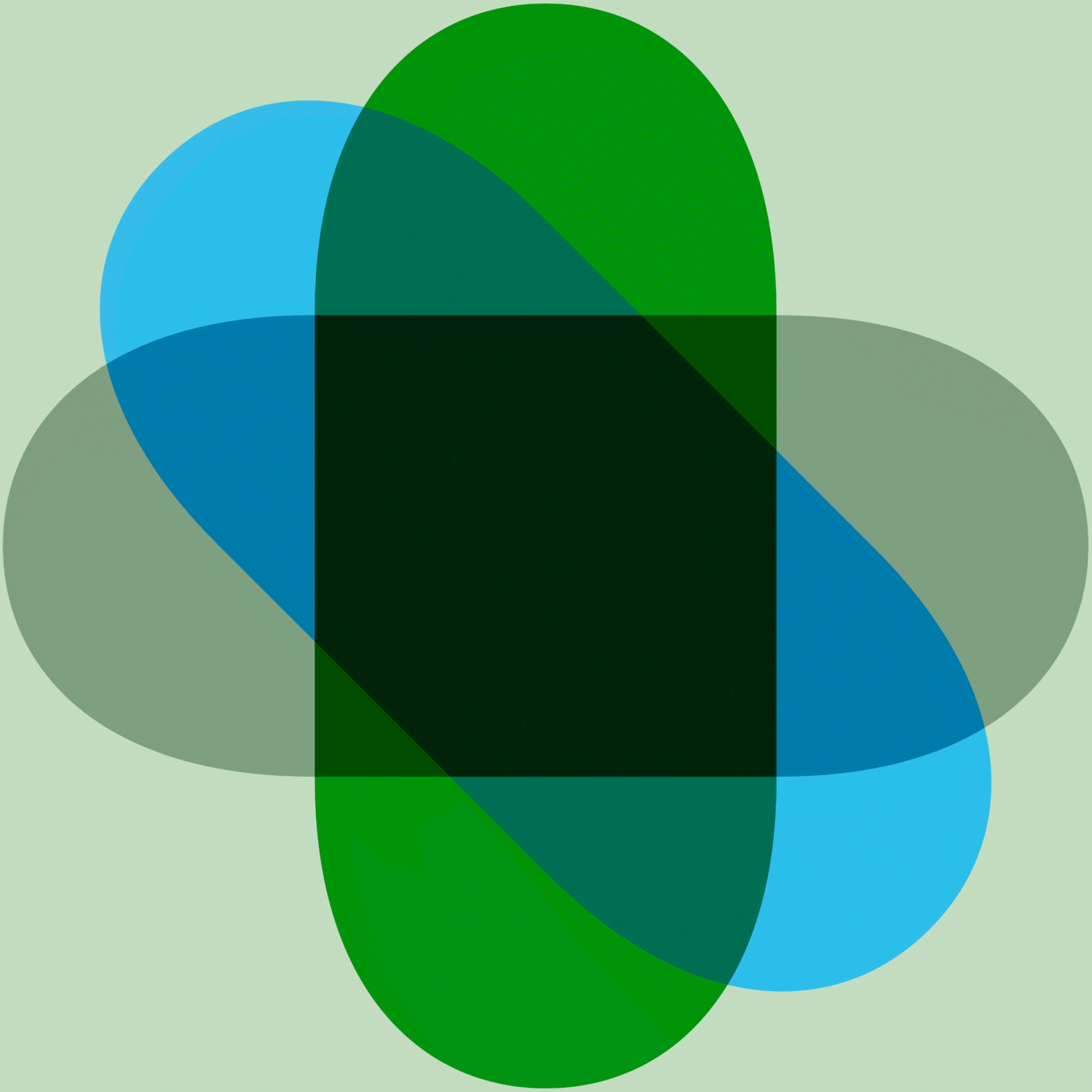


megapixel™

HELIOS®

Technology Overview

2025-03-12

Contents

About Megapixel

Megapixel is the unrivaled authority in cutting-edge professional display technology and video processing for top-tier brands, creatives and design-led homes. Led by Jeremy Hochman and Keith Harrison, our unrivaled team of engineers and designers consistently delivers the most unique and breakthrough LED solutions to market, helping our visionary clients bring their ideas to life in ways that inspire a sense of wonder and make the seemingly impossible possible. With over 300 patents and award wins from Live Design, the Emmys, and the Oscars, we endeavor to always be at the forefront of digital displays and technology for which we set the bar as the industry standard.

