PHILIPS

Ultrasound

White paper

A comprehensive solution using the Philips eL18-4 PureWave linear transducer

The clinical need

James Jago, PhD, Clinical Scientist, Hal Kunkel, PhD, Development Engineer,
Neil Owen, PhD, Systems Design Engineer, Philips Ultrasound

Clinicians today require versatility in their ultrasound equipment in order to address the ever-increasing range of clinical applications and patient body habitus involved when using ultrasound to diagnose and treat patients. However, versatility cannot come at the expense of imaging performance, and therefore, the level of patient care. In addition, imaging facilities are becoming increasingly concerned with higher patient throughput and the pressure this trend places on the need for shorter exam times. With this in mind, Philips set out to develop a solutions-oriented ultrasound transducer that delivers on superb image quality and advanced capabilities across a wide range of clinical options. This one-transducer solution would reduce the need for multiple transducers, lowering operating costs and increasing scanning efficiency. The result is the Philips eL18-4 PureWave linear array transducer.

Combining innovations

The eL18-4 transducer leverages a combination of Philips innovations in order to support a diverse range of clinical applications while delivering extraordinary imaging and depth-of-field performance (Figure 1).

Ultra-broadband

The eL18-4 transducer is an ultra-broadband transducer because it can generate frequencies ranging from 2 MHz to 22 MHz (Figure 2), enabling use in a wide range of clinical applications. Transducer performance has been optimized to operate in the most clinically relevant range of 4 MHz to 18 MHz, which is why it is named the eL18-4 transducer.

Figure 1 Unique technologies combined within the Philips eL18-4 transducer.

PureWave crystal technology

When Philips introduced PureWave crystal technology, it represented the biggest breakthrough in piezoelectric transducer material in 40 years. The uniform crystals of PureWave are 85% more efficient than traditional piezoelectric (PZT) material in converting electrical input into acoustic output. This enables improved penetration in technically difficult patients and also provides the ability to image a wide array of patients with a single transducer, while maintaining excellent detail resolution and flow sensitivity.

The PureWave crystal technology used in the eL18-4 transducer has been further optimized for use in high-frequency, high-power applications. Technically speaking, this optimization has resulted in a PureWave crystal that:

- Is more resistant to depoling, allowing for higher electric drive fields without damage
- Has smaller domain sizes that allow the crystal to retain its properties when ground to acoustic layers thinner than a human hair, which is required to operate at frequencies up to 22 MHz

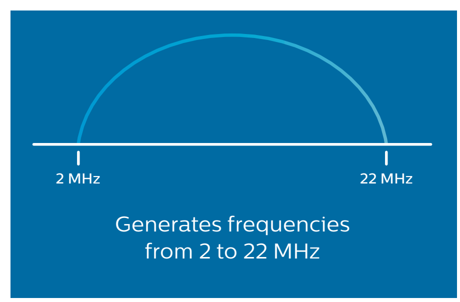
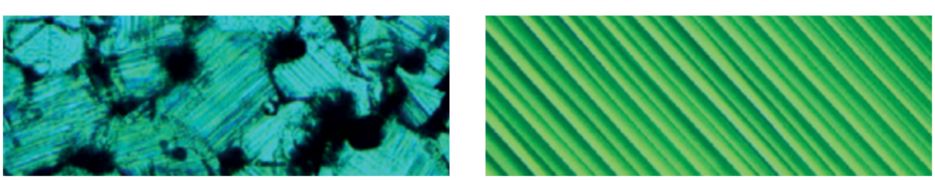


Figure 2 Frequency range of the Philips eL18-4 transducer.

Clinically speaking, this means that the new crystal can be operated with 2x the voltage, delivering 4x the output power. This enables the eL18-4 transducer to achieve exceptional penetration, and also meet the requirements of technically demanding ultrasound modes such as shear wave elastography imaging.



Conventional PZT (x800) **PureWave crystal (x800)**

Figure 3 The uniformity of PureWave single crystals compared with traditional piezoelectric (PZT) material.

***n*SIGHT Imaging architecture**

nSIGHT Imaging is a unique combination of a precision beamformer and massive parallel processing available on the Philips EPIQ ultrasound platform. ***n***SIGHT Imaging technology combines multiple transmit-receive cycles (FIgure 4) with spatially differing transmit beam profiles. (For more detail on how ***n***SIGHT Imaging works, see the Philips ***n***SIGHT Imaging white paper). Enabled by proprietary hardware and software that are able to perform the massive parallel processing required for data reconstruction, ***n***SIGHT Imaging provides multiple improvements in image quality.

