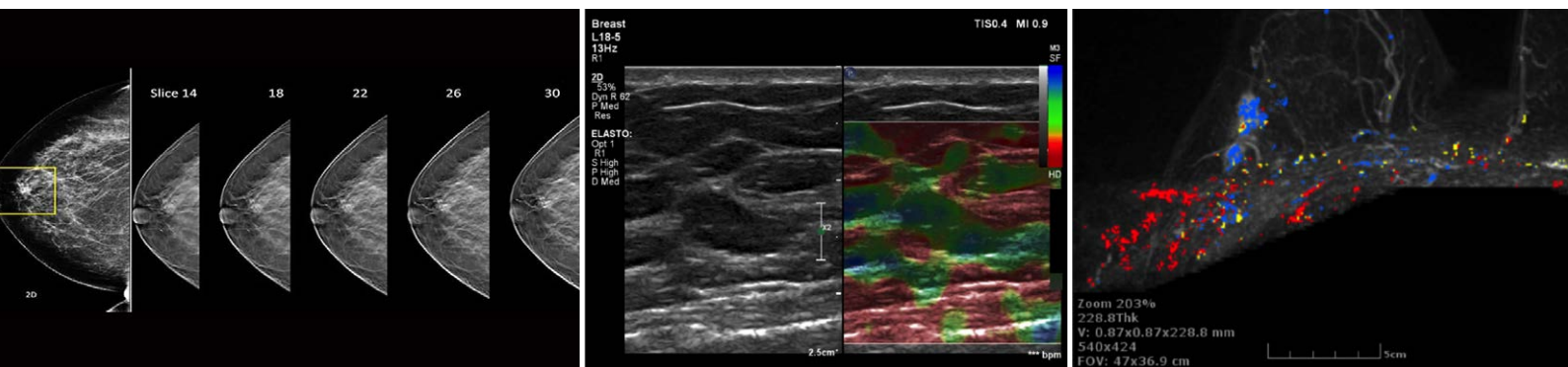


Unifying Breast Imaging

Breast MR, ultrasound, and 2D/3D mammography images working together for effective diagnosis

Pat Montgomery

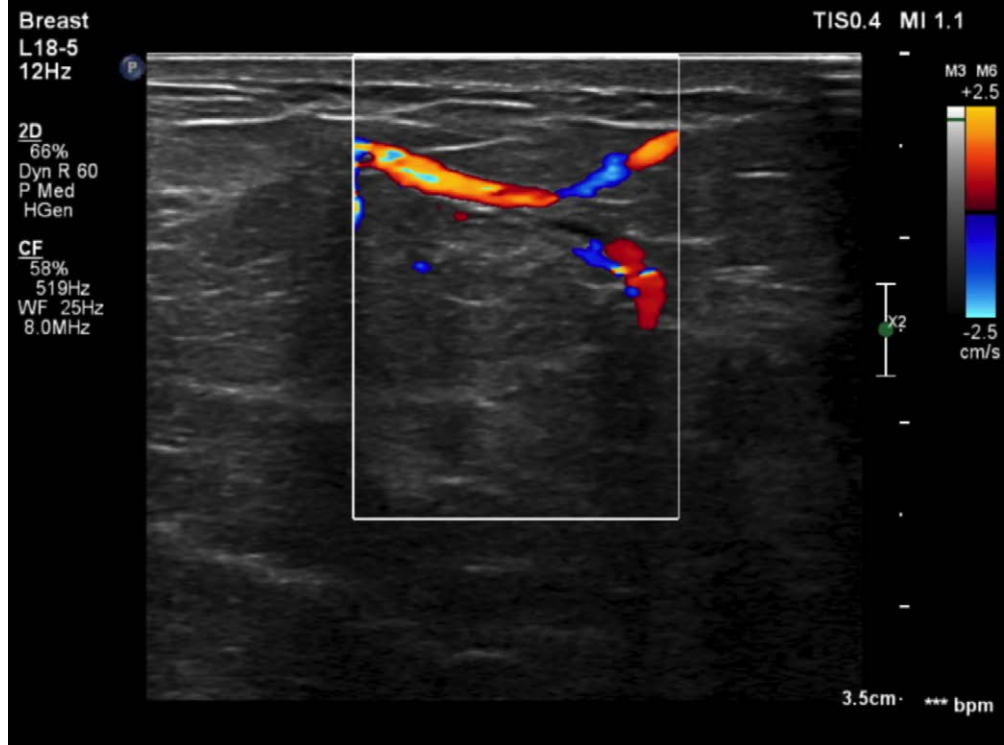
In many aspects the world of medicine revolves around radiology. Radiologists often discover the keys to unlock the puzzle and provide the diagnosis critical to medical decisions and patient care. It only makes sense then, to consider the quality of the tools used by radiologists, as one of the most critical elements in medicine.



