TECH BRIEF

Improving Giant Screen images
Color matters

Christie® scientist Mike Perkins produced a new 3D visual space he calls "Color volume" that explains how HDR (High Dynamic Range) and WCG (Wide Color Gamut) interact synergistically to produce much better images.

In digital graphical images, all pixels can be considered to represent either a direct, diffuse or specular light source (refer to figure 1).

Figure 1: Types of pixels

- **Direct lighting** comes from actual light sources, such as the windows or lamps.
- **Diffuse lighting** are items like the paving stones where ambient light reflects in many directions giving a soft appearance.
- **Specular surfaces** such as chrome fenders or the body of a car reflect light in a directional way like a mirror, giving a hard, metallic look.

Most real-world scenes combine diffuse and specular characteristics. When a specular surface reflects light directly towards the viewer we get a "specular highlight". An example would be the white highlight in a person's eyes in good portraits – without it, their eyes look dull and boring.

The effect of HDR on color

If an image on a standard contrast display has limited brightness in those specular highlights, viewers perceive the image as somewhat "flat". But on an HDR display, the increased brightness is not used to make the bulk of the image brighter, but mainly kept in reserve to make the specular highlight areas gleam. See figures 2 and 3 to compare the localized contrast.

Rounded objects like a black car start to take on a more curved appearance, and small details like gleaming headlights and hubs become more lifelike with HDR, even though the bulk of the image is not affected or made brighter.

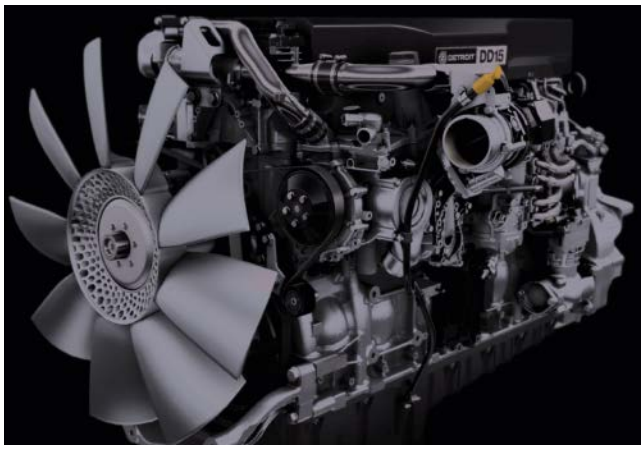

Figure 2: Image lacking specular highlights

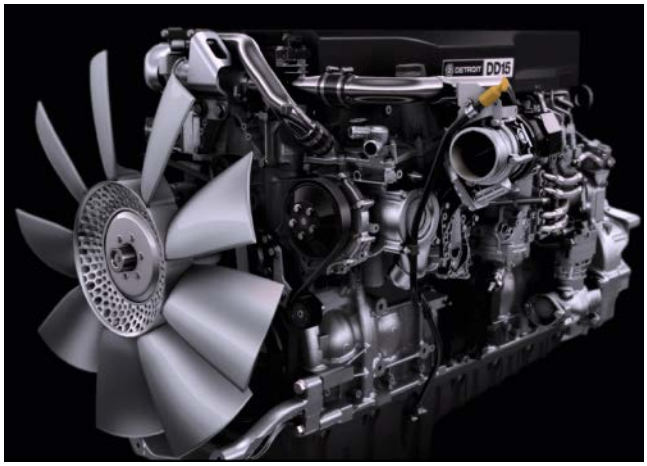

Figure 3: Tone mapped to simulate specular light

The Christie® Eclipse true HDR 4K projection system offers a contrast ratio of up to 20,000,000:1 and an expansive color gamut that approaches the full Rec. 2020 / Rec. 2100 color space.

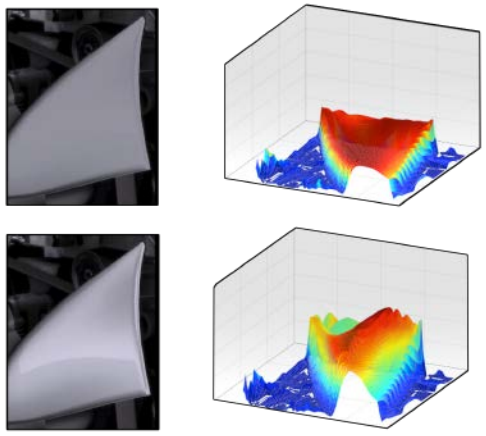

Figure 4: HDR images have complex lighting profiles

If you make a 3D plot of the luminance measured on the fan blades (figure 4) you can see that the flatter image without specular highlights has an almost flat profile but in the HDR case the subtle tones in the fan blade come out. It is the ability to reproduce these natural lighting profiles that makes HDR images so much more realistic than standard dynamic range projectors.