We are the unrivaled authority in cutting-edge professional visual technology and video processing for top-tier brands.

1

Introduction

As direct-view LED pixel pitches get finer, a moderately sized display can quickly go beyond 4K/UHD resolution. While image resolution is important, other image quality differentiators such as dynamic range, contrast ratio, frame rate, bit depth, and color gamut are equally important to image quality. The processing system that is used to drive direct-view LED displays must be equipped with the right features to address and support these important elements beyond simply lighting up the pixels.

With this in mind, what can be done at a processing level to maximize the output performance of the latest LED technologies?

In the next few sections of this document, you will see a series of photographs of actual LED screens performing side-by-side. The images will demonstrate how superior processing results in optimal visual performance, especially in the near-black portion of the grayscale range. All of these displays are of the same model number and production batch for a fair and proper performance comparison. No photos in this document have been altered in any way.

2

Components of near-black video performance

This white paper will focus primarily on the near-black region of Megapixel's HELIOS® LED Processing Platform. There are three major attributes that contribute to processing quality in this video region:

- Grayscale bit-depth
- Gradient smoothness
- Gamma tracking

Grayscale bit-depth and gamma tracking are technical software and hardware performance features that make a display objectively better — these elements can be measured and graphed for accuracy. Gradient smoothness, on the other hand, is often content-related and upstream of a display, yet this attribute can also be improved upon via processing algorithms.

Viewers often incorrectly interchange the terms "grayscale" and "gradient" performance, however they are not the same, as will be demonstrated in the subsequent sections.

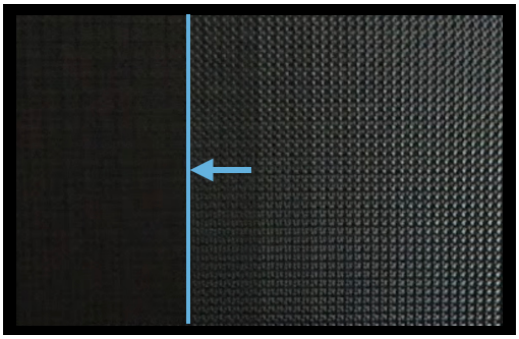
Note: Grayscale is a range of monochromatic shades from black to white. Poor gradient smoothness, or banding, can manifest as visible stripes within a gradation of shades of color.

3

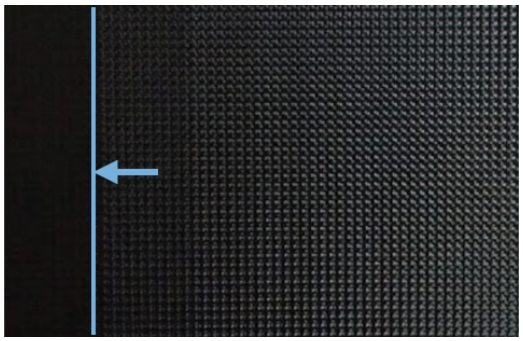
Grayscale Bit-Depth

Grayscale bit-depth dictates the number of steps that a display can produce within a range of 0-100%. In the case of an LED display, 0% is “off.” The most vital metric is the lowest threshold at which an LED actually illuminates. The sooner an LED lights up within a low-end ramp, the better the performance and image quality, especially for HDR content with details in the shadows. In photos below, an observer can see that the light output of the upper tile falls off to black much sooner than the bottom tile. The bottom tile running on HELIOS retains video information displaying closer to black, thus objectively showing that the display is yielding a better bit-depth performance than the traditional processing in the upper tile.

Traditional Processing - Does not have the ability to turn on near black pixles.



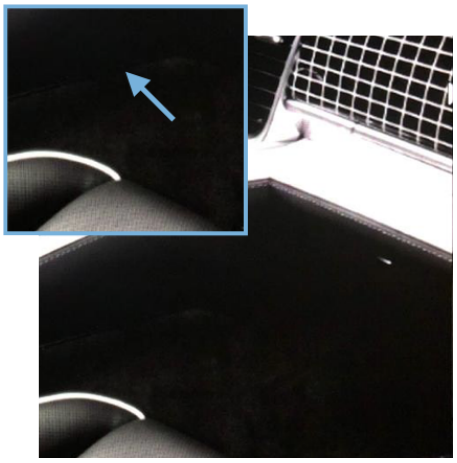
HELIOS Processing - improved greyscale.



