

SteadyColor



As the pioneer and industry leader of medical calibration technology, Barco again raises the standard for image quality for diagnostic viewing applications. Barco introduces new SteadyColor color calibration technology with the launch of its new flagship product "Coronis Uniti." SteadyColor builds on the vast color know-how Barco has developed over the past several decades, while further advancing one of its core technologies.

Increasing use of color in medical applications

As the use of color in medical imaging continues to evolve, going beyond simple annotation to depicting more complex diagnostic information, medical displays must meet a higher standard for color in line with those used for medical grayscale displays.

First generations of medical color displays provided some means to guarantee stable and calibrated DICOM grayscale images. The latest advances in medical imaging, however, mandate more advanced calibration technology to guarantee consistent color images in space and time. Recent technological breakthroughs with respect to color calibration will enable our new generation of diagnostic displays to achieve this goal, and enable radiologists to rely on the diagnostic value of color if present in the image.

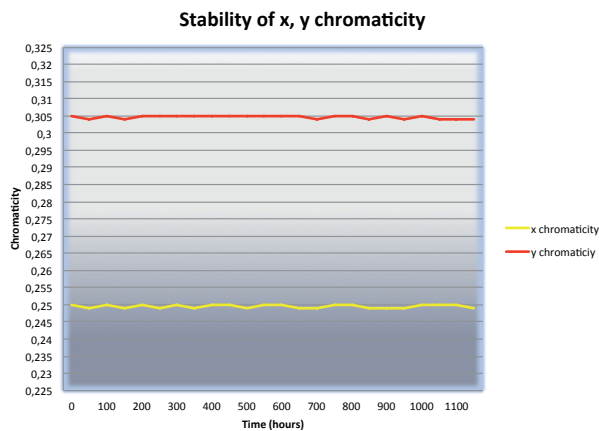


Fig 1: Color stability on Coronis Uniti

It is possible to do a DICOM Grayscale Standard Display Function (GSDF) calibration on a few displays if one has the necessary hardware provisions to keep the image stable over both short and long periods of time. Without proper image stabilization hardware, it is impossible to do a successful software calibration, as the display will quickly drift out of DICOM specification.

Advanced medical displays have multiple sensors that continuously monitor and adjust display parameters to maintain picture consistency over long periods of time. In typical displays, most sensors can measure a single luminance (black to gray), correcting deviations as needed. Few displays are capable of measuring and correcting multiple gray levels. Using the new I-Guard, the Barco Coronis Color display systems can measure color on multiple levels. However, earlier versions of the display could use advanced sensor technology only to maintain DICOM GSDF consistency over time.

The new SteadyColor technology available on the Coronis Uniti display system can stabilize colors and execute advanced calibration for both grayscale and all Just Noticeable Differences (JND's). Coronis Uniti achieves this using multiple sensors in combination with numerous 3D Look-Up Tables (LUTs).

DICOM calibration on previous generations of medical grayscale and color displays

Fig 2 and Fig 3 below clearly illustrate how SteadyColor compares to former DICOM calibration on earlier Barco medical color displays.



Fig 2: DICOM GSDF JND's On Grayscale & Color Displays Perfect Grayscale JND's but color ??

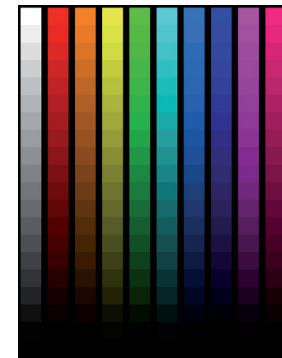


Fig 3: Color JND's On Coronis Uniti Perfect Grayscale JND's & Color JND's

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On previous generations of medical displays, only the grayscale JND's were calibrated (see the black to white grayscale on the left in Fig 2). When properly executed, equal steps in Digital Driving Level (DDL) result in equal perceptual gray differences, as seen in the graphic. However, the red scale completely disappears as soon as the red becomes brighter. Some color JND's in the red area are squeezed, while others are stretched over the available range, which occurs for other colors as well.

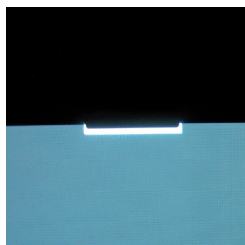
Fig 3 shows how Coronis Uniti's SteadyColor calibrates both gray and color values in adjacent steps, which are also much more equally distributed.

Maintaining image quality and DICOM-compliance under all lighting conditions

Radiologists expect the quality of their medical images to remain stable over time. While data stored in the computer archive is purely digital (and thus, stable), the perceived image on a display is not. Changing ambient lighting conditions in the reading room can influence the display's performance, the resulting image on screen, and consequently, the radiologist's ability to detect subtle information. SteadyColor technology automatically factors in the ambient lighting conditions during the calibration process to ensure accurate color JND's.

New Color I-Guard

As an essential component of Barco's Coronis family of diagnostic displays, I-Guard has become the industry standard technology for monitoring image quality and DICOM consistency. This new generation of I-Guard has been improved to measure much finer gradations of colors spread over the color gamut of the display. See <http://www.barco.com/en/Products-Solutions/Displays-monitors-workstations/Medical-displays/Diagnostic-displays>.



Barco's new Color I-Guard (Fig 4) is an embedded optical precision colorimeter positioned at the front of the LCD screen, which captures precisely what the radiologist sees: the result of the complete image formation process of the LCD, including the graphic board, the LUT, the driving electronics,

Fig 4: New Color I-Guard is discreetly embedded in the display.

the backlight and the Liquid Crystal cells. I-Guard continuously monitors the light and color output of the red, green and blue contributions without disturbing the actual image display. It then communicates its readings to the controlling electronics, which make corrective actions to the LCD in real time.

3D Color Look-Up Table

The new I-Guard also performs a color characterization of the color gamut of the display by measuring a large combination of different colors that can be displayed on the screen. Then, SteadyColor uses an advanced algorithm to determine how the individual colors should be adjusted so that equal color-driving levels result in color JND's. SteadyColor employs floating point calculations with nearly infinite resolution capabilities to calculate the JND's, improving accuracy beyond what typical hardware calculations based on integers can provide due to their fixed bit length.

The resulting information is put in a hardware 3D LUT that enables the display to adjust color driving levels in real time so that the proper Luminance + Color appears at the front of the display. This is the same used in a traditional medical display implementing Grayscale Standard Display Function (GSDF). Here, the DDL are also converted in real time to the proper light output. As GSDF only defines luminance, a one-dimensional LUT can perform this less complex task.

The result can be observed in Fig 5 and Fig 6 below. Fig 5 shows the colors before the JND's are calibrated on the Coronis Uniti display, whereas Fig 6 shows the JND's after calibration.

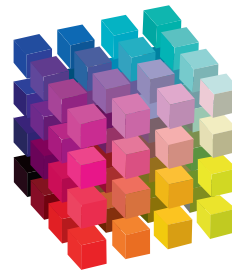


Fig 5: Before Calibration

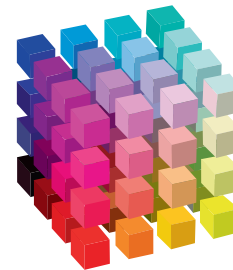


Fig 6: After SteadyColor Calibration