From film to digital

Since Roentgen first discovered X-rays in 1895, the advances in the radiology imaging field have been dynamic. The growth in the complexity of imaging techniques, the addition of 3D technologies and the sheer number of imaging procedures used in the diagnosis and treatment of disease is a true testament to the critical nature of this technology. One of the key developments along this timeline was the move from imaging on film to the capture of digital images that could be displayed on high quality monitors for review by the radiologist. Thus began the on-going journey to continuously develop new methods to display these digital images in a way that optimized the radiologist experience and led to better results for patient care.

It is hard to imagine radiology today without digital imaging. But digital imaging has also brought about its own issues and challenges. In the film world, when images from supporting modalities were requested by the radiologist, it was simply a matter of rearranging the processed film images on a view box so they could be compared side-by-side. In the digital world that is not always as easy, or even possible, as each set of images often have their own very specific display specifications compelling the radiologist to use multiple workstations, perhaps even across multiple reading rooms, to view images aimed at one final diagnosis. Placing images on a view box also allowed the radiologist to look at many images simultaneously without being hindered by a lack of real estate. When those same images are displayed on digital monitors the radiologists can often only see a portion of the images at one time as they are limited by the available screen space of the monitors.

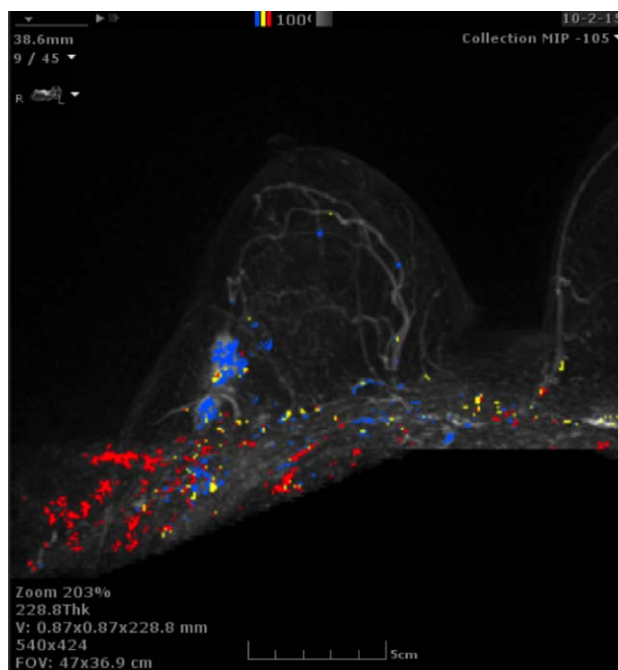


An ultrasound of the breast is often utilized to help characterize mammographic abnormalities and to assess blood flow with Color Doppler.

