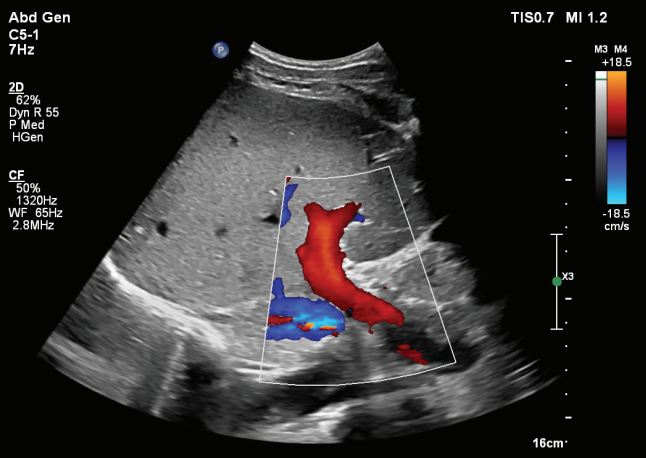
* When comparing Release 10.0 performance to Release 7.0.

Comparing image quality (legacy system versus next-generation EPIQ Elite)

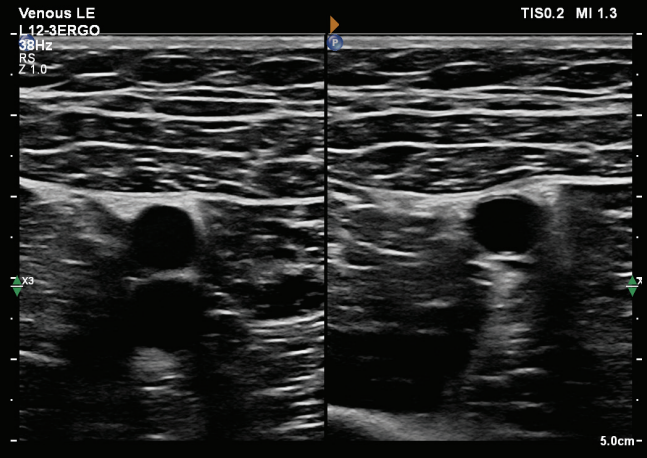
Legacy system

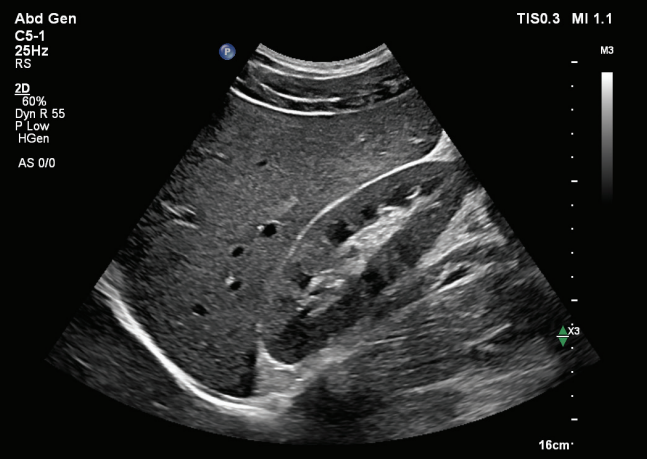


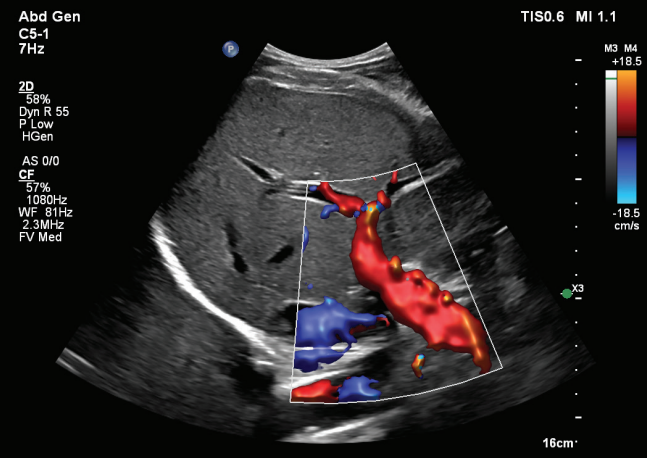




Next-generation EPIQ Elite







Overall sonographer assessment of improvement using next-generation EPIQ Elite

4.6 Overall IQ in relevant windows

4.5 Image uniformity while changing depth

4.6 IQ of vessel lumen in vascular exams

Consistently high satisfactory scores were achieved for image quality parameters

1-5 scale: 3 means Next-generation EPIQ Elite is neutral compared to legacy system.