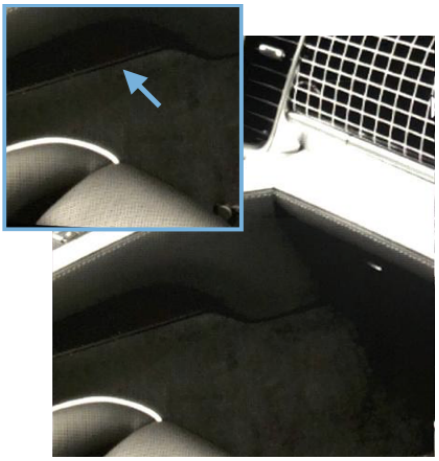
Above: untouched photographs of two different LED processing systems driving the same model display tile.

In the images seen on this page, Megapixel's HELIOS LED Processing Platform is driving the bottom tiles and a traditional processor is driving the tiles above — these are the same model tiles with the same LEDs and same driver ICs, but with a different 'receiver' card installed. Both processors were fed the same source material with all processor settings at unity. Notice that the image on the top falls off to black very quickly with almost no detail — an observer cannot see the black car's interior carpet, nor the transition to the center console.

Traditional Processing - lacks the bit-depth to reproduce the console to carpet transition of a car interior.



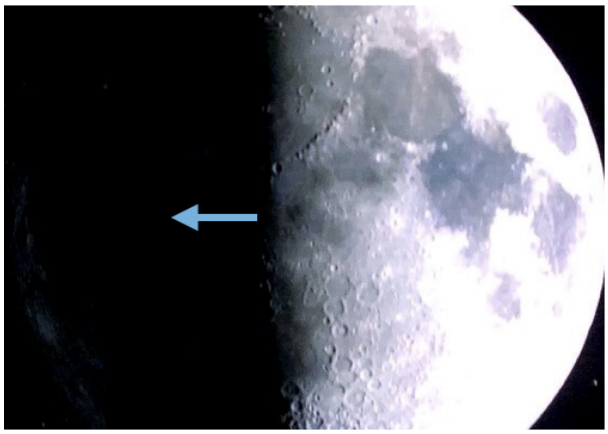
HELIOS Processing - better grayscale with HELIOS' PX1 receiver card. Clear carpet to console transition.



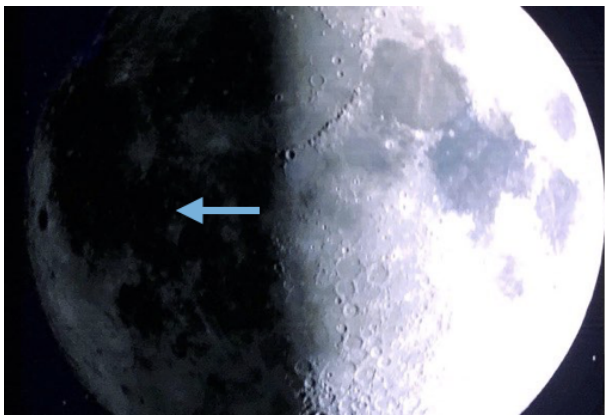
Above: untouched photographs of two different LED processing systems driving the same model display tile.

In another example, a detailed photograph of the moon is used for demonstration. Again, with HELIOS, an observer can see much more detail in the shadow portion of the moon, whereas all of this content detail is missing when utilizing a traditional LED processor.

Traditional Processing - lacks bit-depth to properly reproduce detail in the source image.



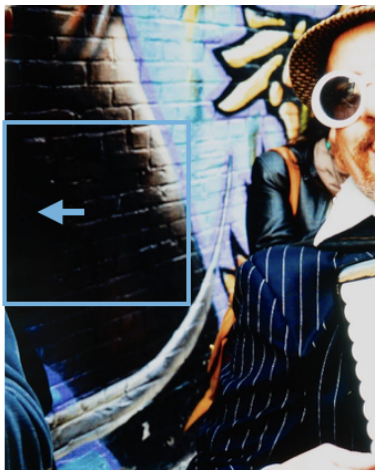
HELIOS Processing - better grayscale with detail on the dark side of the moon.



