MEGAPIXEL
VISUAL REALITY

HELIOS Technology Overview

Breakthroughs in LED Processing Performance

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megapixelvr.com

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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.

Components of Near-Black Video Performance

This whitepaper 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.

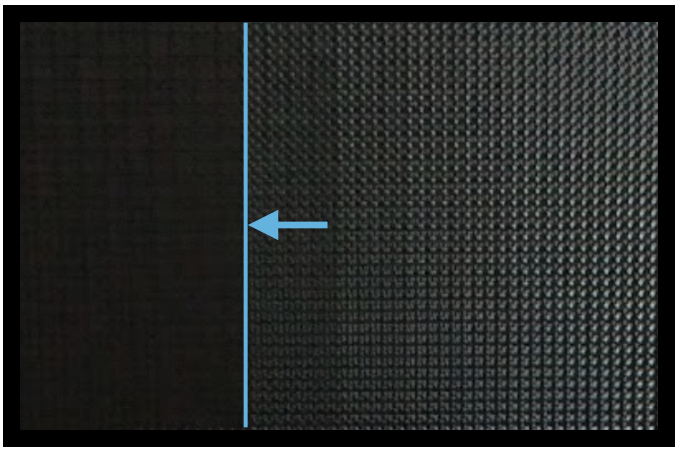
Note: **Grayscale** is a range of monochromatic shades from black to white. **Poor gradient smoothness**, or banding, can manifest as visible stripes within a gradation of shades of color.

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 to the right, 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.

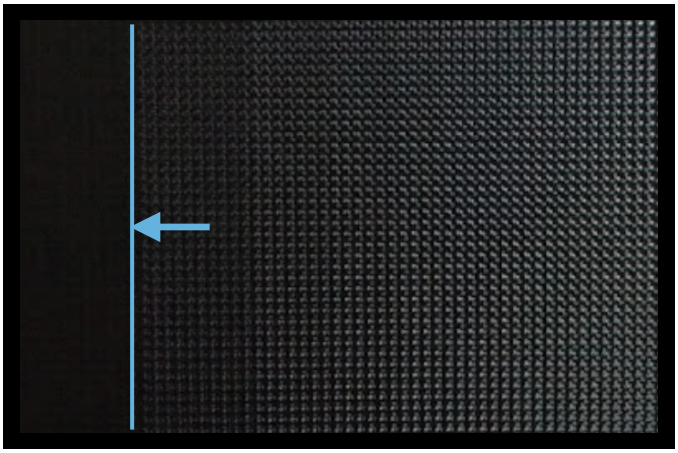
Traditional Processing

does not have the capability to turn on the near-black pixels



HELIOS

better grayscale with HELIOS

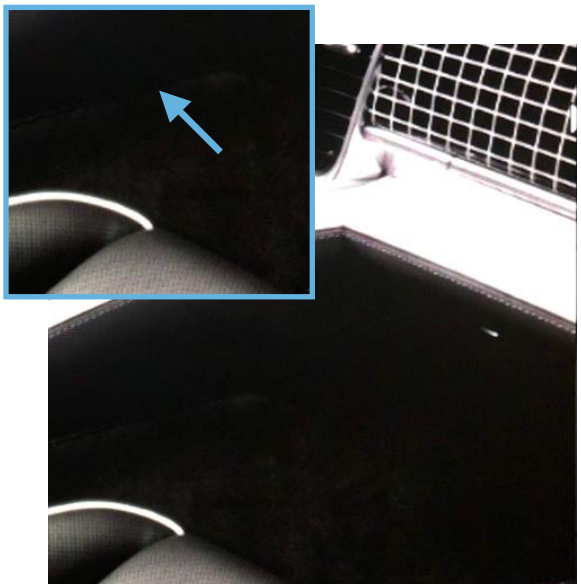


Above: untouched photographs of two different LED processing systems driving the same model display tile.

In the images seen on this page, Megapixel VR'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 interior's carpet, nor the transition to the center console.

