GE Healthcare

Vivid 7 Dimension Real-time 4D imaging and Real-time 4D color imaging

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The Vivid™ 7 Dimension is a premier cardiovascular ultrasound system that builds on the strength of GE's powerful imaging platform, acquiring much more clinical information – and in fewer steps.

GE's innovative transducer technology allows you to use only one probe to acquire multiple planes of images at the same time, and from the same heartbeat, without changing probe positions.

This single, unique transducer gives you multiple imaging capabilities, such as Coded Octave Harmonics, color Doppler, Tissue Velocity Imaging, PW and CW Doppler – plus multi-dimensional and 4D imaging.

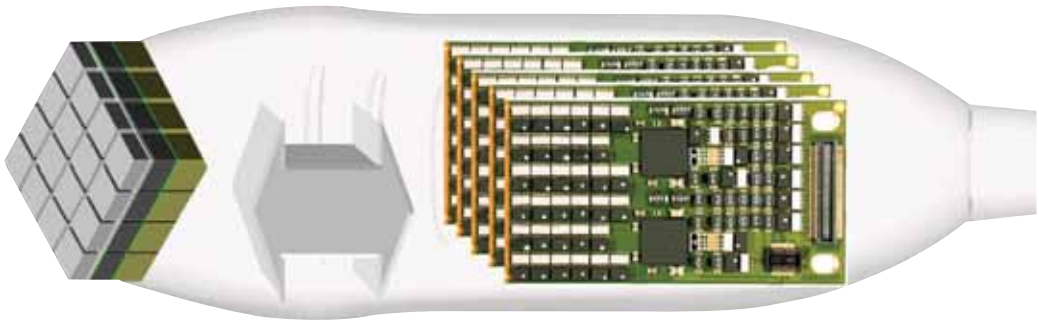
GE's real-time 4D imaging and real-time full volume imaging enable the user to acquire artifact-free depictions of the entire heart, to increase diagnostic confidence.

Real-time 4D color Doppler, and real-time full volume color Doppler imaging, offers instant display of 4D color for improved visualization, including the ability to quantify regurgitant lesions.

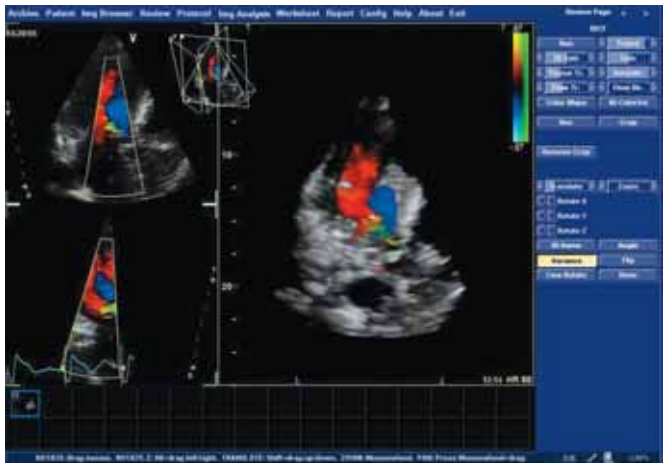
So, one transducer can be used to perform a complete exam, including stress and contrast imaging, which can significantly reduce exam time and streamline workflow.

Technical description:

The foundation for 4D imaging is the unique 3V transducer. This transducer has a true, non-sparse 2D array with thousands of transducer elements. With such a high number of transducer elements, part of the beam forming is made within the transducer itself. Cutting-edge material and electronic technology has made it possible to have very high dynamic range beam forming in the transducer. This results in a probe capable of scanning all modes, including the challenging CW Doppler mode. This technology makes it possible to steer the ultrasound beam in any direction, so that real-time 4D images can be acquired. For color imaging, this translates into unprecedented sensitivity in 4D color flow imaging. Even with such probe complexity, the design has been made with an ergonomically shaped transducer that allows easy access to imaging windows.