Breast imaging: an extra challenge

The field of Breast Imaging has always been one of the leading examples of this challenging, disconnected reading environment. Digital mammographic images require the highest resolution and brightest grayscale monitors for review, while images from supporting modalities such as PET, US, MRI or

NucMed require monitors that support color display. The need to view these supporting modalities is a common occurrence in the daily workflow of the Breast Imaging Radiologist as Breast US and Breast MRI have always been a part of the best practices for diagnostic mammography.



Breast MRI can be a key piece of the determination of the size of a breast cancer or to scan the breast tissue for additional cancers that might not have been seen on the mammogram.

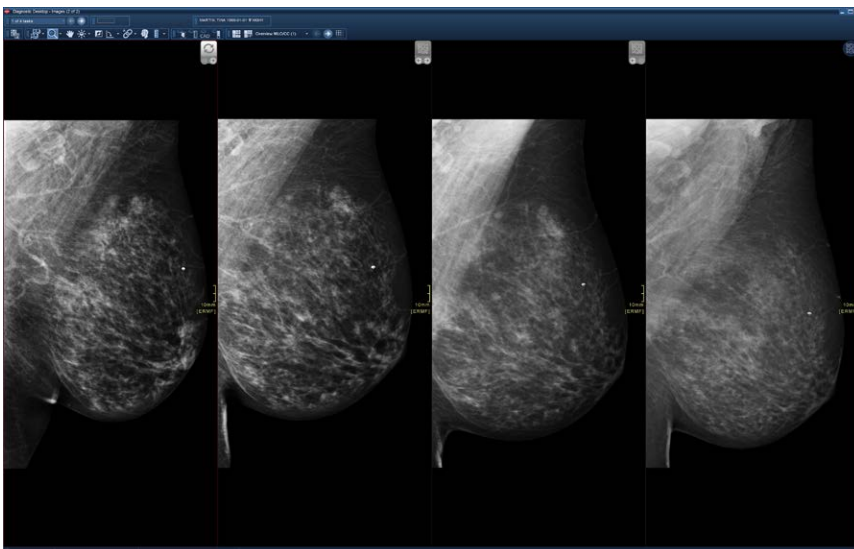
In 2012 the ACR Appropriateness Criteria was updated to reflect support for utilizing Breast US and Breast MRI as a part of the screening mammography best practices for patients in the high risk population for breast cancer. This change to the best practices is a positive move for improving the breast cancer detection rate and improving patient survival, but it also brings more focus onto the hindrance presented to Breast Imaging Radiologists as a result of lack of a color display that supports viewing mammography images. It is increasingly critical to provide ease of access for these studies for the radiologist.

The rise of Digital Breast Tomosynthesis

Breast Imaging Radiologists have been dealing with the limitations of lack of color and limited screen space on a mammography approved display monitor since the conversion from film to digital imaging in the late 1990s. Another new challenge was recently added to their plate with the launch of 3D Digital Breast Tomosynthesis. The Breast Tomosynthesis exam creates a 3-dimensional picture of the breast by reconstructing multiple projection images taken over a limited arc angle. The radiologist then scrolls through individual "slices" of the breast

challenge of limited screen space, they are now also presented with the need to scroll through 50-100 slices of breast tissue for each of the 4 views of a normal screening mammogram.

Regardless of these challenges, Breast Imaging Radiologists are passionate about detecting breast cancer at the earliest stages and welcome any new imaging techniques such as 3D Digital Breast Tomosynthesis that allow them to increase the detection rate and improve the health of their patients. It is important that the technology used to display existing and new imaging technologies keep pace and support the needs of the radiologists. They may be the Sherlock Holmes of medicine but they can't unlock the puzzles without the right set of tools.



Comparing multiple prior screening exams is a critical piece of the review process.