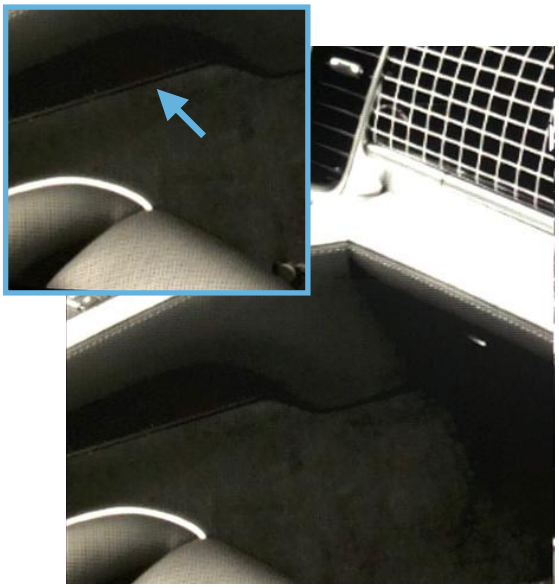
Traditional Processing

lacks bit-depth to properly reproduce console to carpet transition of car interior



HELIOS

better grayscale with HELIOS' PX1 receiver card with clear console to carpet transition

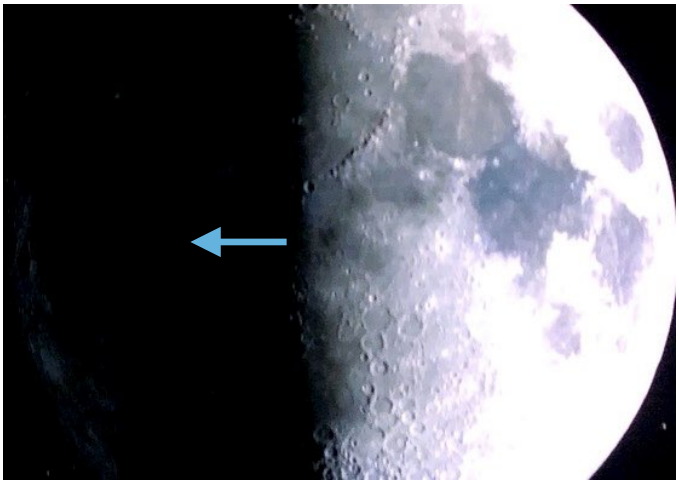


Above: untouched photographs of two different LED processing systems driving the same model display tile.

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.