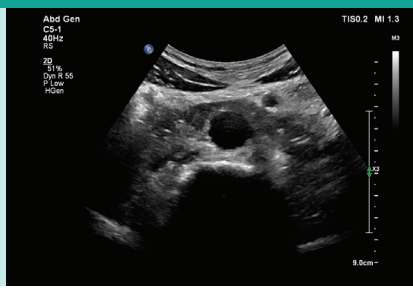
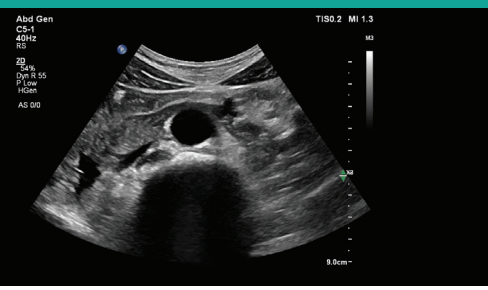
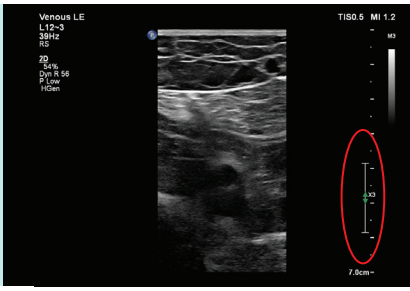
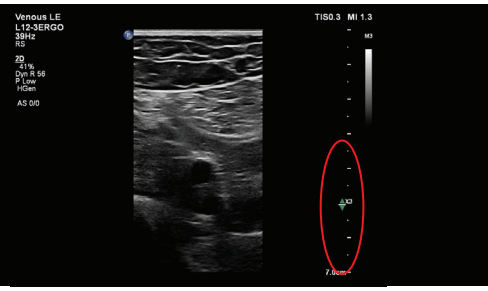
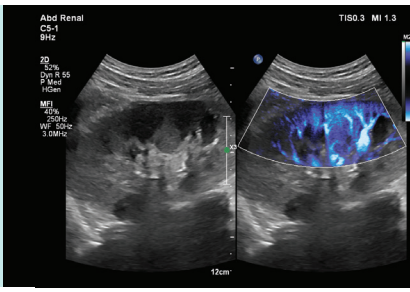
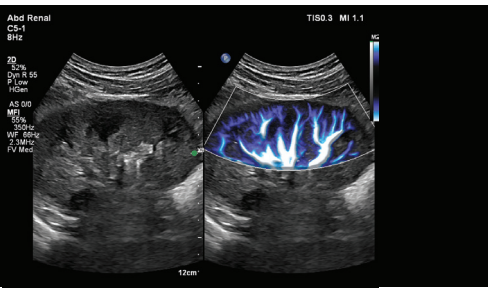
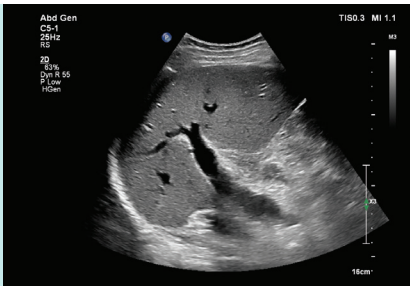
US health system sonographer reactions to next-generation EPIQ Elite

"AutoSCAN is a huge help; TGCs and gain are still sometimes required but far less often."

"Overall color has less flash, feels more sensitive, and Flow Viewer only builds on the improvements."

"Tissue texture has been improved and the images tend to be much more pleasing."

Features contributing to workflow efficiency

	Legacy system	Next-generation EPIQ Elite
Next Gen AutoSCAN Improves image uniformity at every pixel*		
Auto Focus Tracks with all depth changes, eliminating the need for manual adjustment by the user		
Flow Viewer Provides a color 3D-like rendering of flow imaging data to better visualize the cardiac and vascular architecture		
Image quality Enhanced quality and transducer plunkability		

Next Gen AutoSCAN reduces button pushes while improving image uniformity

Philips Next Gen AutoSCAN improves image uniformity, adaptively adjusting image brightness at every pixel, thereby reducing the need for user adjustment while also allowing for increased transducer plunkability. Next Gen AutoSCAN reduces button pushes by up to 54% with pixel-by-pixel real-time optimization.*

The science behind Next Gen AutoSCAN performance

The objective of AutoSCAN is to adjust the gain balance for every image in order to achieve an ideal brightness target. In the next-generation release, Philips significantly revised the underlying algorithm to improve performance relative to the legacy version. This results in markedly improved "plunkability".

One challenge with rendering ultrasound images consists in mapping the high dynamic range (HDR) of the raw data to a display monitor that has much lower standard dynamic range (SDR). For instance, raw ultrasound data may contain both hypoechoic (e.g., rib shadow) and hyperechoic (e.g., bone interface) areas with dynamic range as large as 90 dB. A poor image compression can result in the loss of clinical information at both the highlights and shadows. The conventional method for image compression consists of providing the user multiple manual gain controls to precisely adjust the image to the desired brightness both axially and laterally (EPIQ does this via the controls such as TGC and LGC). While this approach provides good grayscale control for the user, it requires constant adjustments by the user depending on the body habitus.

