Canon

White Paper

Aplio™ i-series

Ultrasound Imaging with New Generation Technology

Intuitive. Intelligent. Innovative

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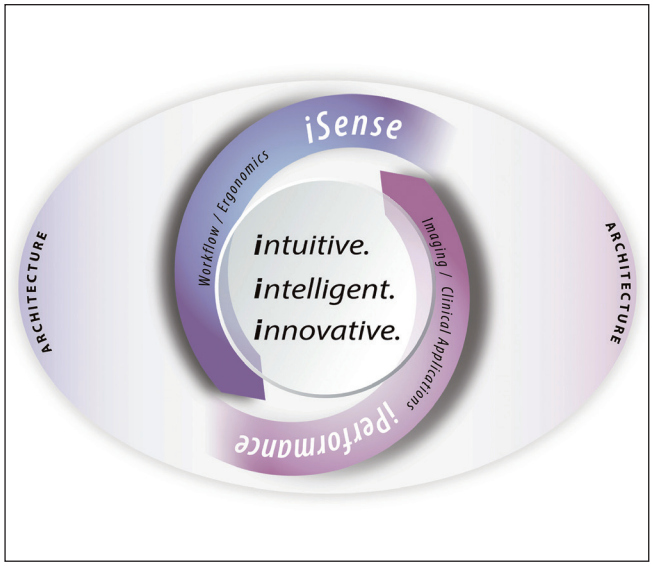
INTRODUCTION

Canon Medical Systems' Aplio™ i-series diagnostic ultrasound systems are the result of intelligent implementation of innovative technologies that provide an intuitive experience for its users from the very first moment. The new generation architecture and advanced transducer technology provide fast and easy workflow combined with superb imaging and clinical applications.

Canon Medical Systems' Aplio i700, i800, and i900 have been designed for whole body ultrasound examinations. The key differentiators of Aplio i-series are innovative beam forming technology (iBeam forming), front-end Intelligent Dynamic Micro-Slice technology (iDMS) and powerful multiplexing technology. The evolution of architecture with this new generation technology provides a new level of image quality and clinical applications.

ARCHITECTURE

More than fifty years of in-house ultrasound evolution has shaped the architectural base of the Aplio i-series. The architecture of Aplio i-series has been designed to prepare clinicians for the challenges of today and the future. In the following section, iBeam forming and multiplexing technology will be explained in more detail.



Design concept of Aplio i-series

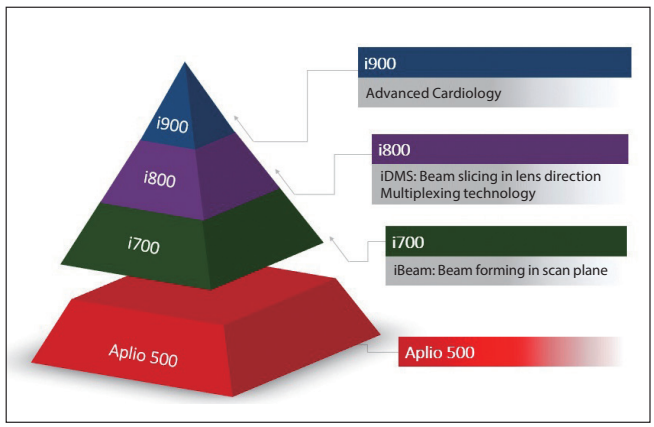
iBeam Forming

iBeam forming consists of three technologies that work together to cumulatively optimize efficiency of the ultrasonic beam: Multi-Sync Pulser (transmitting), Multi-Beam Receiver (receiving), and Multi-Harmonic Compounding (processing).

iBeam ensures the formation of a sharp, uniform and thin slice beam that offers clinical images with high resolution and homogeneity. This unique beam forming technology is able to offer excellent contrast resolution, temporal resolution and spatial resolution in all three aspects: axial, lateral and elevation (or azimuthal).