Lack of color on a display monitor certified for mammography isn't the only display hurdle faced by Breast Imaging Radiologists. They are also often limited by the real estate available on the monitors. For example, comparing multiple prior screening exams is a critical piece of the review process.

tissue in order to improve visualization of breast lesions, particularly in women with dense breast tissue. Studies have shown Breast Tomosynthesis can increase cancer detection by 27% and increase detection of invasive cancer by 40%⁽¹⁾. It is also reported to reduce unnecessary callbacks by up to 40%^(2,3). These results speak for themselves as to the value of Breast Tomosynthesis, but it doesn't come without an impact to radiologist workflow. In addition to requiring multiple reading stations in order to display grayscale and color images, and the

A unified workflow

Luckily there is a new day dawning in the world of radiology and thanks to the Barco Coronis Uniti™ display system that day is bigger, brighter and more colorful than could be imagined. The Coronis Uniti's large 33" form factor and 12MP resolution, combined with 1000 cd/m2 of brightness, is a real game changer. Never before have radiologists had a tool that provided this much real estate with the image quality that comes as a result of the 12MP display and the boost in brightness of the Coronis Uniti. That in itself might seem like a lot to deliver to the market, but the Coronis Uniti doesn't stop there. It provides users the ability to visualize studies in grayscale as well as color.

Now THAT is the real game changer.

The Coronis Uniti is now allowing radiologists to bring it all together on one display. "One display. Any Image." may sound like just another marketing slogan but it is truly at the heart of what is needed for an accurate, efficient diagnosis from the radiologists reviewing these exams. It has been reported that 85% of radiologists today utilize 3 or more displays in their normal workflow and 60% (84% in the US) utilize a mix of color and grayscale monitors⁽⁴⁾. To be able to unify this workflow and bring all the images



The ability to display a mammogram with an identified area of concern on the same display as the corresponding US and MR certainly improves our efficiency in delivering an accurate diagnosis for our patients.

of concern onto a single display is key to improving workflow...and more importantly, patient care. The fact that the Coronis Uniti is able to deliver this performance on a monitor that is cleared by the FDA with intended uses for digital mammography, including Breast Tomosynthesis, is the most significant aspect of this display monitor.

Dr. Alice Rim, Vice Chairman of the Imaging Institute and Head of Breast Imaging In the Department of Diagnostic Radiology at The Cleveland Clinic clearly sees the value of the Uniti display. *"The color capability of the Uniti is a step in the right direction for improved workflow and patient care. The ability to display a mammogram with an identified area of concern on the same display as the corresponding US and MR, certainly improves our efficiency in delivering an accurate diagnosis for our patients."*

Dr. Alice Rim

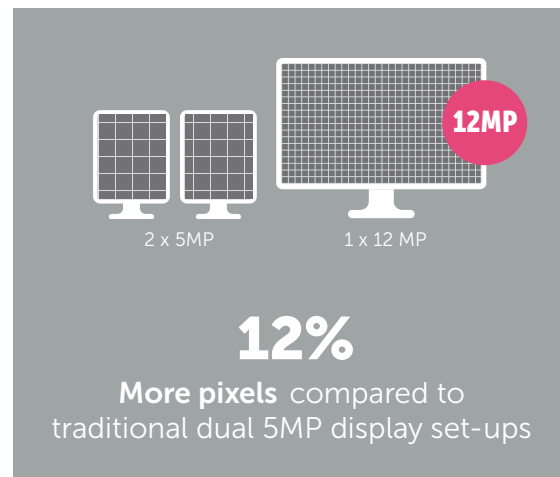


Image quality

We can talk about the lack of color and the limited screen real estate as being critical to radiologist workflow, but 91% of radiologists feel that image quality is the most important factor when it comes to impacting their reading performance⁽⁴⁾. The Coronis Uniti supports this need in multiple ways.

The single 12MP display is a 12% increase in pixels over the dual 5MP displays that have been the accepted norm for digital mammography. The increased number of pixels along with the unique Optical Glass of the Coronis Uniti allows radiologists to visualize more details, especially in dense breast tissue. Additionally, the Uniti offers the highest luminance available today on a digital mammography monitor – 1000 cd/m² – and has the ability for the user to boost this luminance to 2000 cd/m² as needed.