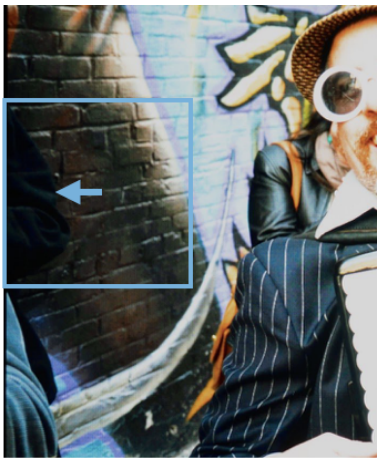
Above: untouched photographs of two different LED processing systems driving the same model display tile.

This example shows how HELIOS processing (lower image) produces more information, including subtle colors, in the brick wall and the pinstripe suit. There is also a person's elbow that is not visible at all in the top photo with traditional processing.

Traditional Processing - Lacks the depth needed to reproduce source image details.



HELIOS Processing - Better grayscale with visible elbow detail, not seen with traditional processing.

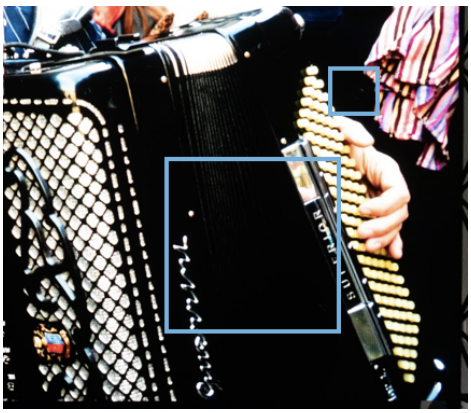


Above: untouched photographs of two different LED processing systems driving the same model display tile. (Source content courtesy of Nikon.)

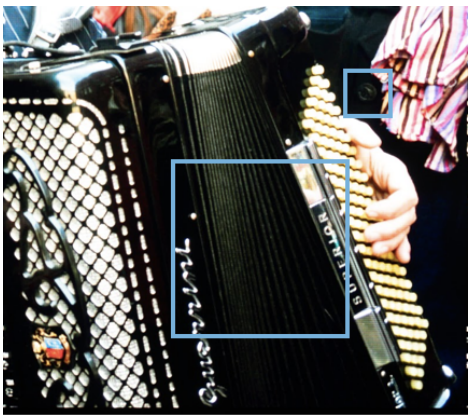
Notice the image detail HELIOS processing can reproduce in the folds of the accordion. In addition, there is a button on the coat of the accordion player visible on the HELIOS-driven image. This detail, however, is completely lost when using traditional processing.

Let's take a look at one more example. HELIOS is the first image showing a grayscale ramp of 0-32 (out of 255). You can see that the W,R,G,B gradients are visible very close to black. The second photo is another processor, and the ramp stops much sooner with very little color information near black. The same reason that the images of the moon and accordion lose detail in the shadow areas with other processing, the ramp shows you what is technically happening.

Traditional Processing - Lacks bit-depth to properly reproduce detail in the source image



HELIOS Processing -Properly reproduces the accordion details and button on coat



Above: untouched photographs of two different LED processing systems driving the same model display tile. (Source content courtesy of Nikon)

4

Gradient Smoothness

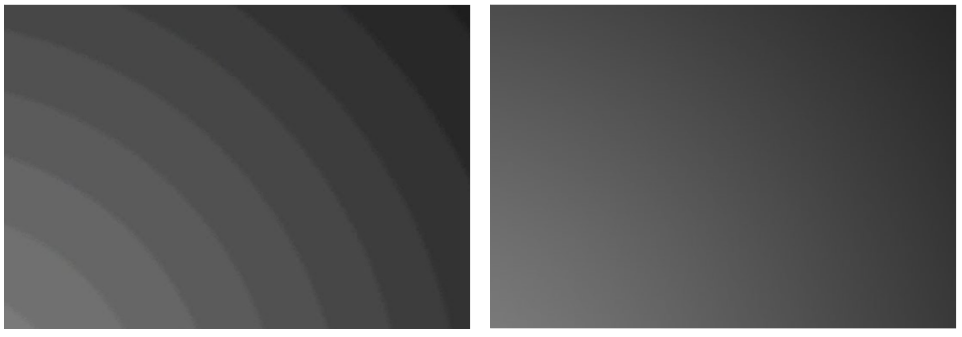
Grayscale: a range of monochromatic shades from black to white.

Poor gradient smoothness: image “banding,” or visible stripes manifesting within a gradation of shades of color.