Harmonic Imaging

To obtain high- resolution clinical images, harmonic imaging is executed which means that fundamental signals are rejected and second harmonic signals are extracted. Tissue harmonic signals have a narrower beam, with lower side-lobe levels and can form high resolution clinical images. In the conventional Aplio system, a twin-pulser technique was used to transmit purer waves. However, in order to have waves that are homogeneous without decreasing the frame rate, a new beam transmitting technology, Multi-Sync Pulser, has been developed. This new beam forming technology can generate symmetrical pulses with a flexible variation in aperture and delay curve for constructing a high quality, harmonic frequency component. As a result, ultrasound images with more penetration, higher spatial resolution and contrast resolution can be obtained.*



Canon Medical Systems' Aplio differentiation chart

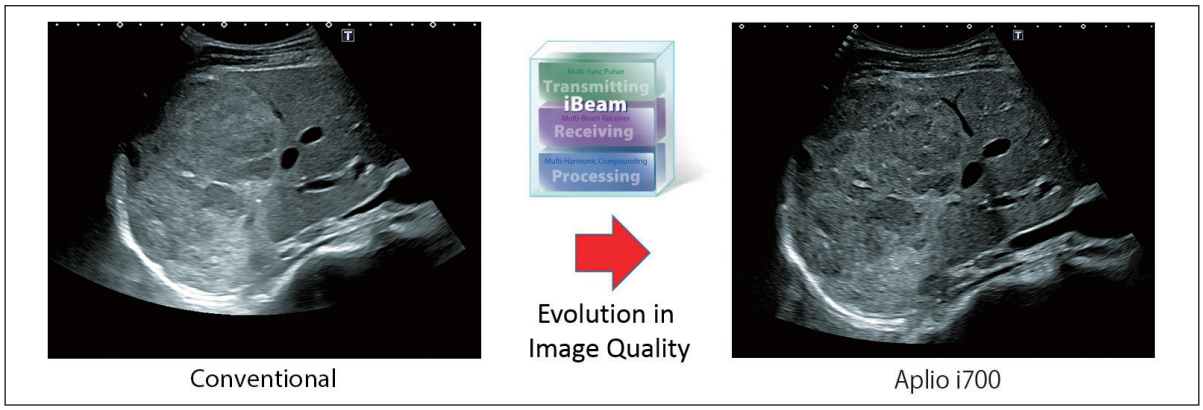
** Compared with Aplio 500 Platinum*

iBeam Receiving: Multi-Beam Receiver

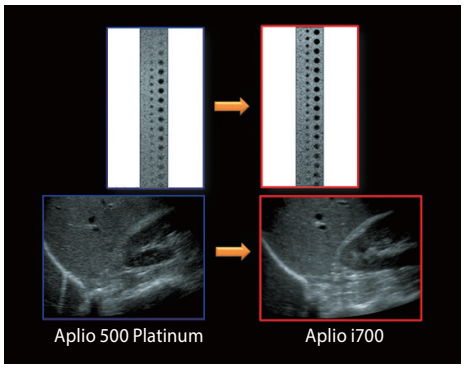
Quadrature signal processing (QSP) in conventional systems has an advantage of higher frame rate with one beam transmission because four signals can be received simultaneously. However the newly implemented Multi-Beam Receiver technology allows multiple beam lines to be received concurrently with one transmission, resulting in a uniform, high density field of scan lines that enables images with more homogeneity and higher frame rates.

iBeam Processing: Multi-Harmonic Compounding

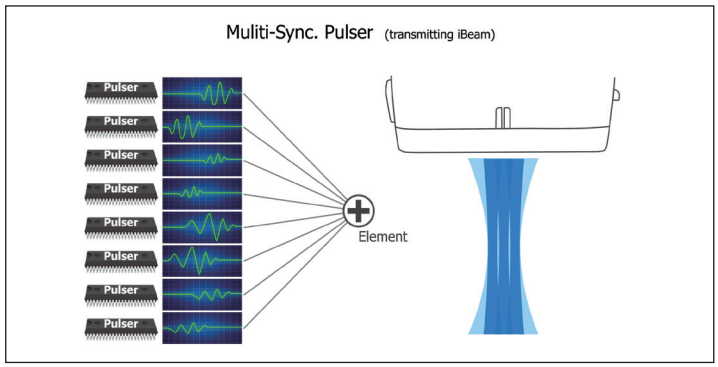
Multi-Harmonic Compounding is a new beam shape-forming technology made possible with the powerful processing capacity on the Aplio i-series platform. By compounding signals from the main beam and the adjacent beams, a fine, sharp and uniform ultrasound beam can be generated, leading to precise clinical images with high lateral resolution and high frame rate. With Multi-Harmonic Compounding, the signal-to-noise ratio is increased, offering better image resolution and penetration.