Real-time, non-gated 4D imaging

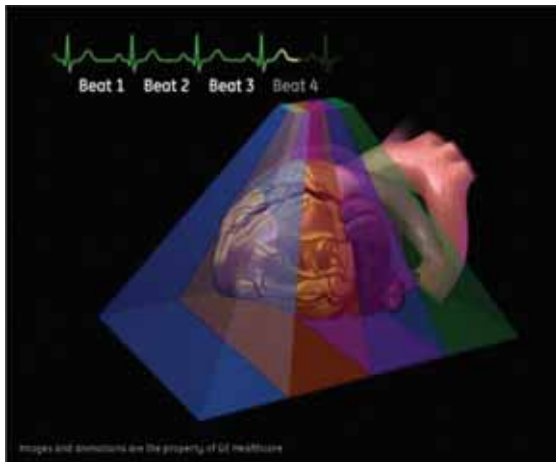


The 3V probe and the Vivid 7 Dimension are capable of acquiring real-time non-gated 4D tissue and color imaging. The volume data is displayed in real time with volume rendering techniques for visualization of valves and structures. The size and shape of the volume can be easily adjusted.

This system can even perform real-time non-gated 4D color imaging. The volume color data is simultaneously rendered with the volume tissue data. Tools like Volume Size enable the user to optimize the size and frame rate for the respective region of interest.

Raw data capabilities exclusive to Vivid systems, offer all the same post-processing functionality for 4D images that are available during the routine examination. For example, controls like color baseline or color maps can be adjusted on the EchoPAC workstation during analysis.

Real-time full volume 4D imaging



The Vivid 7 Dimension system enables the user to acquire large tissue volumes with gated acquisition. The powerful processing capabilities allow for real-time display of the data while the rendering continuously updates, so the user is not blind-folded while scanning, and can see when the correct data are acquired.

The highly efficient acquisition of color Doppler gives high volume rates in real-time 4D full volume color imaging. The user can easily change both the size of the color region of interest and the acquired frame rates using the Volume Size control.

The volume rendering technology for real-time 4D full volume color Doppler allows for effortless jet flow detection. The turbulent flow pattern can easily be rendered within the color volume data.

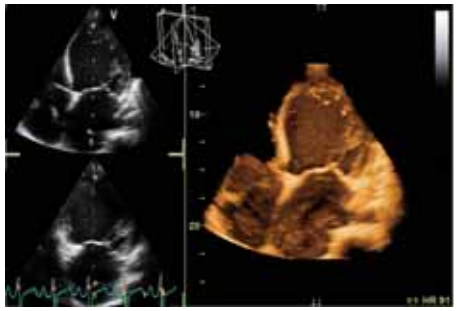
The scan setup for real-time 4D full volume color imaging also includes the flexibility to set the number of required cardiac cycles for acquisition. In addition, a number of navigation and cropping tools are available that allow for optimization of the 4D data.

Case study one

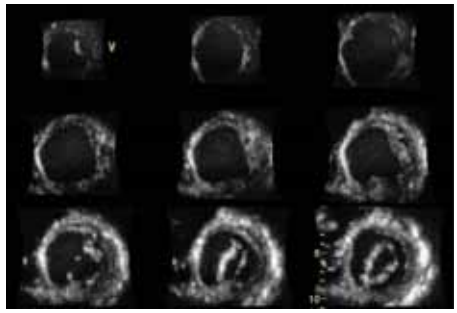
The following are images from a clinical case study evaluating a patient with a history of pacemaker insertion.

Optimization tip:

Increase 2D gain to visualize valves and increase 4D gain to visualize the back wall of the chamber.



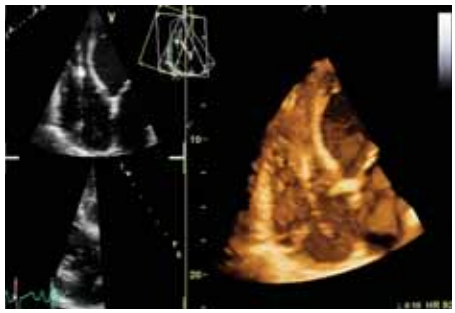
Real-time 4D imaging enables the user to see the 4D rendering in real-time, as the patient's image is continuously updated. This patient was treated with a single chamber pacemaker. This patient was followed with transthoracic echocardiography including real-time 4D imaging.