* When comparing VM10 performance to VM7 performance.

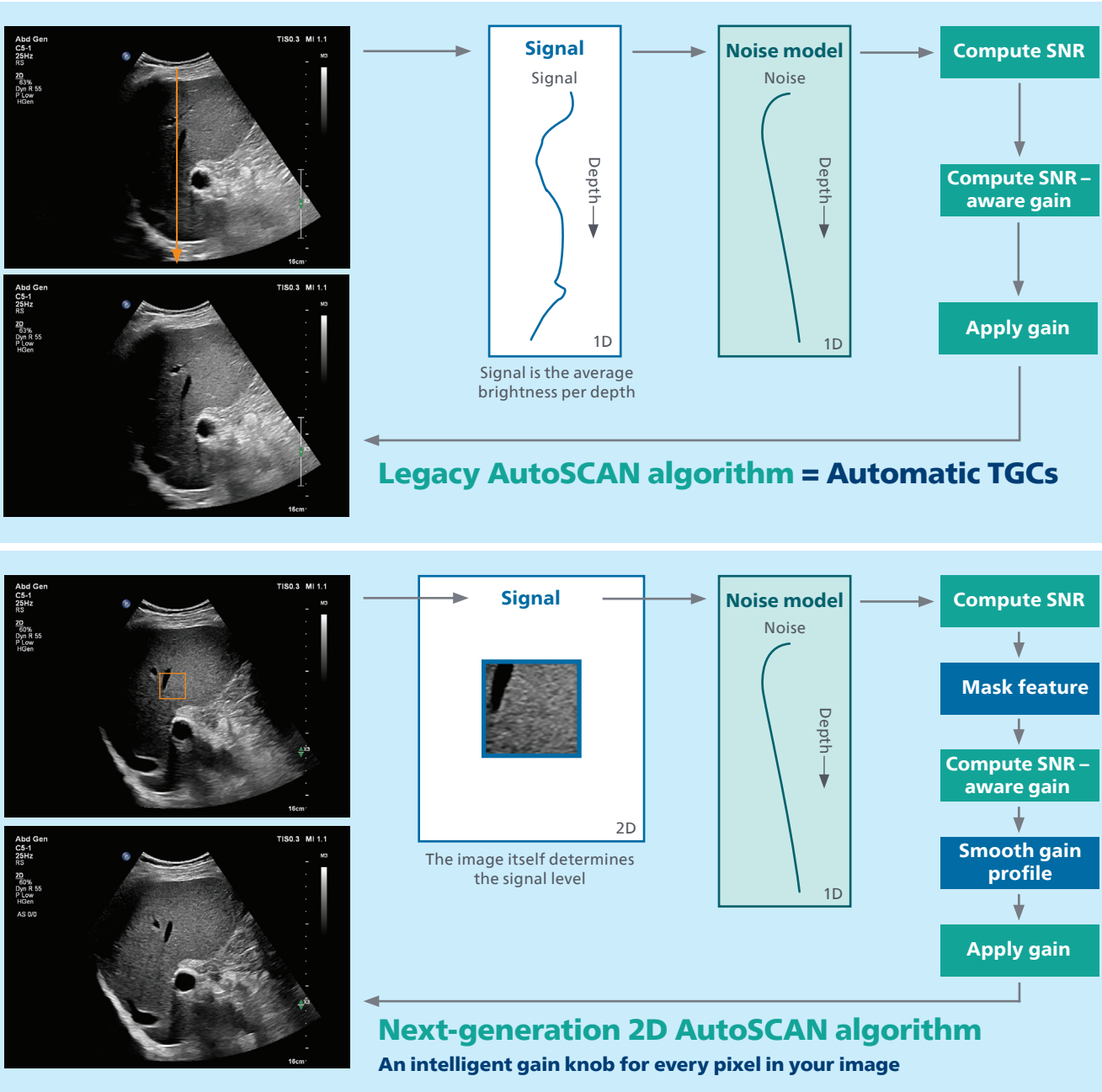


Figure 1 Schematics of legacy AutoSCAN (top) and 2D Next-generation AutoSCAN (bottom).

AutoSCAN was introduced at the first EPIQ release in order to automate gain adjustment workflows. The original AutoSCAN is a one-dimensional gain balancing algorithm that seeks the ideal TGC pattern to produce consistent gain over the image over depth. To perform this adjustment, the average signal is estimated at each depth and compared to the system noise model (providing the signal-to-noise metric, aka SNR). The SNR is the used to compute a frame-adaptive TGC curve that maps each image to a desired target SDR display brightness while limiting the enhancement of undesired structures such as thermal noise and acoustic clutter.