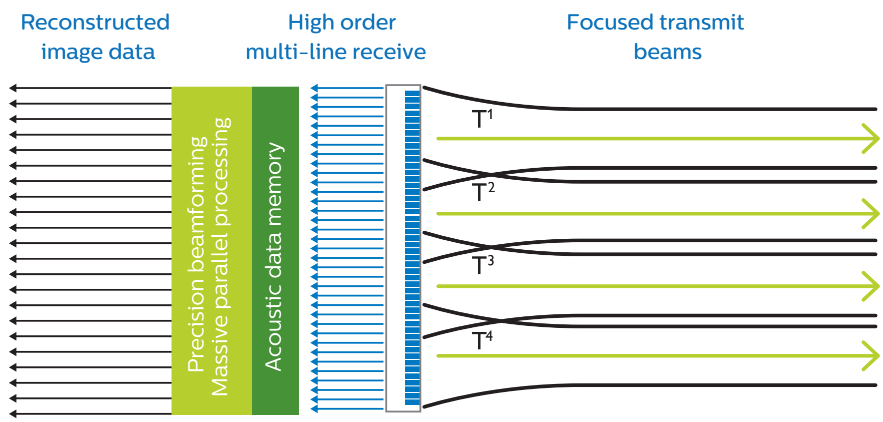


Figure 4 ***n***SIGHT Imaging transmit-receive cycles.

Coherent processing across multiple transmit beams results in dynamic re-focusing on the transmit as well as receive functions at all depths and locations in the image (Figure 5). This significantly improves lateral spatial resolution at all depths, and especially away from the transmit focal zone location, improving the depth of field and reducing dependence on transmit focal zone placement.

Also, ***n***SIGHT Imaging brings improvement in penetration in the far field. Because the signals from multiple transmit-receive events are combined, there is inherent pulse averaging and consequently noise reduction. Weak signals from the far field are enhanced multiple times when signals are combined, providing increased clarity and contrast resolution at greater depths.

Because ***n***SIGHT Imaging improves the depth of field of any individual transmit focal zone, there is less need for multiple focal zones to achieve excellent lateral resolution at all depths. ***n***SIGHT Imaging also generates multiple dynamically focused image lines for every transmit event. Taken together, these benefits allow for significantly higher frame rates than is possible with conventional beamformers.

Although these attributes of ***n***SIGHT Imaging bring important benefits to all transducers on the EPIQ platform, they offer very significant and specific benefits to the eL18-4 transducer. For example, the eL18-4 transducer supports several advanced features such as; ElastQ Imaging shear wave elastography and MicroFlow Imaging that require very high imaging rates but also demand excellent resolution and penetration.

Figure 5
nSIGHT Imaging transmit beam reconstruction.

Elevation focusing

The eL18-4 transducer was designed with clinical versatility in mind, which requires superb penetration and excellent spatial resolution and contrast resolution at a wide range of imaging depths. While ***n***SIGHT Imaging provides excellent lateral resolution at all depths and also helps with penetration, the transducer's elevation focusing capability extends this into the out-of-plane dimension, which has a critical influence on contrast resolution and useful penetration. To achieve this, the transducer's PureWave crystal is cut along its short axis to divide the crystal into multiple main rows of elements. The center row of elements determines the transducer's inner aperture focal point, while the outer row of elements determines the transducer's full aperture focal point (Figure 6).

Philips engineers then leveraged these multiple apertures to optimize transducer performance. Put simply, the smaller elevation aperture promotes detailed spatial and contrast resolution for near-field imaging, while the larger aperture is used to promote depth of penetration and contrast resolution at depth. The result is a transducer that delivers in resolution and penetration across a wide range of clinical applications (Figure 7).

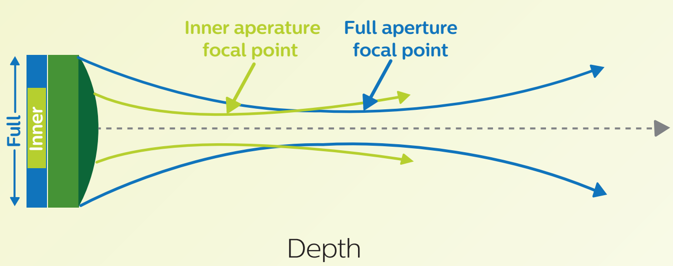


Figure 6 Multiple aperture focal points through elevation focusing.