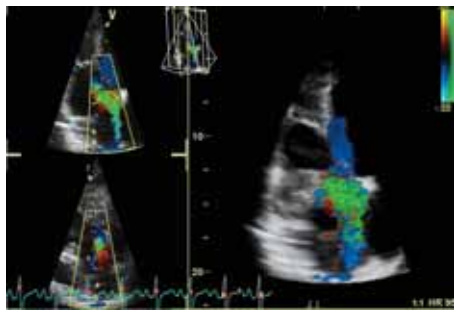
The patient's left ventricular function was assessed with real-time 4D full volume imaging. Following the full volume acquisition, 9 Slice mode can be used to further assess regional wall motion of the left ventricle.

Navigation and reference plane:

Use the navigation image located in the middle of the screen for orientation of the 4D dataset.



The patient's right ventricular function was also assessed with real-time 4D imaging. Here, the patient's pacemaker wire can be visualized through the right ventricle and into the right atrium. During the routine echo examination, mild to moderate tricuspid regurgitation was visualized.

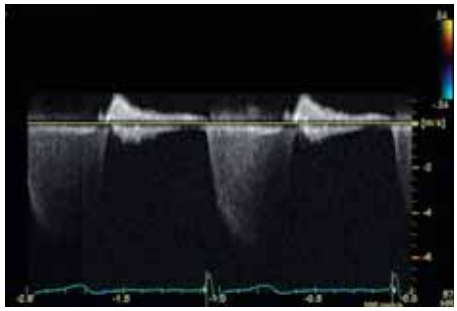


To assess the interaction of the pacemaker wire and the tricuspid valve, real-time 4D full volume color imaging was utilized. Here, the system demonstrates the extent of the tricuspid regurgitation as it extends into the base of the right atrium and is forced into the atrial septum by the pacemaker wire.

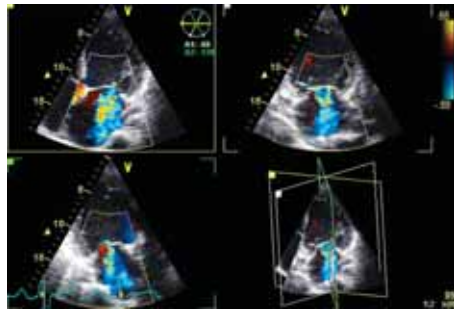
Case study two

The following are images from a clinical case study evaluating mitral regurgitation.

These images are all acquired from the same transducer, improving clinical workflow.



This patient presented with “moderate” mitral regurgitation. This patient’s mitral regurgitation was assessed by combining tools of continuous wave (CW) and acquiring multiple imaging views with color Doppler.



Multi-dimensional imaging, including tri-plane imaging, offers additional clinical confidence by evaluating color Doppler from three orthogonal views simultaneously, from the same heart cycle as seen. This patient’s mitral regurgitation, PISA, can be seen here from all three planes.

Optimization tip:

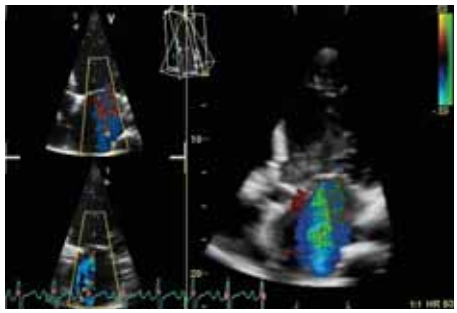
Use tissue transparency to suppress the appearance of the tissue to evaluate the interaction of this tissue structure with the color volume.