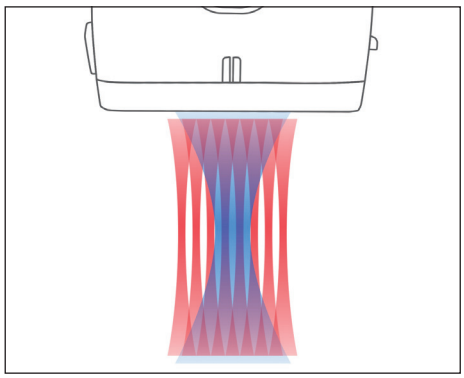
iBeam architecture



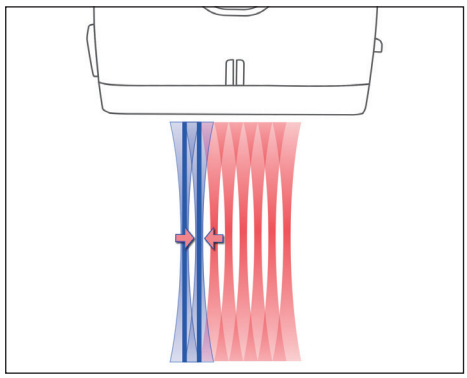
iBeam forming



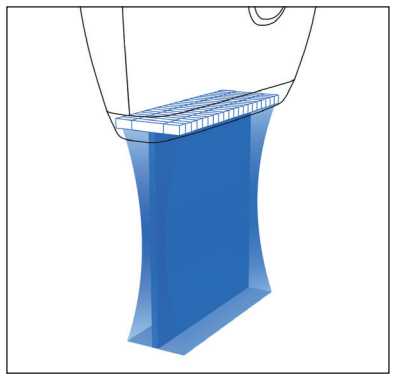
iBeam transmission: Multi-Sync Pulser



iBeam receiving: Multi-Beam Receiver



iBeam processing: Multi-Harmonic Compounding



iDMS technology

PIONEERING TRANSDUCER TECHNOLOGY

Unique i-series architecture leads to next generation transducer technology that can deliver images with more clinical benefits, such as an increased penetration for difficult patients, and a higher resolution. Aplio i-series transducers can be distinguished from conventional transducers by iDMS technology.

The newly developed low attenuation lens, high performance piezoelectric oscillator and optimized matching layer form the foundation for iDMS technology. iDMS is incorporated in the new 1.5D array transducers in Aplio i800 and i900 series for producing sharp and uniform beams in the lens direction, i.e. providing ultra-thin and uniform slices for enhanced elevation resolution. iDMS is a transducer technology that provides high-flexibility electronic focusing in the lens direction. With iDMS, focusing is not only done by aperture control but also by time delay and weighting control between center and adjacent elements. This technology generates a continuous focused beam in the lens direction at all depths. The result is a sharp and homogeneous slice thickness with high sensitivity, contrast and elevation resolution.

Ultra-wideband Transducers

Aplio i-series transducers have a significantly wider bandwidth* and can cover the frequency range normally requiring two transducers. (See Figure 1)

The two-in-one ultra-wideband transducers contain single crystal and re-engineered materials including a new lens, piezoelectric oscillator, and matching layer. This provides optimum resolution and penetration in one transducer, thereby improving the clinical capability, and potentially reducing the financial burden ensuring more effective management of transducers. The innovative ultra-wideband transducers are available for both convex and linear to cover a wide variety of clinical applications.

** Compared with Aplio 500 Platinum*

Professor David Cosgrove, MD.
Imperial College School of Medicine and Consultant in Radiology
Hammersmith Hospital
London, United Kingdom

"The ultra-wideband transducers i8CX1 and i18LX5 provide excellent images with high spatial resolution and contrast. With iBeam forming and iDMS technology, sharp and uniform images can be acquired easily. In addition, the new ultra-wideband transducer provide increased penetration at the same time.

The image of liver metastases (Figure 2) acquired using the i8CX1 shows high-resolution, contrast and penetration. The image is really uniform and contains extraordinary detail. The outline of the color Doppler signal has been enhanced (Figure 3), allowing detailed observation of the vasculature.