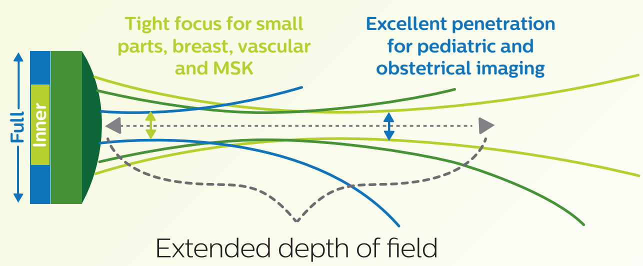


Figure 7 Multiple apertures provide ability to focus over wide range of depths in a single transducer.

The unique combination of PureWave crystals, ***n***SIGHT Imaging and elevation focusing allows Philips to optimize the image for each individual clinical application. This results in the exceptional image quality that Philips ultrasound systems are known for across a wide range of clinical applications.

Integrated electromagnetic tracking (optional)

A built-in electromagnetic tracking coil is available on the eL18-4 transducer that allows tracking of the transducer in space (Figure 8). The Philips Anatomical Intelligence for Breast (AI Breast) software feature uses the integrated EM tacking coil in conjunction with a specialty mattress and tabletop field generator for breast screening exams while preserving superb image quality for full diagnostic studies.

Figure 8 Philips eL18-4 transducers enabled with an optional electromagnetic tracking coil feature an EM symbol.

Clinical benefits of a complete solution

The combination of technologies featured in the eL18-4 transducer allows it to deliver a unique set of capabilities including image uniformity, range of clinical applications from shallow to deep, and shear wave elastography (Figure 9). Never before has a linear transducer been able to cover the range in frequency and clinical applications as the range covered by the eL18-4 transducer. It is truly a multi-transducer solution in a single transducer.

The eL18-4 transducer is an incredible advance across multiple clinical segments, including small parts, breast, vascular, bowel, pediatrics and obstetrics. With an operating frequency range of 2 to 22 MHz, optimized for 4 to 18 MHz, it is a high-frequency transducer that is also capable of up to 14 cm in penetration. Its versatility and excellent default performance reduce the need to switch between different transducers during an exam. With its extraordinary imaging and depth-of-field performance, the eL18-4 transducer allows clinicians to image quickly and with confidence.

When paired with the latest software releases on both the EPIQ and Affiniti ultrasound systems, the eL18-4 transducer provides a well-rounded solution, including elastography, MicroFlow Imaging and precision biopsy, that offers all-in-one functionality with both exceptional imaging and complementary clinical tools.

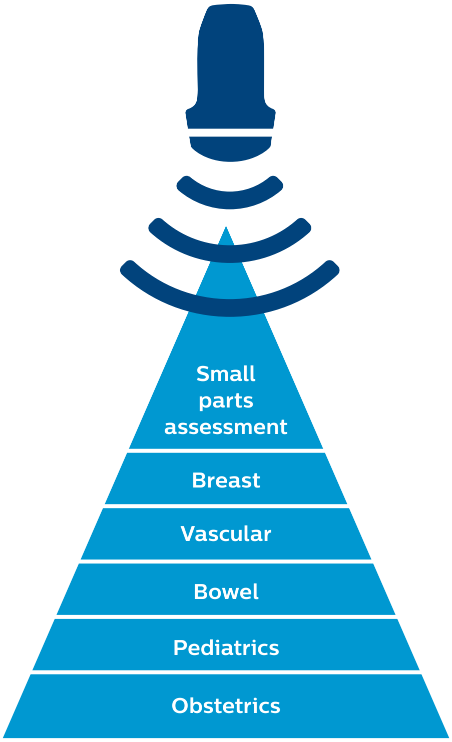


Figure 9 The eL18-4 transducer delivers the exceptional imaging quality of Philips across a range of clinical applications from shallow to deep.

The ultimate solution for small parts assessment

The unique combination of enhanced PureWave technology, a complete elastography solution, MicroFlow Imaging, and precision-guided biopsy offers the ultimate solution for small parts assessment (Figure 10).

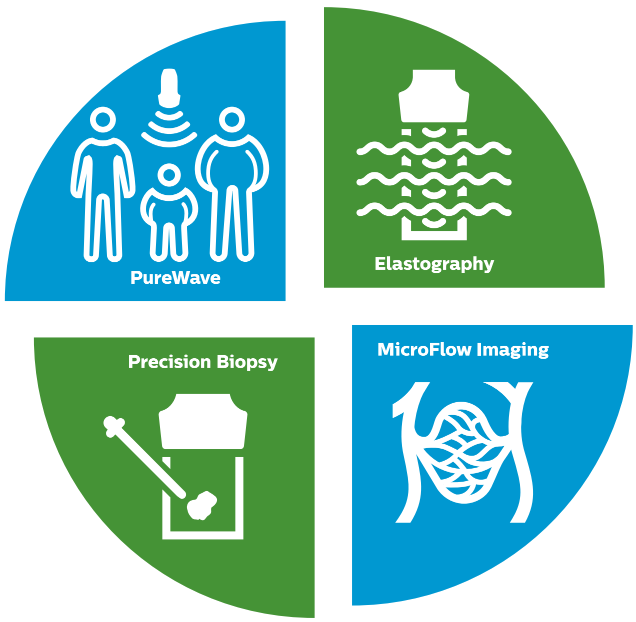


Figure 10 The eL18-4 transducer is the Philips ultimate ultrasound solution for small parts assessment.