The impact on image quality is directly related to patient care as expressed by Dr. Robin Shermis, Medical Director, ProMedica Breast Care and member of Toledo Radiological Associates, *"With the Coronis Uniti, **we can catch more ductal carcinoma in situ (DCIS) lesions, indicating the earliest form of potential breast cancer.** The sooner we can begin treatment, the better our opportunity for a successful outcome".*



Screen real estate and field of view

The thought that went into the design of the Coronis Uniti field of view shows the commitment to radiologist workflow as well as to the health of the radiologist. 87% of radiologists experience physical discomfort when reading images⁴. The 33" diameter screen of the Coronis Uniti eliminates the distraction of the center bezel present on the dual 5MP displays and is designed to mirror a human's natural field of vision to minimize head, neck and eye movement.

The combination has a definite impact on the physical stress of the radiologist, and therefore on their performance during the day. Dr. James Ruiz, Radiologist and Breast Imaging Specialist at Woman's Hospital in Baton Rouge comments: *"The combination of the field of view and the luminance is without a doubt reducing the stress and fatigue I feel over the course of a day or a reading session. The reduction in eye fatigue is noticeable and there is an overall increased level of reading comfort due to the reduction in hand, head and eye movement. **The workflow focus the user gains as a result is the key. It is human nature that when we are less tired, we are smarter.**"*

The additional 20% screen real estate that is a result of the 33" diameter screen allows radiologists to be more efficient and reduce the number of clicks and panning needed to visualize high resolution mammography images. It is still sometimes necessary to zoom or mag the mammogram images and/or display them at the true 1:1 pixel display to take advantage of the high resolution at which they were acquired.

However, the frequency of these steps is lessened and once they are displayed at the larger size, less panning is needed to visualize the entire breast. If even 3 or 4 clicks are eliminated on every screening exam read in a day, the extra real estate of the Coronis Uniti can potentially save a radiologist hundreds of clicks/day. This certainly adds up to a time and physical effort savings at the end of the day.

Color, color, color

The importance of including the capability for color display on the Coronis Uniti cannot be emphasized enough. It is the defining piece of this newest display. As mentioned earlier, it is the real game changer for the workflow of the radiologists, and therefore, for patient care. Breast Imaging Radiologists and the software vendors that provide the reading workstations have been creative over the years in an attempt to allow the reader access to color without the effort to change reading stations.

The drawback was the need to utilize the extended monitor of the workstation, often called the navigation head, to display the color images. This required the radiologist to manually move the color images to the extended monitor and lose the information presented on the monitor, such as patient history. The extended monitor is also smaller than normal diagnostic monitors so the ability to visualize these studies was not optimum. This solution was only a partial fix as there were color applications which could not easily be placed on the extended monitor, such as MR CAD.

With the Uniti color and grayscale combination these workarounds and limitations disappear. Radiologists can utilize the Uniti to read ALL studies on ONE display. A few years ago this was just a dream. The reality of what the Coronis Uniti has delivered is having an immediate impact on radiologist workflow. **"The ability to view color and grayscale simultaneously saves me at least 30 minutes over the course of a day, while reducing fatigue typically associated with moving color images back and forth between extended monitors."** Dr. Ruiz continues, **"The color capability of the Uniti provides us the ability to efficiently integrate and support the need for additional Breast MRI and US studies in the screening environment. Providing these imaging techniques for women in a high risk population is paramount to our drive for the earliest detection of breast cancer."**

The ability to display all images on one display also improves operational efficiency for the department. Stan Casteel, Director of Imaging at Hamilton Health Care System comments, *"The Coronis Uniti is a large part of our technology excellence strategy to deliver better patient care. Quality is number one, with operational efficiency a close second. Uniti is definitely most cost-effective in that it is one display, versus multiple displays. The simplicity and universality of Uniti, of having the quality to read everything from mammo to an extremity x-ray, improves our radiologist productivity."*

Intuitive workflow features

Demonstrating another technology leap, the Uniti display has workflow features built into the display system. Users have normally depended on the modality or PACS vendors that supply the reading stations to deliver the workflow tools. To be able to gain additional tools by way of the display system is certainly an added benefit.