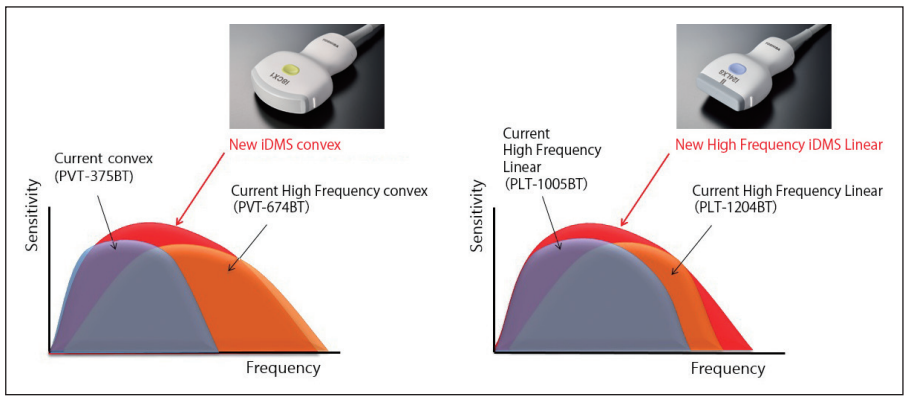


Figure 1. Ultra-wideband transducers

Figure 2. Liver metastases

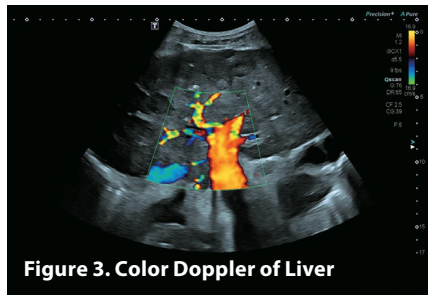


Figure 3. Color Doppler of Liver

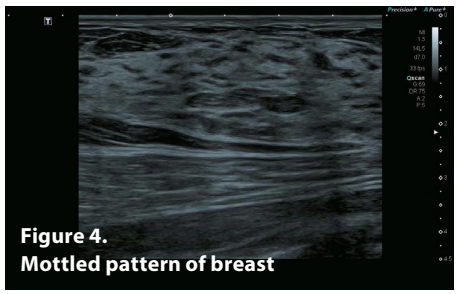


Figure 4.
Mottled pattern of breast

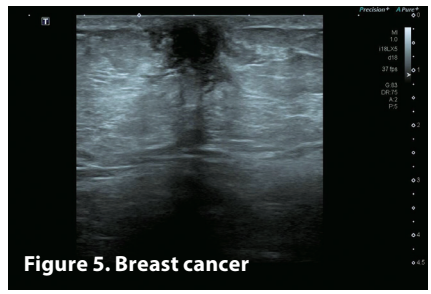


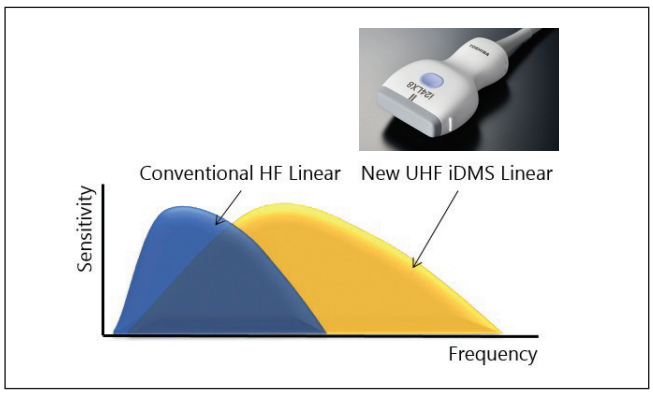
Figure 5. Breast cancer

Figure 2-5. Courtesy of Professor Adrian Lim, Imperial College London and Professor David Cosgrove, MD.