A complete elastography solution

The eL18-4 transducer is designed to support a complete elastography solution. Highly sensitive strain imaging can be used to rapidly assess relative tissue stiffness values across a variety of applications and shear wave elastography utilizes a unique pulsing scheme to generate and detect the propagation speed of shear waves, providing an absolute measure of tissue stiffness. The ability to combine both methods of elastography and deliver excellent imaging performance is an extraordinary clinical accomplishment that helps advance clinical practice.

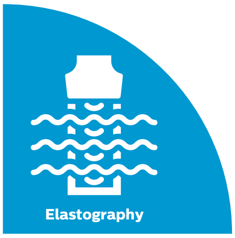
MicroFlow Imaging

The eL18-4 transducer supports Philips MicroFlow Imaging, a new proprietary method for blood flow detection that provides an innovative approach to assessing vascular beds. MicroFlow Imaging overcomes many of the barriers associated with conventional methods to detect small vessel blood flow with high resolution and minimal artifacts. MicroFlow Imaging maintains high frame rate and image quality and applies advanced artifact reduction techniques. 2D image subtraction, blending and side-by-side display options offer excellent visualization versatility across multiple clinical applications.

Precision-guided biopsy

Biopsy procedures, for many practices, are a routine part of an ultrasound examination. Using precision-guided biopsy techniques provides confidence in obtaining tissue targets to reduce multiple needle passes. The eL18-4 transducer is compatible with the CIVCO Verza Guidance System, providing an advanced biopsy guidance system with virtually no dead zone.* In addition, needle visualization software optimizes display of needle reflections for enhanced confidence during procedures.

The ultimate breast solution



Breast cancer is the second most common cancer in the world and, by far, the most frequent cancer among women, representing about 25% of cancer cases in women. Many clinicians depend on ultrasound to elevate diagnostic confidence in detecting cancers in women with dense breast tissue. With mammography, dense breast tissue can mask small cancerous lesions. The addition of a breast ultrasound exam may lead to detection in three to four more cancers per one thousand women.[1, 2]

Clinicians require solutions that not only improve detection and diagnosis but also increase throughput and productivity while maintaining the highest levels of confidence.

Shear wave elastography for quantitative breast tissue stiffness data

The eL18-4 transducer is designed to support a complete elastography solution (Figure 11). Highly sensitive strain imaging can be used to rapidly assess relative breast tissue stiffness, and shear wave elastography uses a unique pulsing scheme to generate and detect the propagation speed of shear waves to provide an absolute measure of breast tissue stiffness. The ability to combine both methods of elastography and deliver excellent imaging performance is an extraordinary clinical accomplishment that helps advance clinical practice.

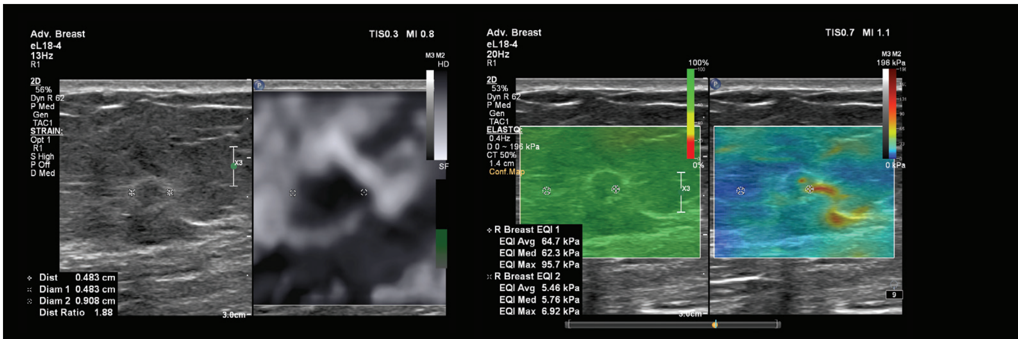
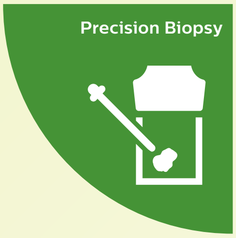


Figure 11 Breast strain and breast shear wave images using the eL18-4 transducer.