Two such tools are SpotView™ and SpotView Mag. SpotView allows the user to boost the luminance in a user defined region of interest while simultaneously dimming the surrounding image. SpotView Mag can then be applied to magnify the illuminated region of interest by 2X.

Dr. James Ruiz is impressed with the result. *"The Uniti comes complete with an impressive software package that allows users to specify color temperature (blue base or clear base from the film world) with a simple click of the multi function touch pad. The Coronis Uniti software package also includes two very impressive tools that have quickly become part of my daily reading routine – SpotView and SpotView Mag."*

These tools have positively impacted my decision making speed when evaluating calcifications for possible call-backs when reading screening mammograms."



SpotView focuses the light on areas of interest

SpotView can decrease errors of perception and I have found it to be helpful in maintaining my focus when scanning patterns are made difficult by distractions or eye fatigue. I have found abnormalities using SpotView even though I thought I had finished searching a case.

Support for 3D Digital Breast Tomosynthesis

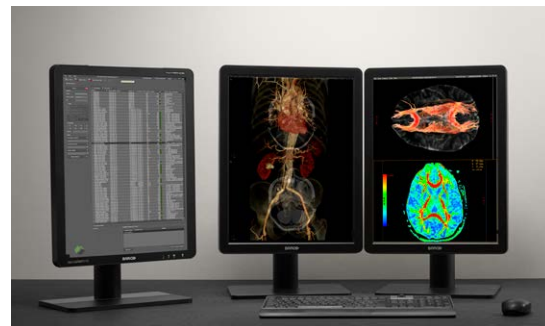
Being able to support and improve the reading of 3D Digital Breast Tomosynthesis studies appears to have been a key driver in the design of the Coronis Uniti as well. The Coronis Uniti display includes RapidFrame™ technology that allows the user to scroll or cine through large sets of Tomosynthesis slices without lag or blurring of the image. Testing has shown a 10% higher detection of micro calcifications while scrolling tomosynthesis images as a result of the RapidFrame technology⁽⁵⁾.

As the number of Tomosynthesis studies grows, this will certainly be a critical advantage for the radiologists AND patients. Dr. James Ruiz reports, "I can detect the improvement when using the Coronis Uniti to scroll through Tomosynthesis slices and also when using zoom or mag on mammography images. If I read these same studies on a workstation without the Coronis Uniti, the difference in image quality and my ability to clearly visualize the slices is evident."

Eliminating the divide

The large 33" form factor of the Uniti allows one monitor to take the place of the standard dual 5MP displays. Eliminating the dividing bezel between the two monitors is certainly less distracting to the eye as the radiologist is comparing studies side-by-side. "I can view multiple images simultaneously in workflow fashion, without the distraction and discomfort of viewing several monitors", comments Robin Shermis, MD, Medical Director, ProMedica Breast Care and member of Toledo Radiological Associates.

One monitor is also always better than two when it comes to maintaining the strict Quality Assurance and Quality Control requirements for digital mammography. Shelly Weber, Quality Control Lead at The Cleveland Clinic Breast Center appreciates the reduction in the sheer number of monitors for conducting the routine Quality Testing. "When you have as many display monitors as we do at the Breast Center, the need to test and certify one monitor per station instead of two, is a definite benefit to our workload."