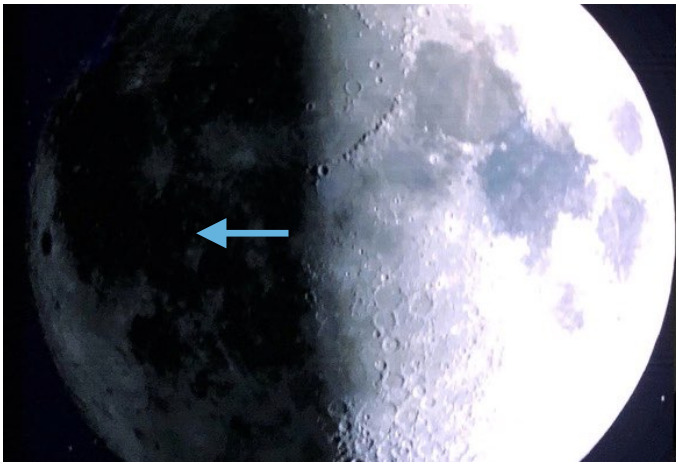
Traditional Processing

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



HELIOS

better grayscale with clear detail on the dark side of the moon

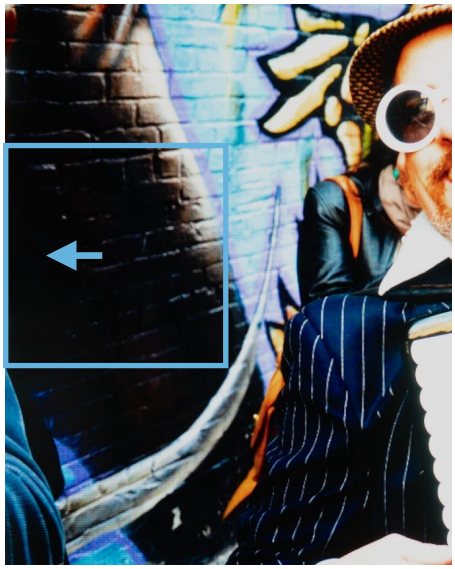


Above: untouched photographs of two different LED processing systems driving the same model display tile.

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.

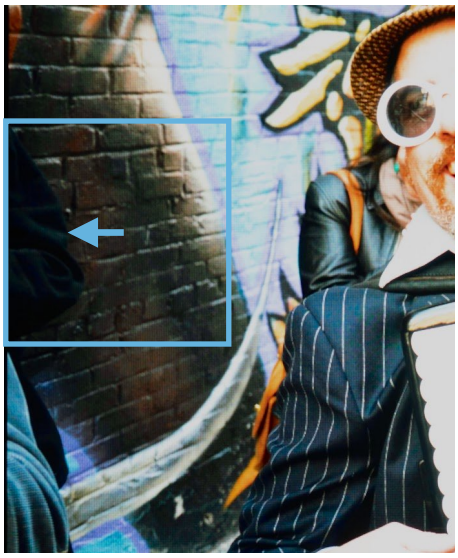
Traditional Processing

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



HELIOS

better grayscale with clear detail showing a person's elbow, which is not visible with traditional processing

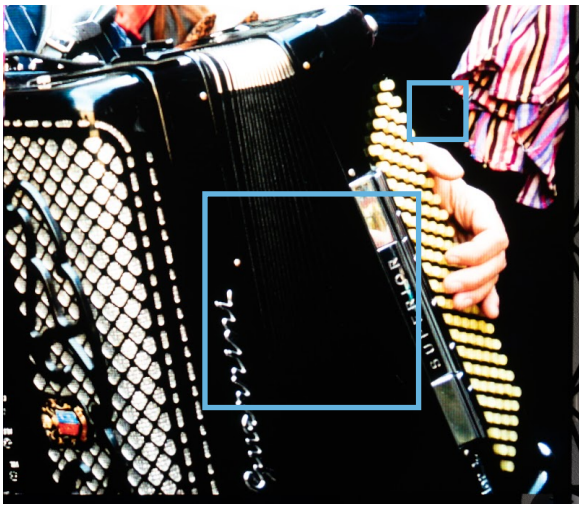


Above: untouched photographs of two different LED processing systems driving the same model display tile. (source content courtesy of Nikon)

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.

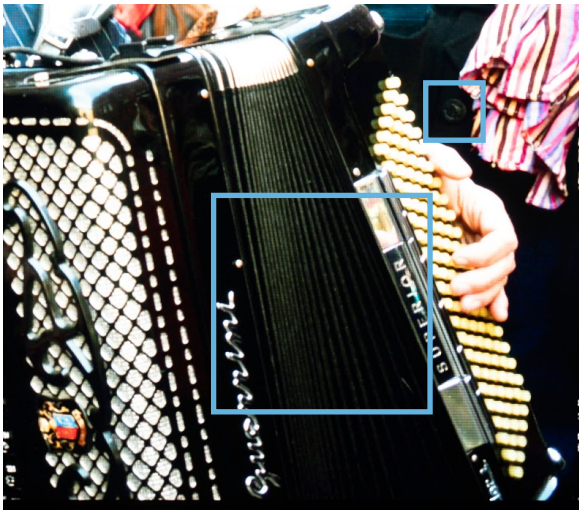
Traditional Processing

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



HELIOS

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)

Gradient Smoothness

Earlier in this whitepaper, the following terms were outlined:

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.