The i18LX5 wideband transducer is an outstanding versatile transducer that bridges many small parts applications. The two-in-one transducer provides exceptional detail and high penetration. The mottled pattern in the breast (Figure 4) can be observed with great contrast, resolution and uniformity, especially at depth. The invading margin of the breast cancer (Figure 5) is clearly shown in detail with good penetration. "

Ultra-high Frequency Transducers

The new Aplio i-series transducer i24LX8 offers an ultra-high frequency (UHF) of up to 24 MegaHertz with high spatial resolution. The new lens, piezoelectric oscillator, matching layer and backing combination allow high frequency emission. The elevated frequency range expands the horizon for clinical applications especially for small parts, MSK and other potential clinical regions.



Ultra-high frequency

Professor Jiro Hata, MD.
Department of Clinical Pathology and Laboratory Medicine
Kawasaki Medical School
Kurashiki, Japan

"For me, the i24LX8 transducer has become irreplaceable for diagnosis. The high frequency transducer has an extraordinary high spatial resolution that is useful for clinical regions such as thyroid, breast, vascular and MSK. At Kawasaki University, we receive a lot of requests for skin ultrasound. With the high-resolution, the epidermis and dermis can easily be differentiated and the origin of the lesion can be diagnosed accurately. A malignant melanoma (Figure 6, 7) which is only one millimeter thick, can be observed in high-resolution, followed by Superb Micro-Vascular Imaging (SMI)** to visualize its vasculature.

It is thought that penetration usually is a limitation for high frequency transducers, however, it is possible to examine the liver and gastrointestinal tract (Figure 8, 9) in clear detail with the 24L ultra-high frequency transducer.

SMI is a Canon Medical Systems unique Doppler method for delineating low velocity blood flow in high-resolution and in real time. The 24L is excellent for visualizing low velocity flow in minute vessels and SMI in Aplio i-series provides an even higher resolution and more penetration (Figure 10, 11). Detail information about vasculature in deeper regions can be obtained and the use of SMI can be further expanded. I believe that knowledge about diagnosis and pathology can be increased based on these new capabilities. I strongly believe that there will be dramatic changes in every clinical region."

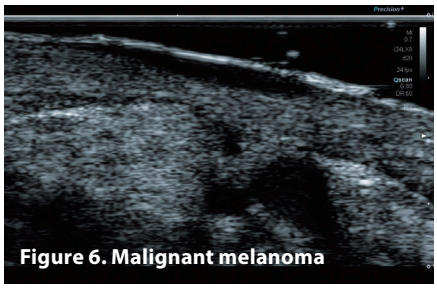


Figure 6. Malignant melanoma

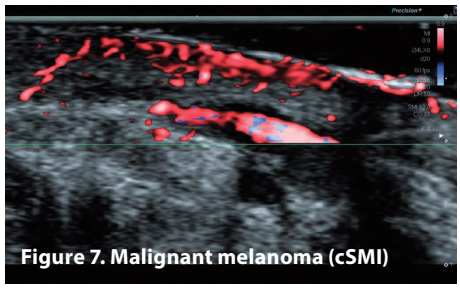


Figure 7. Malignant melanoma (cSMI)

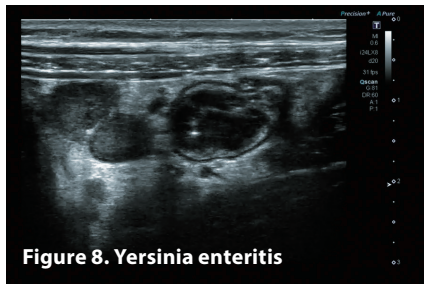


Figure 8. Yersinia enteritis

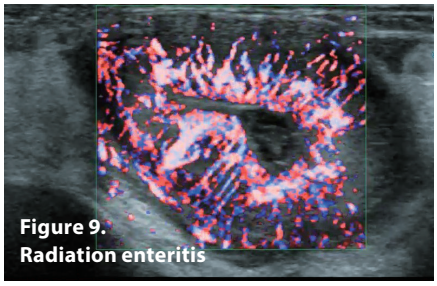


Figure 9. Radiation enteritis

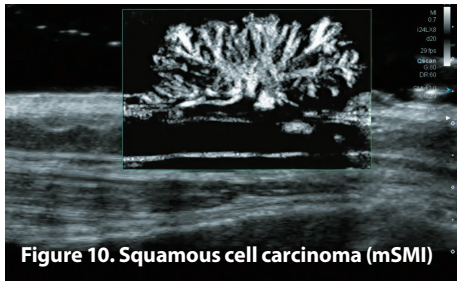


Figure 10. Squamous cell carcinoma (mSMI)