Higher bit-depth and better low-end control of the LEDs are some of the key ingredients to superior image quality resulting in significantly improved gradient smoothness (and lack of banding). It is important to note, however, that other factors contribute to “smooth” visual grayscale performance in an image. In the extreme near-black dark portions of an image, it is inevitable to see banding, especially on an LED tile that has a high maximum luminance.

Banding is common when not enough bit-depth resolution is available in the source image or in the display device, and it can be seen throughout all brightness regions on a low quality LED display, especially when run at low luminance levels.

On the left, a source image with banding. On the right, a lack of banding due to higher bit-depth.

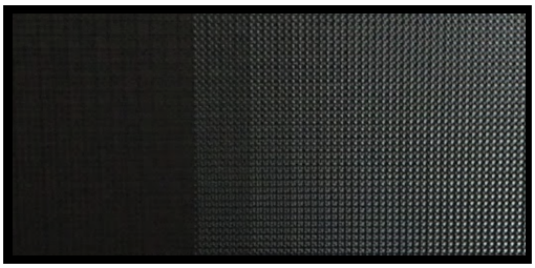


In this set of images to the below, extreme banding can be seen in the top photo, whereas a much smoother gradient image is seen below. The smooth gradient in the bottom image is not accomplished by higher bit-depth on the input or the display side. Instead, it is accomplished by strategically adding dither to the video stream.

Using this technique, dither is applied to the grayscale ramp in order to yield an observably smoother ramp from black to white. This technique is often utilized in content codecs such as Apple ProRes and Avid DNxHD.

The HELIOS Light Science algorithm increases the effective bit depth of an LED tile by injecting luma and chroma dither lower than the driver chip's quantization noise floor. By utilizing both a spacial and temporal dither, a superior image is obtained. By analyzing the signal-to-quantization noise ratio on a frame-by-frame and pixel-by-pixel basis, HELIOS processing achieves the best possible image performance regardless of a tile's dynamic range.

Traditional Processing

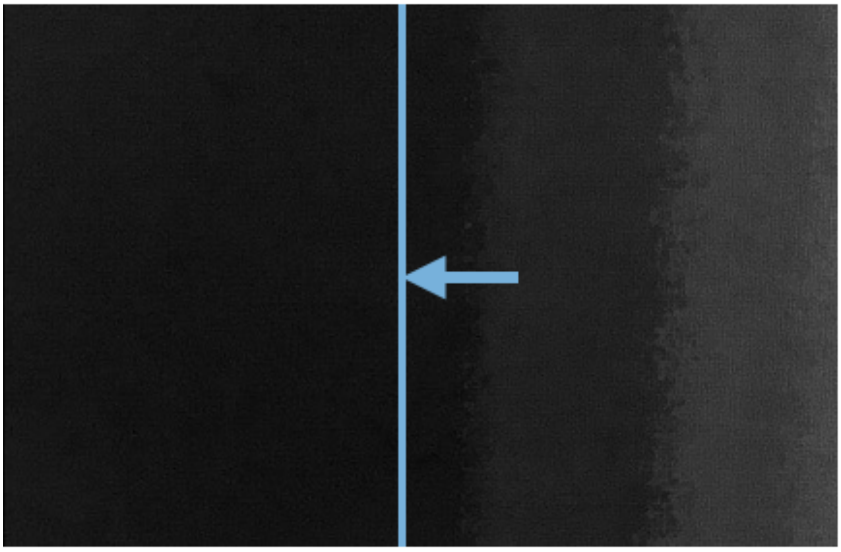


HELIOS Light Science

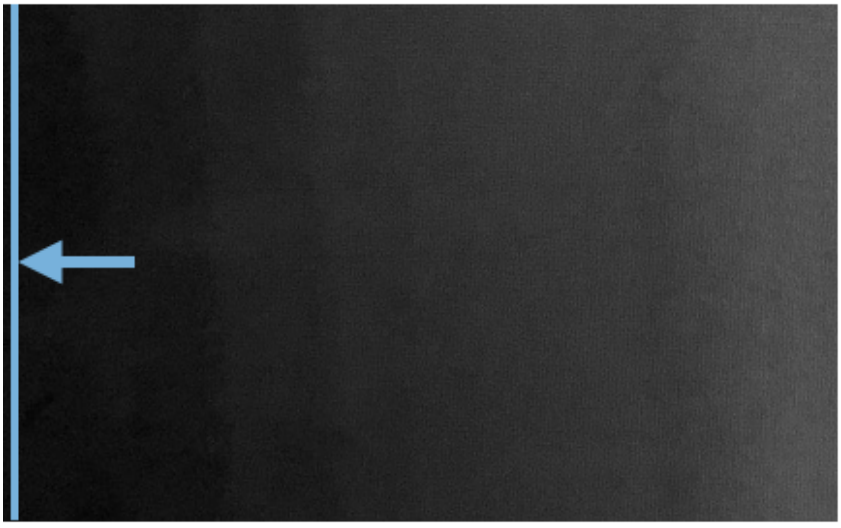
Above: untouched photographs of two different LED processing systems driving the same model display tile.