Precision Biopsy capabilities reduce needle blind zones

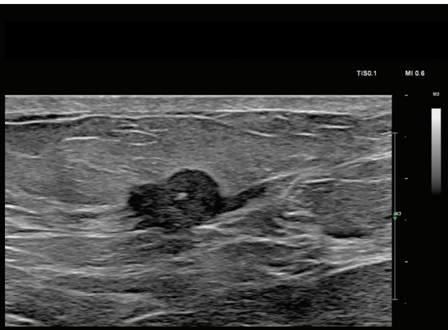
Needle visualization gives the user more confidence by reducing needle blind zones and supports the ability to enhance the display of needle reflections during interventional procedures. The eL18-4 transducer is compatible with the CIVCO Verza Guidance System, providing an advanced biopsy guidance system with virtually no dead zone. Using precision-guided biopsy techniques allows confidence in obtaining breast tissue targets, to reduce multiple approaches.

Facilitate breast-screening exams while preserving superb image quality for full diagnostic capabilities

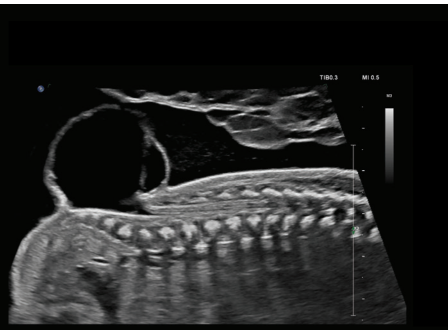
The Anatomical Intelligence for Breast (AI Breast) feature is a powerful software using the eL18-4 transducer with an integrated electromagnetic tracking coil in conjunction with a specially designed mattress and tabletop field generator to perform breast screening exams.
AI Breast allows visual mapping of screened anatomy, assuring full coverage of the breast during the acquisition phase. Images are stored while performing sweeps to allow for later review.

During acquisition, key images can be bookmarked for quick review. Images can be auto-annotated and quick orthogonal views of anatomy can be easily retrieved for enhanced workflow and documentation. The AI Breast Review Suite will be supported as on off-line workstation for review and reporting.

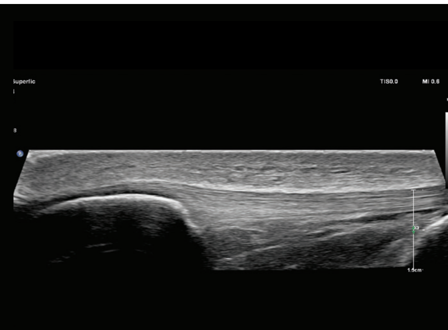
Clinical image gallery



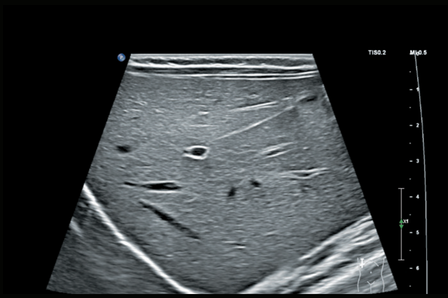
Breast lesion



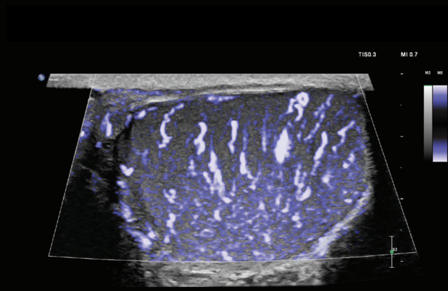
Fetal spine imaging



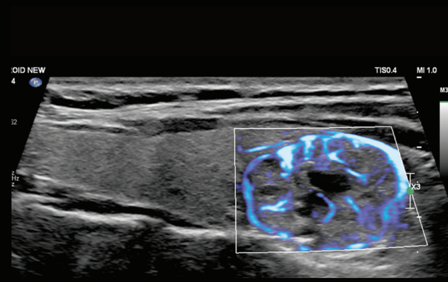
Patellar tendon insertion



Pediatric liver



Testicle with MicroFlow Imaging



Thyroid lesion with MicroFlow Imaging

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2 Ho JM, et al. Dense breasts: A review of reporting legislation and available supplemental screening options. American Journal of Roentgenology. 2014;203:449.

* CIVCO Verza Guidance System is a trademark of CIVCO Medical Solutions.

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