The old reading room

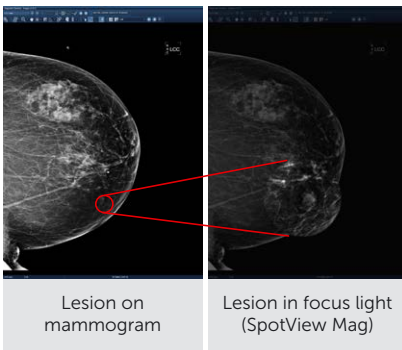


The new reading room

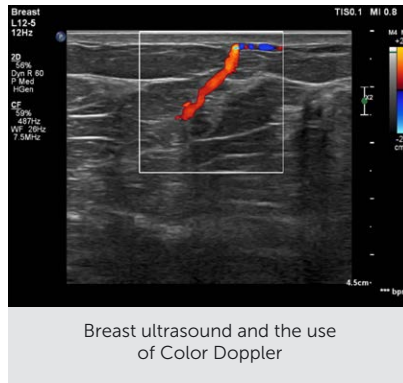
Use case

Perhaps looking at a common scenario faced by Breast Imaging Radiologists is the best way to emphasize the value of the Coronis Uniti for delivering a unified workflow and improving patient care.

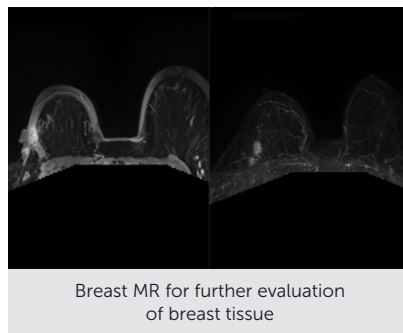
Let us consider the case of a screening mammogram on which the radiologist visualizes an irregular mass with spiculated margins. Perhaps this lesion is visible on the 2D mammogram or on one of the slices within the 3D Breast Tomosynthesis study. Visualizing this mass can be made easier with the high resolution and luminance of the Uniti and the use of the RapidFrame technology to scroll the 3D slices. Following any additional mammographic imaging, the standard of care would likely then be to recommend a Breast US of the area of concern to further define the lesion.



The US is utilized to evaluate shape and margins of the lesion as well as to evaluate if the lesion is cystic or solid. The use of Color Doppler on the US is critical to evaluate the speed and direction of blood flow as malignant lesions may stimulate the growth of abnormal blood vessels. The use of color is one way to evaluate the vascularization of the area, and thus the potential for malignancy. The ability to view the Color Doppler US on the same display as the mammogram greatly supports the radiologist in the characterization of the lesion and to define the next steps for the patient.



Based on the results of the Breast US, it may be determined that a Breast MR is the best method to further refine the diagnosis and to evaluate the breast tissue for other cancers that may not have been visible on the mammogram or US. Providing a display system that gives the radiologist the ability to view all of these studies simultaneously on one high resolution color monitor is the RIGHT thing to do for improving patient care.



Dr. Alice Rim agrees that the Coronis Uniti goes a long way towards the ultimate goal of unifying the radiology workflow, including the demanding world of Breast Imaging Radiology. "The Coronis Uniti is **one display** that can be used to view **any image** - color or grayscale, static or dynamic - with enough real estate available to bring it **all together** for a **unified workflow**. This game changing display will allow facilities to change the reading room dynamics so the radiologist focus is solely on the care of their patients without concern for which workstation to utilize to view images."

There truly is a new day dawning in the world of radiology, and thanks to the Barco Coronis Uniti that day is bigger, brighter and more colorful than could be imagined.

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About the author



Pat Montgomery is a recognized industry expert in the field of Digital Breast Imaging with extensive background in efforts to improve patient outcomes through solutions that provide the

highest image quality and optimized radiologist workflow. Pat began her career with E.I. DuPont in 1979 where she held various engineering and management roles within manufacturing facilities, including the facility where Mammography Film was produced. In 1998, Pat combined her expertise in workflow efficiencies and dedication to quality standards into the role that became her life's passion – Product and Marketing Manager, Breast Imaging for Agfa HealthCare. Pat retired from Agfa in 2014 after developing award winning campaigns such as “Every Woman is a Hero” and “Embrace the Passion for Women’s Care”.