Pictured on the right is an especially difficult image to replicate. The tile is displaying a gradient from 0.0-0.1 nit in a dark environment. Note how the tile driven by traditional processing fails to reproduce the lowest bits of information, leaving more than half of the tile black.

Traditional Processing



HELIOS

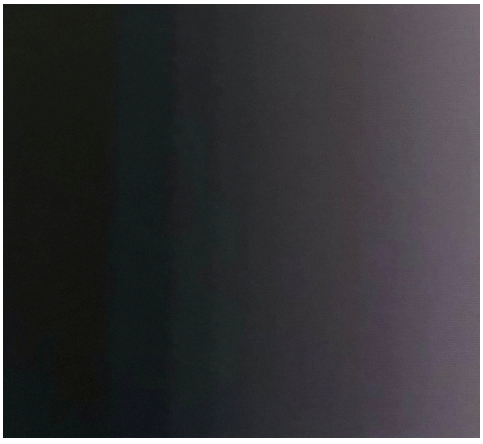


Above: untouched photographs of two different LED processing systems driving the same model display tile.

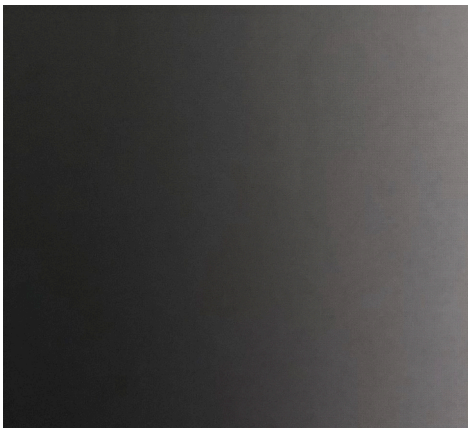
In the images below, a 0.0-1.0 nit gradient is shown. HELIOS processing, in the bottom image, has a smooth grayscale ramp while maintaining uniform color temperature. The top image, running on another system, fails to track color temperature properly (in addition to its poor grayscale performance), which results in an overall inferior image reproduction on a display.

Due to the fact that poor gamma tracking can yield differing results throughout the grayscale range of a tile, it is not uncommon for observers to say that the processing quality is poor without being able to specifically pinpoint what they feel is missing.

Traditional Processing



HELIOS



Above: untouched photographs of two different LED processing systems driving the same model display tile.

5

HDR Considerations

Previous sections demonstrate how imagery can be processed on a display device in the highest quality with the most accuracy.

Many processing and display manufacturers implement HDR by only increasing the luminance capability of a display. While this does increase a display's overall dynamic range, the near-black performance is not improved, and thus the overall image quality can in fact appear reduced. The quality gains of HDR are actually much more important for camera capture than for LED displays themselves. Looking at the images to the right, an SDR image is shown on top and an HDR image below. The HDR labeled image certainly looks more rich and "better." However, both of these images embedded in this document are actually SDR! It is the dynamic range of the system that created the image that made the difference.

So, what does this mean?

While HDR is an important feature in LED processing and display technologies, the most important attribute of a system is in fact its ability to display the source content accurately by implementing superior bit-depth, reduced banding, and accurate gamma tracking.

Images courtesy of Wikipedia

Conclusion

Advanced LED processing is about far more than simply the input resolution a processor can receive or how many pixels it can drive. Often when shopping for a display, users focus on the screen itself and neglect the critical difference that the processing can make in the image quality. Many vendors claim to have the best processing but these can often be unsubstantiated claims. It takes a critical eye, good test content, and side-by-side comparisons to truly evaluate the performance of a processing system.

Most of the differences are magnified when evaluating a display at lower brightness levels, which is how many displays are often deployed and configured for their final intended usage in the field. Evaluating grayscale bit-depth, gradient smoothness, and gamma uniformity are all critical in ensuring you have the highest quality system that can reproduce mastered content in the most accurate manner possible without banding or loss of fidelity.