Example source image with banding

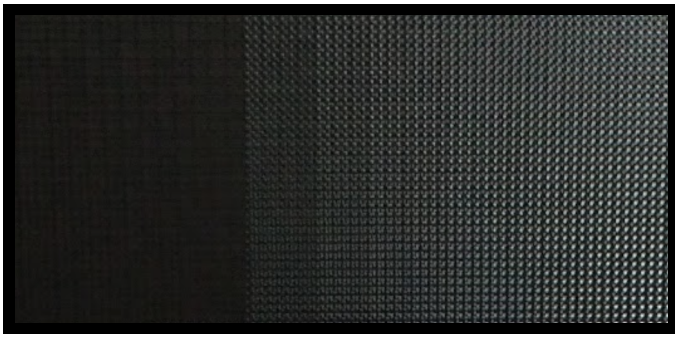
Lack of banding due to higher bit-depth

In this set of images to the right, 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, however. 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

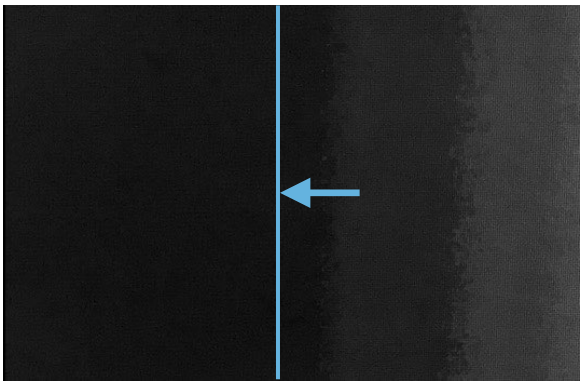


HELIOS *Light Science*

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

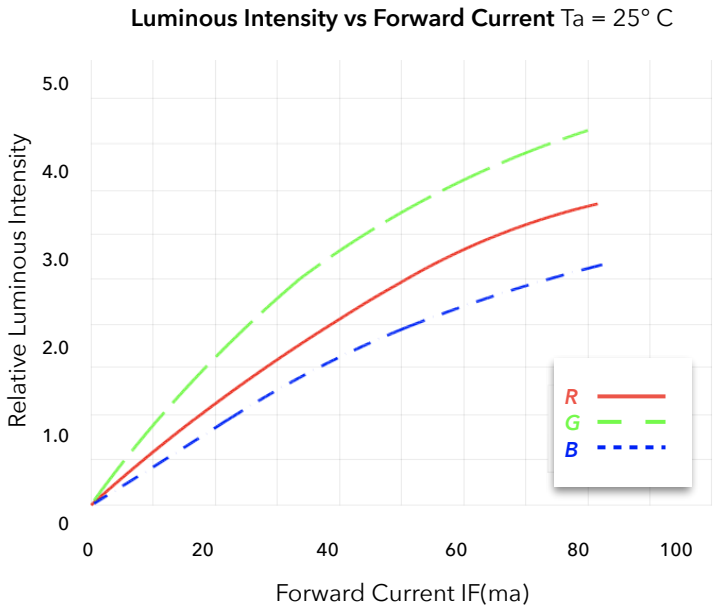
Above: untouched photographs of two different LED processing systems driving the same model display tile.

Gamma Tracking

Video systems use the concept of gamma, which helps to utilize more or less bits of data in ranges where the human perception of luminance is most sensitive. A gamma of 2.2 is common for desktop publishing, whereas 2.6 is defined for digital cinema.

Displays are typically calibrated to emit a D65 (daylight 6504 Kelvin) white point at their peak luminance. Traditional processing is then able to consistently output a pleasing white field at a high brightness with a generally acceptable picture. However, closer to the low ends of the luminance scale, LEDs behave in a non-linear fashion, which can make the output color behave unpredictably.