As part of the next-generation release, Philips improved the AutoSCAN algorithm based on the recent progress in HDR tone-mapping technologies. The 2D Next Gen AutoSCAN algorithm is now fully pixel-adaptive and seeks the ideal brightness at every point of the image.

Instead of computing SNR per depth, the new AutoSCAN algorithm computes SNR over local image patches and the global brightness of each patch is mapped to a target brightness. This provides an ideal gain for every pixel while still mitigating enhancement of thermal noise and acoustic clutter. Novel image processing strategies were also introduced to limit the clipping at the highlight and black point. Most importantly, Next Gen AutoSCAN only applies a soft gain correction to the image and can only amplify details that already exist in the raw ultrasound data but would be otherwise difficult to visualize with a conventional image compression.

A significant advantage of Next Gen AutoSCAN over the legacy version is its ability to equalize the image laterally. A common use case would be poor transducer coupling or rib shadow, neither of which are supported by the legacy AutoSCAN **(Figure 1)**.

AutoSCAN offset and penetration controls

AutoSCAN offset acts as a global gain for Next Gen AutoSCAN and was first introduced in the legacy AutoSCAN. It behaves very similarly to the standard digital gain knob on the control panel but is more robust. The AutoSCAN penetration (pen) control was introduced with Next Gen AutoSCAN and controls the amount of thermal noise, or clutter, tolerated by the AutoSCAN module. For those familiar with the Adobe Photoshop tool, Next Gen AutoSCAN can be thought of as acting in a similar fashion to a black point control. This control is particularly helpful in recovering information in more challenging patients in the far-field without saturating the near-field **(Figure 2)**.

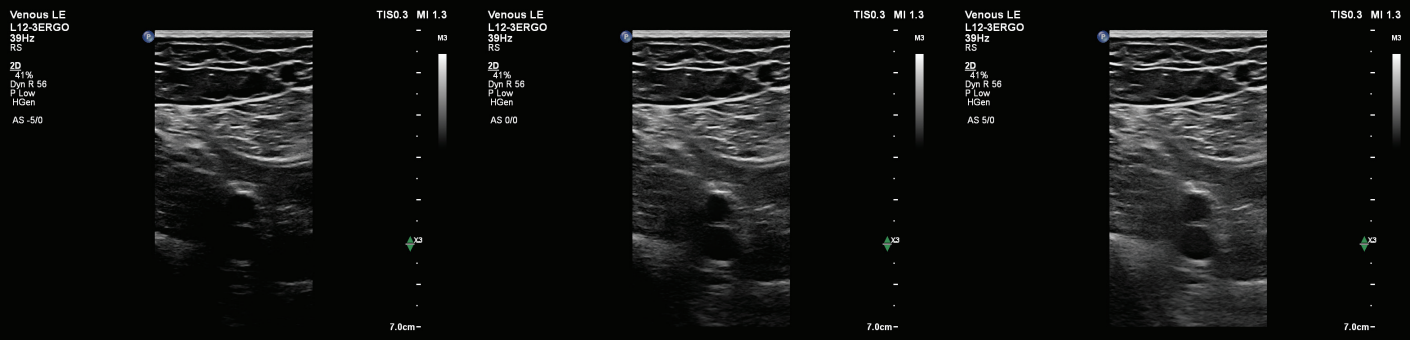


Figure 2 Effect of AutoSCAN pen control. Increasing AutoSCAN pen recovers information in the far-field but introduces more thermal noise. Note how the distal noise floor becomes visible, while near-field structures are not affected.

Summary

Every sonographer in the study was able to complete high-quality ultrasound exams with significantly fewer imaging button pushes (54%) using the next-generation release of EPIQ Elite versus the legacy system.* Fewer button pushes were needed during the entire exam in 84% of the exams.* Sonographer reactions to the image quality offered by the workflow advances were extremely favorable. A consistently high satisfaction score (average 4.6 out of 5.0) was achieved across sonographers for image quality, image uniformity during changes of image depth and image quality of the vessel lumen.

Conclusion

The next-generation release of EPIQ Elite demonstrates a significant reduction in button pushes needed to perform a successful high-quality ultrasound exam. Efficiency advances such as Next Gen AutoSCAN with pixel-by-pixel real-time optimization support an improved experience for sonographers and patients.

* When comparing Release 10.0 performance to Release 7.0.

Reference

1. Burnout in the sonographic environment: the identification and exploration of the causes of sonographer burnout and strategies for prevention and control. Younan K, Walkley D, Quinton AE, Alphonse J. Sonography. 2022;9:175–185. DOI: 10.1002/sono.12333.

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