HDR in combination with the wider color gamut produced by RGB pure laser illuminated projectors is even more powerful.

The effect of HDR on color (continued)

The reason is that the area of the color gamut multiplied by the peak brightness gives us the total volume of colors the display can provide. Rec. 709 content is expected to be mastered to a calibrated display of 100 cd/m2 but most modern HDTV's in the home operate at signficantly more, closer to 300 cd/m2, and HDR10 displays can support peak brightness of 1000 cd/m2 or more. In Figure 5 in the 2D xy color space of CIE 1931 that does not look that impressive as the outer triangle is not that much bigger. However, if you add the third dimension of luminance and rotate that graph you can see that the total color volume displayed is much larger than Rec. 709 (Figure 6).

So really color is a three-dimensional phenomenon as the area of the color gamut multiplied by the peak brightness gives us the volume of colors the display can provide. In Figure 7 the volume of HDR10 is approximately seven times the volume of Rec. 709 color we use today in DIGSS 2.0.

The only way to accurately mimic the real world is with HDR displays that can have both higher peak brightness and wider color gamut. This is what Christie RGB pure laser projection technology with HDR capabilities (Christie Eclipse) can give you in your theater – much more accurate, real-world colors.

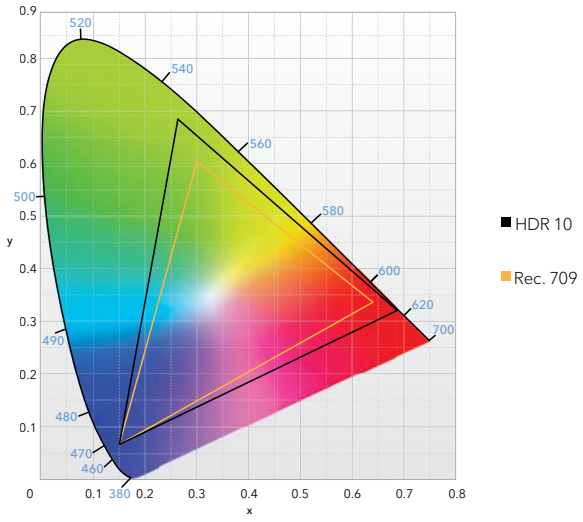

Figure 5: 2D color gamut comparison of Rec. 709 vs HDR10

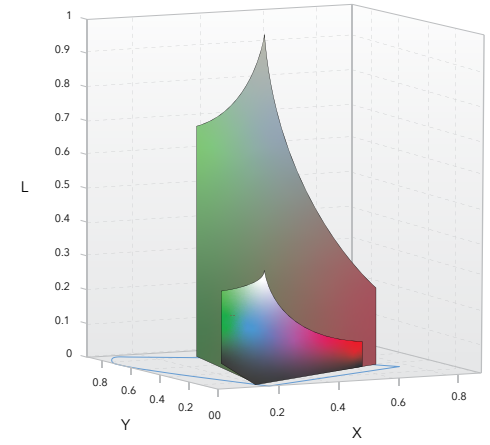

Figure 6: Adding luminance to the CIE1931 gamut reveals the much larger color volume of HDR10

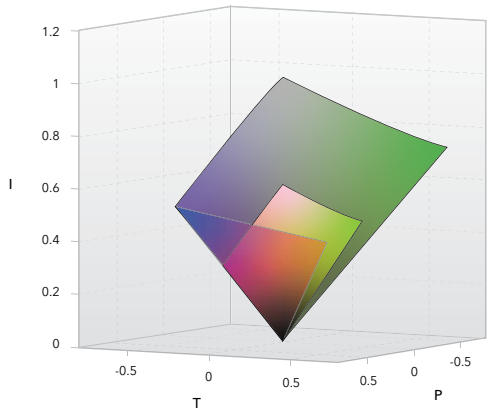

Figure 7: In IPT color space the volume of HDR10 is seven times that of Rec. 709 color

Connect with an expert

If you have additional questions, or if you need some help in selecting the right solution, please contact us. We can connect you with our team of experts who will be happy to help you work through the various steps of your evaluation and procurement process.

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