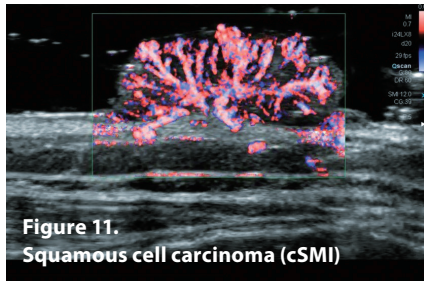


Figure 11. Squamous cell carcinoma (cSMI)

Figure 6-11. Courtesy of Professor Jiro Hata, MD.

***Available on the Aplio i-series, Aplio 500 Platinum, Aplio 300 Platinum and Xario 200 Platinum*

Multiplexing Technology

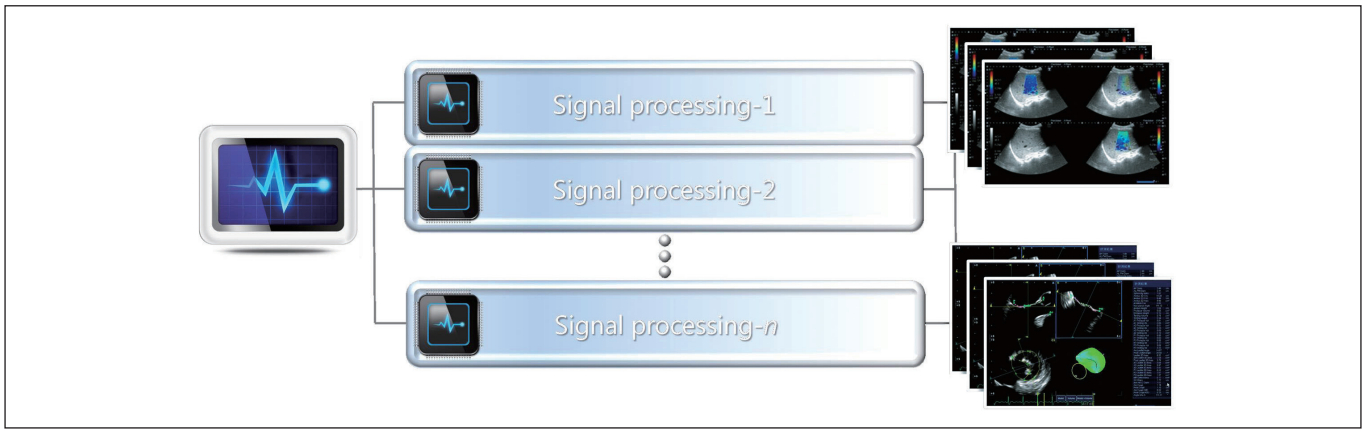
Multiplexing technology is capable of handling large volumes of data at high speed, which allows parallel processing of multiple advanced operations. Controlling the elements of the new iDMS transducers requires two to three times more computing capacity compared to conventional transducers. In addition, increased volumes of received signal data, caused by real-time processing of complex clinical applications, make powerful parallel signal processing technology essential.

The extraordinary power of parallel signal processing allows execution of different advanced applications which need huge computational performance, such as Quad View, Shadow Glass and Smart Sensor 3D.

Professor Fuminori Moriyasu, MD.
Center for Cancer Ablation Therapy
International University of Health and Welfare
Sanno Hospital, Japan

"Fusion imaging is really important for ultrasound-guided RFA. The new Ultrasound-Ultrasound (US-US) fusion function on Aplio i-series offers easy-to-use and accurate orientation information to assist RFA (Figure 12).