HELIOS and PX1 (Megapixel VR's tile-side receiver card) address this issue by utilizing sophisticated color algorithms to accurately reproduce, or track, the intended light output throughout the entire luminance range. PX1 not only tracks the proper gamma, but also dynamically readjusts parameters on a content-dependent, pixel-by-pixel basis. This results in extremely accurate color reproduction throughout the entire gamut and brightness range of the LED display, staying accurate to the input source and maintaining the artistic intent.

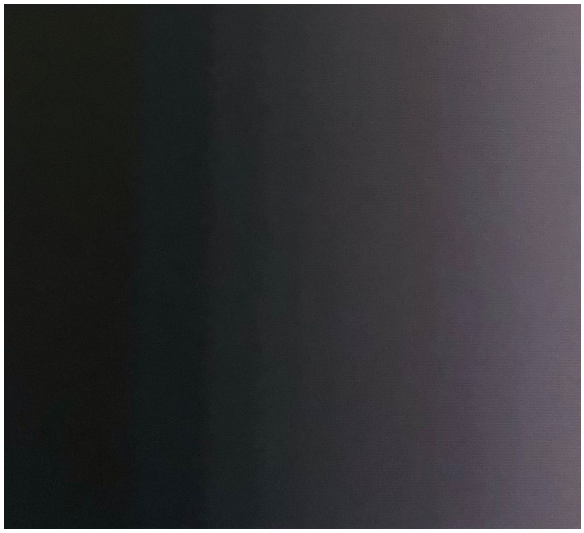


Above: graph shows how each emitter color is non-linear

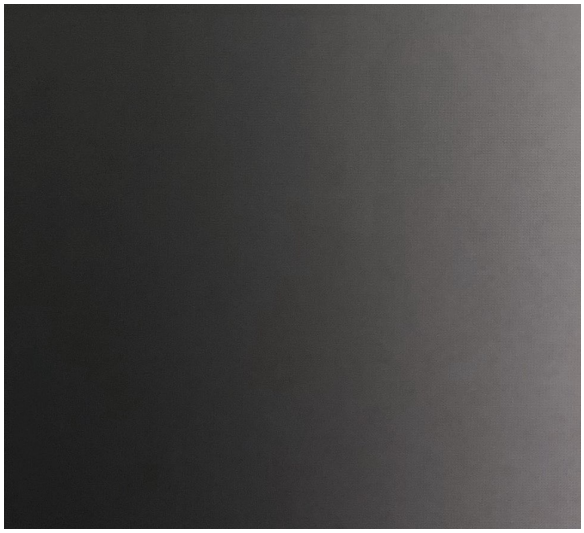
In the images to the right, a 0.0-1.0 nit gradient is shown. HELIOS processing, in the bottom image, has a smooth grayscale ramp while maintaining uniform color temperature. The top image, running on another system, fails to track color temperature properly (in addition to its poor grayscale performance),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

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.

Megapixel VR Background

Megapixel VR is an innovative technology partner dedicated to delivering fast-tracked, customized, state-of-the-art LED displays and processing to the world's leading artists and architects.

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 200 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 provide superior product design development, manufacturing expertise, and successful deployment to deliver unsurpassed visual performance for any project and look forward making the world's next iconic projects a reality.

Visit www.megapixelvr.com for more information on HELIOS.

Megapixel Visual Reality
832 N. Victory Blvd.
Burbank, CA 91502

Jeremy Hochman
CEO & Innovator
19 years experience
LED Video Design & Manufacturing

Previous
- Executive Director R&D, VER
- Director of Product Management, Barco
- Founder, Element Labs *(acquired by Barco)*

Major Product Accomplishments
- All VER / Revolution Display LED systems
- Barco C-Series
- Element Labs COBRA tile
- World's first creative mapping software (RasterMAPPER)

Keith Harrison
COO
30 years experience
LED Video Operations

Previous
- Executive Director LED, VER
- Managing Director, PSL Los Angeles
- Managing Director, Gearhouse Los Angeles

Major Project Accomplishments
- MGM Macau – Spectacular, Theater, Exterior
- Radio City Music Hall, NYC
- Coldplay "A Head Full of Dreams" Tour