Vena contracta width ranges[3]:

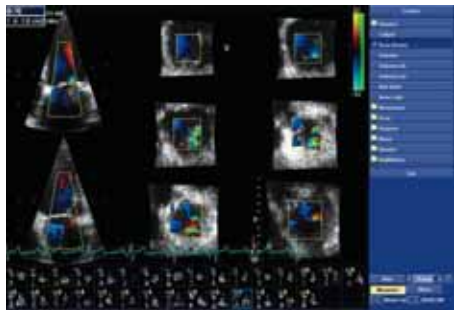
<0.3cm Mild

.3-.7cm Moderate

>.7cm Severe



The advances in 4D imaging can improve accuracy in the assessment of valvular regurgitation. What has been quantitatively evaluated from two dimensions can now be evaluated from a color volume acquisition. To assess this patient’s mitral regurgitation, we acquired a real-time full volume. The advantage of GE’s real-time 4D color acquisition is that the clinician views the information as the 4D image continuously updates in real-time.



One of the challenges in evaluating mitral regurgitation has been the ability to accurately evaluate the vena contracta. Following the acquisition of a full volume dataset, the user can use the 6 Slice mode to quantify the color volume acquisition in 6 short axis slices, giving the user the ability to isolate the vena contracta to perform a planimetry area of the narrowest part of the regurgitation.

Acquiring and rendering 4D datasets are easy to learn and adopt into clinical practice.

Real-time 4D acquisition

1. Select **3V probe**
2. **Optimize** IQ settings (gain, depth, TGC, etc.)
3. Press **4D** button
4. Adjust **4D (Active) Gain** as necessary
    a. Increase **2D gain** to see valves
    b. Increase **4D (Active) gain** to see back of the chamber
5. Select **Full Volume**
6. Press **Image store or Freeze**

Tissue rendering

7. Press **Angle**
8. Trackball **(Translate/ Rotate)** for image orientation
9. Use **Volume Optimize** or **Clarity** if necessary
10. Press **Image Store**

Real-time 4D color acquisition

1. Press **2D** and enter **Color** mode (Optimize IQ – depth, gain, TGC and ROI)
2. Press **4D** (RT Color)
3. Press **4D CF Prepare Mode**
4. Press **Full Volume** – (RT 4D Color FV)
5. Press **Image Store** or **Freeze**

4D color rendering

6. Press **Angle**
7. Use Trackball **(Translate/Rotate)** to optimize dataset for region of interest
8. Increase **Tissue Transparency** Evaluate Flow Transparency
9. Press **Store**

References:

1. Fang L, Hsiung MC, Miller AP, Nanda NC, Yin WH, Young MS, Velayudhan DE. Assessment of aortic regurgitation by live three-dimensional transthoracic echocardiographic measurements of vena contracta area: usefulness and validation. Echocardiography. 2005 Oct;22(9):775-81.

2. Khanna D, Vengala S, Miller AP, Nanda NC, Lloyd SG, Ahmed S, Sinha A, Mehmood F, Bodiwala K, Upendram S, Gownder M, Dod HS, Nunez A, Pacifico AD, McGiffin DC, Kirklin JK, Misra VK. Quantification of mitral regurgitation by live three-dimensional transthoracic echocardiographic measurements of vena contracta area. Echocardiography. 2004 Nov;21(8):737-43.

3. Zoghbi WA, Enriquez-Sarano M, Foster E, Grayburn PA, Kraft CD, Levine RA, Nihoyannopoulos P, Otto CM, Quinones MA, Rakowski H, Stewart WJ, Waggoner A, Weissman NJ. Recommendations for evaluation of the severity of native valvular regurgitation with two-dimensional and Doppler echocardiography. J Am Soc Echocardiogr. 2003 Jul;16(7):777-802.

4. A report from the American Society of Echocardiography's Nomenclature and Standards Committee and The Task Force on Valvular Regurgitation, developed in conjunction with the American College of Cardiology Echocardiography Committee, The Cardiac Imaging Committee Council on Clinical Cardiology, the American Heart Association, and the European Society of Cardiology Working Group on Echocardiography, represented by: William A. Zoghbi, MD, Maurice Enriquez-Sarano, MD, Elyse Foster, MD, Paul A. Grayburn, MD, Carol D. Kraft, RDMS, Robert A. Levine, MD, Petros Nihoyannopoulos, MD, Catherine M. Otto, MD, Miguel A. Quinones, MD, Harry Rakowski, MD, William J. Stewart, MD, Alan Waggoner, MHS, RDMS, and Neil J. Weissman, MD

Healthcare Re-imagined

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