Another new advantage of Aplio i-series is the Quad display for Smart Fusion which presents CT/MR volume images, 3D body mark, US image, and blended US and CT/MR image respectively. The location of the transducer and the position of B-mode in relation with the volume is clearly



Multiplexing technology

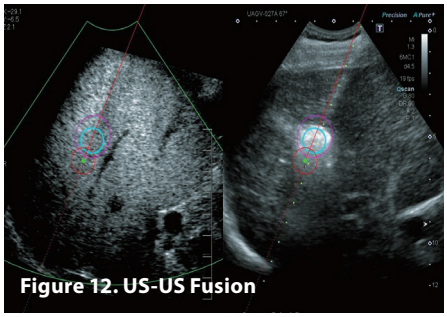


Figure 12. US-US Fusion

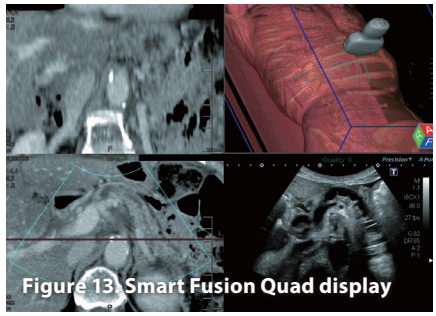


Figure 13. Smart Fusion Quad display

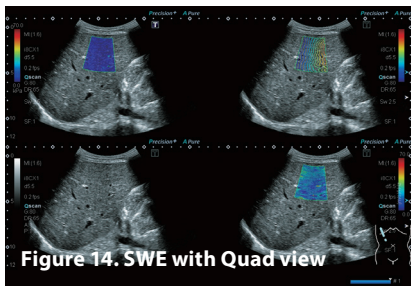


Figure 14. SWE with Quad view

Figure 12-14. Courtesy of Professor Fuminori Moriyasu, MD.

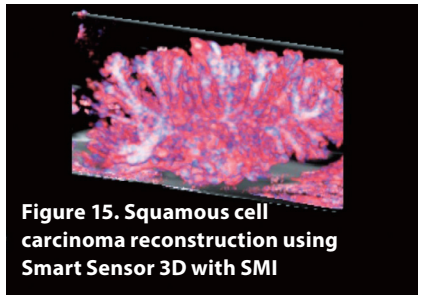


Figure 15. Squamous cell carcinoma reconstruction using Smart Sensor 3D with SMI

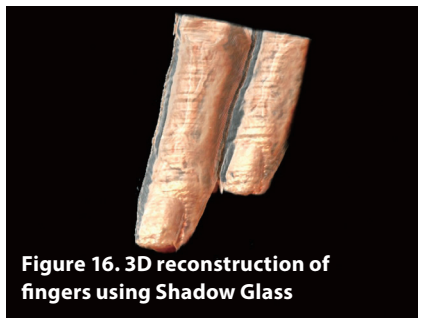


Figure 16. 3D reconstruction of fingers using Shadow Glass

Figure 15-16. Courtesy of Professor Jiro Hata, MD.

demonstrated in the 3D body marker. This gives a clear understanding of 3D orientation (Figure 13).

In shear wave elastography, a real-time propagation map, speed map, elasticity map, and B-mode image can also be displayed in Quad View, providing an intuitive overview for easy selection of ROI. Measuring using One-Shot acquisition delivers accurate, reproducible and reliable data for quantitative analysis. I believe that it will be widely used for diffuse liver disease, focal liver disease and other clinical regions (Figure 14)."

Professor Jiro Hata, MD.
Department of Clinical Pathology and Laboratory Medicine
Kawasaki Medical School
Kurashiki, Japan

"With Aplio Platinum 500, 3D images can be reconstructed using 2D transducers and Smart 3D. With 3D SMI, the entire vasculature in an area of interest can be visualized, potentially allowing more effective surgical planning and treatment evaluation. Now, with Aplio i-series, 3D images with accurate positioning information can be acquired by utilizing Smart Sensor 3D technology. By adding this orientation data, measurements on 3D SMI volumes can be performed and accurate surgical planning is possible (Figure 15).

One of Aplio i-series' new features for volume rendering is Shadow Glass. 3D semi-transparent volumes are reconstructed to observe tissue outlines (Figure 16). These volumes can also be combined with 3D color images of vascular flow. This allows clear understanding of tissue in relation with location of vessels which is helpful for accurate surgical planning."

CONCLUSION

Canon Medical Systems' Aplio i-series is an evolution for system architecture and transducer technology, driving image quality to a new level. The highly improved image quality and advanced applications, innovative transducer technology and advanced ergonomic design of the Aplio i-series provide healthcare professionals with more clinical confidence and increased clinical capabilities.

The clinical results described in this brochure are the experiences of the authors. Results may vary due to clinical setting, patient presentation and other factors.

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